
**SCHOOL OF GRADUATE STUDIES**

# EVALUATION OF PRODUCTION AND REPRODUCTION PERFORMANCE, EGG QUALITY AND CARCASS CHARACTERSTICS OF INDIGENOUS CHICKEN UNDER TRADITIONAL MANAGEMENT SYSTEM IN KAFFA ZONE, SOUTHWESTERN ETHIOPIA

**MSc. THESIS**

**ADDISU GEBREYESUS**

**JANUARY, 2024**

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**WOLKITE UNVERSITY**

**SCHOOL OF GRADUATE STUDIES**

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**A Thesis Submitted to School of Graduate Studies, in Partial Fulfillment of the Requirements for the Degree of Masters of Science in Animal Production.**

**Addisu Gebreyesus**

**Major - Advisor: Zena Kidane (Ph.D.)**

**Co-Advisor: Wasihun Hassen (Asst.Prof.)**

**JANUARY, 2024**

**Wolkite, Ethiopia**

# WOLKITE UNIVERSITY

## SCHOOL OF GRADUATE STUDIES

We here by certify that we read and evaluated this Thesis titled" **Evaluation of Production and Reproduction Performance, Egg Quality and Carcass Characteristics of Indigenous Chicken Under Traditional Management System in Kaffa Zone, Southwestern Ethiopia''** prepared under our guidance by Addisu Gebreyesus Addo. We recommend that the Thesis shall be submitted as fulfilling the requirements for the award of a MSc. degree in Animal **Science.**

**Zena Kidane (PhD)** _____ _____

**Name of major advisor** **Signature** **Date**

**Wasihun Hassen (Asst.Prof.)** _____ _____

**Name of co-advisor** **Signature** **Date**

As member of the Board of Examiners of the Master of science Thesis open defense examination, we have read evaluated this thesis prepared by Addisu Gebreyesus and examined the candidate. We here by certify that, the thesis is accepted for fulfilling the requirements for the award of the degree of Master of Science (MSc.) in Animal Science.

**1. Yosef Tadesse (PhD)** _____ _____

**Name of external examiner** **Signature** **Date**

**2. Shiferaw Mulugeta (Asst.Prof.)** _____ _____

**Name of internal examiner** **Signature** **Date**

**3. Tesfaye Feyisa (PhD)** _____ _____

**Name of chairman** **Signature** **Date**

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# DEDICATION

This thesis work is dedicated to the Almighty God, who gave me all the strength and courage.

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Name: Addisu Gebreyesus Signature: _____

Date: _____

School/Department: **Animal Science**

# BIOGRAPHICAL SKETCH

The author was born on August 20 1981 in kaffa zone of South west Ethiopia peoples Regional State Gimbo district Bita-chega Kebele. He attended his elementary school at Birbira elementary school and then he attended his junior secondary school at Wush-wush junior school. Then he attended his senior Secondary High School at the previously Bonga Secondary school (currently Bishaw woldyohanis Secondary school). After successfully passing Ethiopian School Leaving Certificate Examination (ESLCE) in 2001, he joined Alage Agricultural TVET College in 2002 and awarded Diploma in Animal production on August 2004.

Soon after his graduation, he was employed at kaffa Zone Chena district Agricultural Development Office and serves as development agent, supervision and Kebele Agricultural officer, from September 2004 to August, 2009. Then he joined Mizan-Tepi University from 2010 to 2014 and awarded B.Sc. in Animal production. Then from 2015-2016 he served as animal production expert, extension group team leader and office leader position. From September 2017-2020 he served as Kaffa zone Livestock and Fish Resource Development Unit expert. Then in 2021, he joined Wolkite University, School of graduate studies to pursue Master of Science in Animal Production.

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# LIST OF ABBREVIATIONS AND ACCRONOMYS

| | |
|---|---|
| AgEc | Agro-Ecology |
| AH | Albumen Height |
| Al.wt | Albumen Weight |
| ANOVA | Analysis of Variance |
| CSA | Central Statistics Agency |
| CV | Coefficient of Variances |
| E.C. | Ethiopian Calendar |
| EEA | Ethiopian Economic Associations |
| EW | Egg Weight |
| FAO | Food and Agricultural Organization |
| H/rs | Hectares |
| HHs | Households |
| HL | Highland |
| HU | High Unit |
| ILRI | International Livestock Research Institute |
| KZAO | Kafa Zone Administration Office |
| LL | Lowland |
| LSD | Least Significance Differences |
| M.a.s.l. | Meters Above Sea Level |
| ML | Mid-Land |
| SD | Standard Deviations |
| SE | Standard Error |
| SNNPRS | South Nation Nationalities Peoples Regional States. |
| SPSS | Statistical Package for Social Science |
| SWEPRS | South West Ethiopia Peoples Regional State |
| TVET | Technical Vocational Educational Training |
| Y.wt | Yolk Weight |
| YC | Yolk Color |
| Y.h | Yolk Height |

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# ABSTRACT

*The study was conducted in three purposively selected districts of Kaffa Zone in South Western Ethiopia People's Regional State with the objective of evaluating production and reproduction performances, egg quality traits and carcass characteristics of local chickens reared under traditional production method. Total of two hundred fifty-five (255) households were selected purposively from nine kebeles of different agro-ecology in the districts by the agriculture and natural resource office, development agents and kebele committees based on potentails for indigenous chicken's populations, production experiences, accessibility and representativeness of the area.*

*Three kebeles from each district of the each agro-ecology types were selected based on altitude levels, presences of indigenous chickens' and the experience of chicken production selected by district agriculture and natural resource office experts, kebele Development agents and by kebele representatives'. And the proportion of HH number was determined by the number of populations with in the specific sampling area and interviewed using semi-structured questionnaires. Total of two hundred seventy (270) fresh eggs were collected from each kebeles of every agro-ecology types. Total of eighteen (18) representative indigenous chickens (9 male and 9 female) and three (3) male and three (3) female chickens per district were used for carcass yield evaluation.*

*The results shown flock size per household was 10.72 with 1:2.3 cocks to hen ratio. The mean age of cockerel at first mating and pullet at first egg laying in the study area (Chena, Bita and Cheta) and agro-ecology (high-land, mid-land and low-land) were (5.63 and 6.35) and (5.51 and 5.92) months, respectively. The average number of eggs per clutch and the annual egg production per year in the study area and agro-ecologies (high-land, mid-land and low-land) were (13.83 and 47.6,) and (13.9 and 45.83), respectively. The mean number of eggs incubated, hatchability and survivability in the study districts (Chena, Bita and Cheta) were (11.62, 80.3% and 64.8%) and agro-ecologies (high-land, mid-land and low-land) were (11.61, 9.4 and 80.82%), respectively.*

*The study outcomes of the areas shown variations in production and reproduction performances, egg quality traits and carcass characteristics among the studied*

*districts and agro-ecologies. Indigenous chickens generally can best fit with low management inputs under scavenging production systems in terms of their productive and reproductive performances. Therefore, additional studies should be conducted to assess more about the effects of different agro-ecologies and districts on indigenous chickens under scavenging production system which were not covered in this study.*

***Key words:*** *Agro-ecology, Carcass yield, Districts, Egg quality, Indigenous chicken, Traditional production.*

# 1. INTRODUCTION

## 1.1. Background of the study

Poultry includes all home birds reared to human food (meat and eggs) production including chickens, ostrich, guinea fowl, ducks, doves and pigeons. Poultry includes all home birds reared to human food (meat and eggs) production including chickens, ostrich, guinea fowl, ducks, doves and pigeons. Domestic chickens are the most common birds in the world. All over the world, more than 300 varieties of the domestic chicken species (*Gallus domesticus*) are present. Domestic chickens are the most common birds in the world, (CSA, 2020).

Ethiopia is naturally endowed with different agro-ecological zones, appropriate environmental conditions, for livestock production and is home to many livestock species (CSA, 2021). Chicken production is one of the vital livestock subsectors in Ethiopia. It operates significant shares in terms of creating employment opportunities, refining household nutrition, and empowering women (FAO, 2019). An estimate shows that the country is home to about 57.01 million chickens (CSA, 2021). By these numbers, poultry is ranked second next to cattle. The Ethiopian chicken population is almost entirely composed of local chickens. Chickens comprise cocks, cockerels, pullets, laying hens, non-laying hens, and chicks. Recent estimates showed that 78.85%, 12.02%, and 9.11% are indigenous, hybrids, and exotic poultry, respectively (CSA, 2021). It is an appropriate business for poor households due to the small amount of land required and the low investment expenses required to start up and route the operation. Also, their production has important economic, social, and cultural benefits and plays a significant role in family nutrition in developing countries (FAO, 2019).

Ethiopia has approximately 60% of the total chicken population of East Africa, which comprises local, exotic, and hybrid chicken varieties (Fuals et al., 2018). The highest percentage of chicken comprises of laying hens (34.26%), followed by chicks (32.86%). Pullets, Cocks, cockerels and non-laying hens are accounts for 11.36%, 11.2%, 5.74%, and 4.59% of the country's total poultry population (CSA, 2021). The average number of birds kept by rural households is five or six (Bushra, 2012). Ethiopian households own poultry holdings of variable size. However, approximately 80 per cent of households with poultry keep 1 to 9 chickens. The sector is indeed

dominated by the indigenous breed, extensive scavenging and small extensive scavenging family poultry production systems (FAO, 2019; CSA 2020).

Indigenous chickens are hard egg shells, high fertility, hatchability and high dressing percentage. The mean annual egg production is assumed to be 60 small- size eggs per year with a thick shell and deep yellow yolk color. External and internal egg quality characters are the determinant features for the embryonic growth of an egg and finally for the capability of the new emerged chicks. In addition, certain egg quality characters like egg shell thickness and strength are important to handle the egg while transportation from place to place and to consumption (Fisseha *et al.*, 2010).

The overall egg quality can be determined under two broad categories, namely, external and internal quality (Monira *et al.,* 2003). The external egg quality is determined by egg weight, egg width, and egg length (Bain, 2005). The internal quality is measured based on the quality of the albumen as indicated by the Haugh units (HU), the relative size of the various internal components such as weight of yolk, yolk color and the integrity of the shell membrane. Several studies have examined egg quality in chickens (Ahmedin, *et al.* 2016; Yonas *et al.,* 2019; Aberra 2019; Welelaw E. *et al*. 2018). In addition, the type of incubation influences the hatchability of eggs and the production of viable chicks. Most farmers in Ethiopia hatch their eggs by a natural incubation method using broody hens to incubate eggs and rear chicks (Addisu *et al.,* 2013). Different studies have been performed on the egg quality, fertility and hatchability of local chickens. Additional egg quality characteristics like yolk color have an important effect on the egg market (Dana *et al*., 2010; Fisseha *et al*., 2010). Moreover, certain egg quality traits like egg shell thickness are very important to carry the egg during transportation from time of layinguptoconsumption (Melesse *et al*. 2005).

### 1..2. Statement of the problem

Indigenous chickens have been mainly kept by the rural poor farmers due to their significance for the source of animal protein, generation of extra cash incomes and religious /cultural importance. Different research scholars' indicated indigenous chicken breeds are known by their fair productive, reproductive performances and best fit ability with little inputs, poor management and traditional production systems. Currently zonal and district report shown that there are large number of indigenous

chicken population kept in study area. But due to lack of sufficient and consistent study information on the effects of different districts and agro-ecologies on the production and reproduction performance, egg quality traits and carcass yield potentails of indigenous chickens in the study areas, the contributions of traditional chicken production in terms of production and reproduction performances, egg quality traits and carcass yield potentails to the community is very low. Therefore, the present study was conducted with the following objectives:

## 1.3. General objectives

- To Assess the Production, Reproduction Performances and Egg quality traits of Indigenous Chickens under Traditional Production System in different Districts and Agro-Ecologies of Kaffa zone.

### 1.3.1 Specific objectives

- To assess the effects of districts and agro-ecology on Production performances of indigenous chickens in the study area.
- To assess the effects of districts and agro-ecology on Reproduction performances of indigenous chickens in the study area.
- To determine the effects of districts and agro-ecology on external and internal egg quality traits in the study area.
- To evaluate the effects of districts and agro-ecology on carcass characteristics of indigenous chickens in the study area.

# 2. LITERATURE REVIEW

## 2.1. Indigenous Chicken production

Chickens are the most popular poultry worldwide irrespective of culture and religions. The current state of knowledge on indigenous chicken genetic resources of the tropics: domestication, distribution and documentation of information on the genetic resource, (Mahendra, 2016). In Ethiopia a huge number of indigenous chickens distributed across diverse agro ecological zones under a traditional family-based scavenging management system (Getachew, 2016). Traditional chicken production in Ethiopia characterizes an important part of the national economy in general and the rural economy in specific, and contributes 83.5% of the national egg and meat products (CSA, 2016).

Indigenous chickens are known for their difference in color, comb type, body conformation, inherent scavenging, nesting habit, and adaptation ability to the harsh environment. There are about ten ecotypes of indigenous chickens available in the country, namely, Chefe and Gebsima (barley plumage color indigenous ecotypes); Horro, Jarso, and Keyi (red plumage color and barley plumage color); Naked Neck and Netch (white plumage color); Tepi and Tikur (black plumage color); and Tilili (ILRI, 2016). Moreover, there are several ecotypes like white-barley, golden-red, black-tailed white, silver and buff/yellow ecotypes, (Bayesa, 2021**)**.

More than 80% of the world chicken production is in village production system contributing up to 90% of chicken products in some developing countries. Village poultry makes a substantial contribution to household food security throughout the developing world. It supports to diversify income, provides high quality food and fertilizer, and acts as form of household savings and insurance (Besbes, 2009). The purpose of keeping chickens in tropics varies from region to region and from community to community within a region. In these regions small land holders keep chickens for their socio-religious functions. This is because the commitment of an individual/community to a particular spiritual being, deity or season, traditional and religious holidays is evaluated by the quality of the contribution that satisfies special morphological features of the chicken demanded by the receiver (Tadele *et al*., 2012). Regardless of low output from native chicken in the tropics they can thrive and produce with irregular supply of feed and water and with minimum healthcare. They are part of balanced farming system and have vital roles in the rural households as a source of

high-quality animal protein and emergency cash income and play a significant role in the socio-cultural life of the rural community (Yonas, 2019).

Though, indigenous chickens are slow grower and poor layers of small sized eggs, they are, however, ideal mothers and good sitter's excellent foragers, and hardy and possess natural immunity against common diseases. The small body size of indigenous chickens is a desirable character in tropical and subtropical environment. One of the most important positive characters of native chickens is their hardiness, which is ability to tolerate the harsh environmental condition and poor husbandry practices without much loss in production (Tadele *et al*., 2011). They play significant roles in rural economies in most of developing and underdeveloped countries of rural poor and marginalized sector of the people with respect to their subsidiary revenue and also afford them with nutritious chicken egg and meat for their own consumption, (Mahendra, 2016).

Poultry are generally maintained by rural women and children that generate cash revenue and that supply sufficient eggs and meat to their individual family's diet. Chickens mostly scavenge around the homestead areas during day time, where they eat kitchen waste, left over cereal like rice, pulses, wheat, insects, green grass, and other available feed stuff. These waste feedstuffs are utilized by these native chickens to produce a good quality, cheap source of animal protein (Tadele *et al*., 2011). In scavenging chicken production system, more than 90% of the national poultry, egg and meat output is from local poultry (Chaimiso 2018). In Ethiopia, chicken added significant socio-economic impacts on food security, generating income, and religious and other purposes (Gulilat *et al*. 2021). Poultry production in Ethiopia has a significant role in the country's economy, representing 98.5% and 99.2%, respectively, of chicken egg and meat production (Rajkumar *et al*. 2019).

## 2.2. Flock Distribution and Composition

The flock composition of hens was the most abundant followed by young chicks along with small number of cocks and cockerels (Moreda *et al*., 2013). In Ethiopia, the number of chicken flocks per household in most rural households was small; constituting an average of 7–10 mature chicken, 2–4 adult hens, a male bird (cock) and a number of growers of different ages (Tadelle *et al*. 2001). This might be due to low culling rate of aged hens and high occurrence of disease and predators in the area as chicks are more susceptible than the other age groups. In addition to this, large proportion of hens in the flock might justify the need of households to increase egg production by increasing the number of hens in the flock (Moreda *et al*., 2013). The report of average cock to hen ratio was 1:2.9; however, it was higher than the value reported in southern Ethiopia (Nebiyu *et al*., 2013). The average chicken flock size per household was 4.85 in southwest and southern parts of the country, (Moreda *et al*., 2013). The flock size observed in Sheko district (9.2) was lower than the flock size in south bench and north bench (11.5 and 10.4) districts of Bench Sheko Zone SouthWest Ethiopia, (Welelaw *et al*., 2018). The variation in flock size in different districts might be attributed to the difference in the availability of scavengable feed resources; chicken management and flock off take rate, (Fisseha *et al*., 2010). The same report by several writers for average flock size were like (Azage *et al*. 2010) reported,13 and 12 in Bure and Fogera woreda, (Melese, 2014) reported 13 chickens in East Gojjam zone of Ethiopia, and (Taju, 2017) presented 10.28 of chicken per households respectively.

## 2.3. Productive performances of indigenous chicken

The productive performance of indigenous chickens, which includes clutch number, average number of eggs laid per clutch, average days per clutch, average number of eggs per hen per year, slaughter age and weight of chickens. The national average clutch number of Ethiopia indigenous chicken was 4 per year. The average number of clutches per year recorded from the Gomma Wereda was 3.43 (Meseret, 2010). The average clutch number of indigenous chickens in North Wollo of Amhara region was 3.62 per year reported by, (Addisu *et al*., and 2013). The mean clutch number of indigenous chickens in Bench-maji Zone Southwest Ethiopia was 3.74 per year by (Welelaw E. *et al*. 2018). This result shown that the national average clutch number was higher than the findings of the rest researchers. Clutch number also had very

significant influence on average egg production/hen/clutch. (Bogale 2008) reported a hen lay about 36 eggs in three clutches and 12 to 13 eggs per each clutch per year.

The average eggs laid/clutch/hens are 16.88, 14.23 and 11.9 eggs for Quara, Alefa and Tach Armachiho districts, respectively (Addisu *et al* 2013). Numbers of eggs per clutch per hen per year for indigenous chicken were 11(Habte *et al* 2013). According to (Alem, 2014) findings the mean number of eggs laid per hen per clutch was 13.6 for local hens and ranged from 9 to 18 eggs, in lowland and midland agro ecological zones of central Tigray, in northern Ethiopia. (Fisseha *et al* 2010) reported that the average number of eggs/hens per clutch is 15.7, 13.2 and 4.9 in Bure, Fogera and Dale Woreda, respectively. According to a report by (CSA, 2016) as cited by Welelaw E. *et al*. 2018), an indigenous chicken in Ethiopia produces 12 eggs per clutch. On the other hand 14.3 small eggs per clutch in Mezhenger, Sheka and Bench-Maji zones of south western Ethiopia, the review of (Welelaw E. *et al*. 2018). The average clutch length (days) of indigenous chicken was 20 days in kafa zone southwest Ethiopia by, (Abiyu T. 2019). Similarly the average clutch length of indigenous chicken was 23.3 days in west Amhara reported by (Worku *et al.*2012).

According to (Melkamu, 2014) an average of 65 eggs is laid per hen per year. Indigenous chickens, have low productivity average yearly egg production is predictable at 60 eggs (average 38 g). According to (Kidane 1980) report the average annual egg production potential of indigenous chicken at Wolita agricultural development unit was ranged from 30-60 eggs under village free range production systems. (FAO, 2004) stated, the mean egg production of local chicken was 34 eggs per year under village condition annually. Likewise, At Asela, (Brannang and Pearson 1990) discovered that the average egg production of local chickens was 34 eggs/hen/year with average egg weight of 38g.. The mean annual egg production of indigenous chicken was 54.6 (Fisseha *et al*., 2010).

The age of pullets at first egg laying in South bench, Sheko and North bench were 6.6, 6.6 and 6 months (Welelaw. *et al*. 2018). The report of (Getachew, 2016) indicates the average age at first laying pullets of village chicken ranges from 5.82 to 5.92 months conducted in Bench Maji Zone, South Western Ethiopia. This is shorter than the report of (Mekonnen 2007) age at first egg of 7.07 months from indigenous pullets of Dale woreda the value of which is longer than that of the Gomma Woreda of Jimma by 0.73

months (Meseret, 2010). In North West Ethiopia 31.92 % of the pullets reached maturity at 28 weeks late sexual maturity. In Mid-rift valley of Ethiopia, the age at first egg is 6-7 months indicating late maturity (Halima, 2007). According to (Alem, 2014) Average age at first egg was 27.2 weeks for indigenous breeds ranged from 24 to 28 weeks. The average egg weight of indigenous chickens around Arsi district, Ethiopia, was 38 g (Kassa *et al*., 2021) and the average egg weight of 42 g for naked-neck chicks was reported by (Kemal,2016).

### 2.3.1. Carcass yields of indigenous chicken breeds

The average live weights of matured male chicken were 1449g in southern Ethiopia (Melesse, 2011). The average carcass yields (weight) of indigenous chicken were 996g in Benchmaji Zone Southwest Ethiopia. The average dressing percentage of local chickens was 66.7% in Bench maji Zone southwest Ethiopia. On the other hand in most carcass characters of chickens reared in Sheko (1056g) district had higher masses of carcass constituents than chickens reared in South Bench (897g) and North Benchs (947g) in Bench maji zone Southwest Ethiopia, (Welelaw *et al*., 2018). The average dressing percentage of Koekoek chickens ranging from 59-63.3% were reported by (Melesse *et al.,* 2013).

### 2.3.2 Egg quality traits of indigenous chicken breeds

#### 2.3.2.1. External egg quality traits

The mean egg weight of 43.9 g was reported by, (Welelaw E. *et al*. 2018) in Bench maji zone Southwest Ethiopia. The egg weight value of 41.1 g for indigenous chicken in western Shewa zone of Oromia region, were reported by (Getachew *et al*., 2016). This could be attributed to the type of chicken ecotype, feed availability and the agro-ecological differences of the study sites. The average egg width, egg length and shape index in South-bench, Sheko and North bench were 52.1 mm 37.8 mm and with 72.7% (Welelaw E. *et al*. 2018). The average egg weight of local chickens around Arsi district Ethiopia, was 38 g (Kassa *et al*., 2021) and the average egg weight of 42 g for naked-neck chicks was reported by (Kamel, 2016).

Eggs from Sheko district were significantly higher in egg length (57.1mm) than those of the two districts (Sheko district, 57.1 mm, South Bench, 53.6 mm and North Bench, 50.9 mm). Eggs from Sheko (57.1 mm) district were significantly higher in egg length,

than those of the two districts (South Bench, 53.6 mm and North Bench, 50.9 mm). Eggs from Sheko (39.3mm) district were significantly higher in egg width than those of the two districts South Bench 36.9mm and North Bench 37.2mm (Welelaw E. *et al.* 2018). The mean egg length reported by (Tesfahun K. *et at*.2019) for local chickens in Metekel zone Amhara region were 52.8mm. The report of (Kgwatalala *et al*. 2016) mean egg length for normal strains of Tswana indigenous chickens of Botswana was 5.31cm, respectively. The average egg width of indigenous chickens was 38.8mm in different districts of Bench maji zone Southwest Ethiopia, reported by (Welelaw E. *et al.* 2018). Similarly the average egg width of local chicken reared in Metekel zone Ethiopia was 39.2mm reported by (Tesfahun K. *et at*.2019).

Eggs from South Bench were higher in shell thickness (0.34mm) than Sheko (0.31mm), and North bench (0.33mm), respectively, The average egg shell thickness reported by Welelaw E. *et al.* 2018) was 0.31 in Bench Maji Zone Southwest Ethiopia which is comparable with the average shell thickness reported by (Desalew *et al*., 2015) in East Shewa, Ethiopia. These variations in shell thickness among the indigenous chicken ecotypes reared in various parts of the country might be due to the availability of mineral calcium in the feed material, type of management and type of chicken breeds. On the other hand eggs from South Bench were lower in shape index (71.5%) than Sheko (73.3%) and North Bench (73.3%) respectively.

#### 2.3.2.2. Internal Egg Quality traits

The mean yolk color in Chelliya District Western Shewa, Ethiopia was 10.9 (Getachew et al., 2016). High value of yolk color in many places in the country might be attributed to the quality and availability of greenish scavengable feeds in the free-range production system. It is generally assumed that since indigenous chickens get their feed merely by scavenging their eggs comprise considerable quantities of xanthophyll, which is accountable for deep yellow color of the yolk (Melesse *et al*. 2010). Eggs from North Bench (13.9mm) district were significantly lower in yolk height than those of the two districts (South Bench 14.1mm, and Sheko 14.1mm), (Welelaw E. *et al*. 2018). However, (Melesse *et al*. 2010) reported higher (16.9 mm) yolk height in eggs of naked neck indigenous chicken. (Meseret (2010) reported 11 mm yolk height for fresh eggs and 9.1 for market purchased eggs, which are lower than the results of (Welelaw E. *et al*., 2018).

Eggs from North Bench were better in albumen height (South bench, 3.3mm, Sheko, 3.4mm and North bench, 3.6 mm) and HU (South bench, 59.5, Sheko, 60.7and North

bench, 63.4) but lower in yolk weight (South bench, 15.1g, Sheko, 15.3g and North bench, 14.8 g) and yolk color (South bench, 11.2, Sheko, 11.1and North bench, 10.3). These variations might arise from differences in nutrient composition of the existing feed resources, culling exercise, egg handling, and storage systems. Eggs from South Bench were higher in shell thickness (South bench, 0.34mm, Sheko, 0.31mm and North bench, 0.33mm), while low in shape index (South Bench, 71.5%, Sheko, 73.3% and North Bench, 73.3%) (Welelaw E. *et al*., 2018).

### 2.4. Reproductive Performances of Indigenous chicken

Average number of eggs incubated and hatchability percentage in Halaba District of Southern Ethiopia were 11.8% and 82.2% as reported by (Nebiyu *et al*. 2013). The average number of eggs incubated per broody hen and hatchability in Gena Bossa District of Dawro Zone, were 12.7 and 81.72% (Matawork *et al*., 2018). The hatchability of the egg was 82.6, 78.9 and 89.1% at Bure, Fogera and Dale woreda (Fisseha *et al*., 2010). Very low hatchability value (22%) was reported in Gomma Woreda, southwestern Ethiopia (Meseret, 2010). These variations might be associated with culling practices, nutritional management and incubation management in different positions. The survival rate of chicks up to 5 month of ages was 38.85% in Gena Bossa District of Dawro Zone (Matawork *et al*.,2018), which was lower than (Fisseha *et al*., 2010) who reported the survival rate of chicks were 60.5, 74.3 and 54.2% at Bure, Fogera and Dale woreda, respectively. These low survival rate of the area might be due to highest occurrence of diseases, predators and lack of vaccination practice of the farmers (Matawork *et al*., 2018). Age at first egg laying and first mating age of pullets and cockerels in Mezhenger, Sheko and Bench-maji Zone were (5.59 and 5.00), (5.19 and 4.90) and (5.14 and 5.28) months, respectively (Endale *et al*., 2017).

# 3. MATERIALS AND METHODS

## 3.1.Description of the Study Area

The study was conducted in Kaffa Zone which is located between 6 24' to 8 13' North latitude and 35°30' to 36°46' East longitude and is a part of the South West Ethiopian Peoples Regional state (SWEPRS) and 460 km south west from Addis Ababa, the capital city of Ethiopia. Administratively, Kaffa Zone is divided into twelve districts and five administrative cities and has three predictable climatic zones based on differences in elevation and temperature. These are highland (2500 -3000 M.a.s.l), Midland (1500 - 2500 m.a.s.l) and lowland (500 - 1500 m.a.s.l).

Chena district is one of 12 rural districts in the kafa zone S/W/E/P/R/State. It is located at a distance of 78 km from Bonga and 540 km from the capital city Addis Ababa. The district located at $07^0$18'48''N latitude and $036^0$16'25''E longitudes. Total area 901.92km$^2$ (Tezera, C. 2008). The mean annual temperature ranging from $9^0$c to $35^0$c. Elevation ranging from 500 to 2800 *masl*. The average rainfall of the district ranges from1380 mm to 2100 mm (CWFEO, 2012). The total population of the district was 90,400 men and 92,935 female Total 183335 (CSA, 2011). The livestock population is estimated to be 105493 cattle, 201074 sheep, 77546 goats, and 56384 horses, 1395 mules, 6981 donkeys and 453781 poultry. The main agricultural practices in the areas include maize, inset, tef, coffee and barely, (Source, Chena district agriculture, cooperative and environmental protection Office socio-economy report, and 2023).

Bita district is one of 12 rural districts in the kafa zone S/W/E/P/R/State. It is located at a distance of approximately 80 km from Bonga and 542 km from the capital city Addis Ababa. The district was located at $7^0$16'36'' N latitude and $35^0$46'28'' E longitudes. Mean temperature ranging from $7^0$c to$36^0$c. Elevation ranging from 500 to 3300 *masl*. The average annual rainfall of the district ranges from 800 mm to 2100 mm. The total population of the district is 109000. The livestock population is estimated to be 142429 cattle, 207778 sheep, 81456 goats, 17284 horses, 8616 mules, 10888 donkeys, and 231250 poultry. The main agricultural practices in the areas include maize, coffee, inset, barely, wheat, and sorghum (Source, Bita district agriculture, cooperative and environmental protection Office socio-economy report, 2023).

Cheta district is one of 12 rural districts in the kafa zone S/W/E/P/R/State. It is located at a distance of 62 km from Bonga and 525 km from the capital city Addis Ababa. It is located at $7^0$30'35'' N, latitude and $36^0$13'86''E. longitudes. Mean temperature ranging from $10^0$c to 37 $^0$c. Elevation ranging from 541 to 2690 *masl*. The average annual rainfall ranges from 750 mm to 2000mm. The total population of the district is Male 33380 Female 33359 Total 66,739. The livestock population is estimated to be 141004 cattle, 167335 sheep, 67185 goats, 13928 horses, 9977 mules, 962 donkeys, and 838730 poultry. The main agricultural practices in the areas include tef, inset, barely, maize, sorghum and coffee (Source, Cheta district agriculture, cooperative and environmental protection Office socio-economy report, 2023).

### 3.2.Selection of Study Households

#### 3.2.1. Sampling Techniques and Sample Size Determination

The study consisted of a survey part, egg quality and carcass evaluation of indigenous chicken breeds in the traditional production system. The survey part was conducted in three districts namely Chena, Bita and Cheta, which were purposively selected based on their potential for chicken populations, production potentials and accessibility. Then, three Kebeles were purposively selected from each district representing each agro-ecology (Hl, Ml and Ll) by using above 2600 m.a.s.l. for high-land, between 1100-2600m.a.s.l. for mid-land and 1000 m.a.s.l. for low-land areas (District land resources and Socio-Economic Report, 2022). A total of 255 households were purposely selected from three districts (90 HHs from Chena, 97 HHs from Bita and 68 HHs from Cheta) of selected kebeles with different agro-ecology. Then sampling of each districts and kebeles was determined by the proportion of populations. Households who possess at least two and above indigenous chickens with best production experiences were purposely selected and interviewed using semi-structured questionnaire augmented with focal group discussions. Then finally total number of sample households was determined by using the formula (Yemane 1967) as follow:

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

Where:

n = required sample size

N= total population in three districts (Chena, Bita and Cheta) (718)

e = level of precision (0.05)

Based on the formula, the required sample size of the respondent was calculated with 95% confidence level was calculated as:

$$\text{Sample size (n)} = \frac{718}{1+718(0.05)^2} = \frac{718}{1+718(0.0025)} = \frac{718}{2.8} = 255$$

Table 1. Sampling frame of households in each district, kebele and agro-ecology.

| Districts | Agro-Ecology Type | Kebele | populn | Number Of Observations |
|---|---|---|---|---|
| Chena | highland | kulish | 108 | 38 |
| | Mid-land | Boba wodit | 87 | 31 |
| | Low-land | Gota | 58 | 21 |
| Bita | highland | Yawura | 30 | 11 |
| | Mid-land | Sheda1 | 204 | 72 |
| | Low-land | Sheda2 | 39 | 14 |
| Cheta | highland | Diya | 42 | 15 |
| | Mid-land | Kola | 76 | 27 |
| | Low-land | Duba | 74 | 26 |
| | | | 718 | 255 |

### 3.2.2. Data Types, Sources and Collection Methods

Primary and secondary data were used to attain the aims of this study. Semi-structured questionnaire was used to gather data from primary source which mainly comprised of households. Secondary data was obtained from reports of Zonal and District agricultural Office, development agents, published and unpublished sources prepared by various governmental and non-governmental organizations. Therefore, Socio-economic characteristics of the study area and households **(**Sex, age, family size and education level) ,chicken population, flock compositions, management practices (feeding and feed types, housing, watering, and, types of chicken disease were collected), productive and reproductive performance (age at first egg, age at first mating, average egg laid per hen per year, average number of eggs per clutch, clutches

per year, average length of inter clutch period, average length of single clutch, clutch interval, fertility and hatchability of eggs and survivability of chicks) were collected by using the questionnaires prepared to gather data. Group discussion was held with groups composed of basic informants like; five male and one females development agents and five male Livestock and Fishery development expert.

### 3.2.3. Egg quality Characteristics

Total of 270 indigenous chicken fresh eggs 90 eggs from each districts (Chena, Bita and Cheta) and 30 eggs from each kebele which representing different agro-ecology (HL,ML and LL) districts were collected for external and internal egg quality analysis. The collected eggs were taken to Jimma University College of Agriculture and Veterinary Medicine for laboratory analysis where external egg quality traits were evaluated. Each egg was individually weighed using sensitive balance and egg width and length were then measured using digital caliper. Following external egg quality evaluation, each egg was internal egg quality parameters were accessed by breaking eggs on a flat glass plate and measuring the most valued egg quality characters. Albumen weight (gm) and yolk weight (gm) was determined using sensitive balance. Albumen and yolk height (mm) was measured using tripod micrometer. Yolk colour was determined using 1–15 leveled colour fans and was computed by dividing egg width with egg length. Haugh unit was calculated according to Haugh (1937) by fitting the average albumen height and egg weight in to the following equation: $100 \times \log [\text{albumen height} + 7.57 - 1.7 (\text{egg weight}^{0.37})]$.

### 3.2.4. Carcass characteristics

Total of 18 indigenous chickens (i.e., 3 male and 3 female from each districts 1 male and 1 female from each kebeles which representing each agro-ecology (HL,ML and LL) were identified and kept by selected households from hatching to ages of evaluation (six month ages) by existing husbandry system of in the study area. The birds were starved for 12 hours and weighed directly before slaughtering and the measurement was taken as slaughter weight. The birds were then killed and bled hanged from a bleeding cone for about three minutes. Following bleeding, the birds were de-feathered manually after scalding in hot water for approximately two minutes. Dressed weight was measured after removal of blood and feather. Dressing

percentage was also calculated as the proportion of dressing carcass weight to slaughter weight multiplying by one hundred. From eviscerated carcass drumsticks, thighs, breast meat, wings, neck and back were separated and weighed separately.

### 3.2.5. Statistical Analysis

Data collected on socio-economic, production systems; productive performances (egg and meat production), reproductive performances and egg quality traits of indigenous chicken populations were coded and entered into a computer using Microsoft Office Excel 2010. Survey data; like socioeconomic, fertility, hatchability, live weight, age at first mating and age at first egg, egg production performances and carcass yield characters were analyzed using simple descriptive statistics like frequencies and percentage using Statically Package for Social Sciences (SPSS. version, 23). A Chi-square test was employed to identify differences and compare data among categorical variable between districts and agro-ecologies. Egg qualities were evaluated using the Statistical Analysis Systems software (SAS).

Model for

$Y_{ij} = \mu + Ai + Di + Di*Ai + \varepsilon_{ij}$

Where:

$Y_{ij}$ = the $j_{th}$ observation in $i_{th}$ variable

$\mu$ = overall mean of the respective variable

Ai= effect of agro-ecology (high-land, mid-land & low-land)

Di= effect of districts (Chena, Bita and Cheta)

$\varepsilon ij$ = the random error term normally and independently distributed.

# 4. RESULT AND DISCUSSION

## 4.1. Household Characteristics of the Study Areas

The household characteristics of the respondents are presented in Table-2. From the total interviewed indigenous chicken owning households, 44.4%, 79.4% and 92.6 % were males in Chena, Bita and Cheta districts, respectively. A higher proportion of female respondents (55.6%) were observed in chena district than Bita (20.6%) and Cheta (7.4%). This indicates that female farmers are mainly involved in managing and caring for chickens in the Chena district than Bita and Cheta districts, respectively. Even if the lower numbers of female participants involved in current interviews in Bita and Cheta districts, the interviews respond females were mainly involved in managing and caring for chickens. The average age of respondents in current study area was 36.3, 43 and 33.8 years in Chena, Bita and Cheta districts, respectively.

The educational level of respondents showed that about 20, 37.1 and 23.5 % in Chena, Bita and Cheta districts, respectively were illiterate. These indicate farmers in rural areas particularly in this area had no access to education before. Others can read and write and some were involved in formal education such as primary first cycle (1- 4th); second cycle (5-8th) and high school (9-10th or 12th) and above in all study districts. The Marital status of all respondents in all current study districts were married none of respondents were unmarried (single), Divorce and Widow. The average family size of the current study was 5.1, 5.2 and 5.0 in Chena; Bita and Cheta districts respectively with the overall mean family sizes of 5.1. Bita district was higher average family size than the rest chena and Cheta districts. Thus, this result was in line with the national average of 5.2 (CSA 2003).

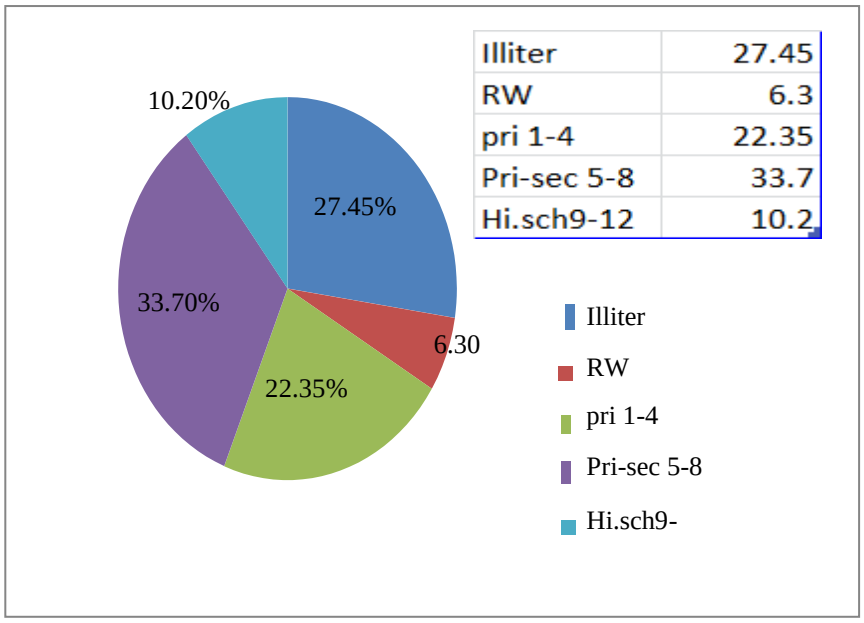
Table 2 Household characteristics of respondents in the study area (N = 255).

| **Household characteristics** | | **Chena** | **Bita** | **Cheta** | **Overall** |
|---|---|---|---|---|---|
| | | **N = 90** | **N = 97** | **N=68** | **N=255** |
| Sex of Respondents (%) | Male | 40(44.4) | 77(79.4) | 63(92.6) | 180 (70.6) |
| | Female | 50(55.6) | 20(20.6) | 5(7.4) | 72 (29.4) |
| Average age of respondents(years) | | 36.3 | 43 | 33.8 | 37.7 |
| Educational | Illiterate | 18(20) | 36(37.1) | 16(23.5) | 70(27.45) |

| | | | | | |
|---|---|---|---|---|---|
| level (%) | Read and write | 8(8.88) | 8(8.2) | - | 16 (6.3) |
| | Primary first cycle (1-4) | 23(25.5) | 20(20.6) | 14(20.6) | 57 (22.35) |
| | Primary second cycle (5-8) | 32(35.5) | 25(25.8) | 29(42.6) | 86 (33.7) |
| | High school (9-12 and above) | 9(10) | 8(8.2) | 9(13.2) | 26 (10.2) |
| Marital status of respondents (%) | Single | - | - | - | - |
| | Married | 90(100) | 97(100) | 68(100) | 255(100) |
| | Divorce | - | - | - | - |
| | Widow | - | - | - | - |
| Occupations of respondent | Farmer | 84(93.3) | 97(100) | 60(88.2) | 241(94.5) |
| | Civil-servant | 6(6.7) | - | 8(11.8) | 14(5.5) |
| | Self employed | - | - | - | - |
| Average family size (number) | | 5.1 | 5.2 | 5.0 | 5.1 |

N: Number of observations; Numbers in parenthesis are percentage values

Figure1.Educational status of the study area.




### 4.2. Livestock, Land Holding and Chickens Flock Composition of the Study area

The average farmland size per household in Chena, Bita and Cheta district was 2.8, 1.7 and 2.2, with the overall mean of 2.23 hectares (h/r) (Table 3). The higher average land sizes were reported from Chena district whereas; lower average was reported from Cheta district respectively. However, the current result was higher than the report of national average 1.02 ha (EEA, 2002), and 1.28 ha land in North West Amhara region was reported by (Halima 2007*)*.The farming system practiced in the study area were mixed farming system (livestock with crop production) and the major crop types grown in all districts and agro-ecology types were maize, tef, inset, barley and Sorghum, whereas coffee were grown mainly in mid lands followed by low lands respectively partly and wheat grown in high lands of the area. The average number of livestock owned per household were 4.7, 6.7, and 3.7 cattle, 4.3, 2.5, and 3.15 shoat and 0.4, 0.64 and 0.46 equines in Chena, Bita and Cheta respectively.

Table 3.Land and livestock holding per household in the study area (N = 255).

| Land and livestock holding | | Chena N = 90 | Bita N = 97 | Cheta N=68 | (Mean ± SE) N=255 |
|---|---|---|---|---|---|
| Average land(h/r) | | 2.8±0.9 | 1.7 ±8.6 | 2.2±1.09 | 2.23±3.53 |
| Livestock holding | Cattles | 4.7±2 | 6.7±5.4 | 3.7±1.27 | 5.03±2.89 |
| | Shoat | 4.3±1.15 | 2.5±2.18 | 3.15±1.64 | 3.31±1.65 |
| | Equine | 0.4±0.53 | 0.64±2.11 | 0.46±0.37 | 0.5±1.0 |

N: Number of observations; SE=standard error, h/r=hectare

The mean flock size per household was 12.7, 9.6 and 9.86 in Chena, Bita and Cheta districts, with the overall mean of 10.72 was presented on (Table 4). The current report indicated that Chena district was significantly higher number of flock size ($p > 0.05$) than Cheta and Bita districts. There was also a significant variation in flock size among the studied districts. Accordingly, the overall flock size observed in Bita district was lower than the flock size in the rest two districts. The mean flock size reported in current study was relatively comparable to the mean flock size of 8.8 and 9.2 chickens/ household reported by *(*Asefa 2007). Similarly, the mean flock size reported in current study was higher than the mean flock size of 7-10 chickens/ household from the central highlands of Ethiopia (Tadelle, 1996). According to (Moreda *et al.* 2013), the flock composition indicated that young chicks were the most abundant followed by Pullets, hens along with small number of cocks and cockerels.

Table 4Flock composition of Chicken in the study area (mean ± SE).

| **Flock Composition** | **Chena** | **Bita** | **Cheta** | **(Mean ± SE)** |
|---|---|---|---|---|
| | **N = 90** | **N = 97** | **N=68** | **N= 255** |
| Chicks | 5.2 [a] ±2.06 | 3.0 [c] ±2.17 | 3.8 [b] ±1.7 | 4.0±1.96 |
| Pullets | 2.3 [a] ±1.07 | 2.0 [a] ±0.9 | 1.8 [a] ±0.9 | 2.03± 0.9 |
| Cockerels | 1.7 [a] ±1.09 | 1.6 [a] ±0.7 | 1 [b] ±0.97 | 1.43±0.9 |
| Hens | 2.3 [a] ±0.8 | 1.7 [b] ±0.9 | 2.07 [a] ±0.97 | 2.02±0.9 |
| Cocks | 1.2 [a] ±0.6 | 1.3 [a] ±0.4 | 1.19 [a] ±0.4 | 1.23±0.46 |
| Overall | 12.7[a] ±5.6 | 9.6[b] ±5.08 | 9.86 [b] ±4.8 | 10.72±5.1 |

[abc] Row means with different superscript letters are significantly different ($P < 0.05$); SE: Standard error of the mean, N: Number of observations.

### 4.3. Productive and Reproductive Performance of Indigenous Chickens

The performance of indigenous chicken was presented in Table -10. Age at first egg (months) was generally longer and similar value was reported both for chickens reared in Chena (6.4 months) and Cheta (6.4 months) districts than Bita (6.27 months) districts. This implies chicken reached early age at fist egg in bita than Chena and Cheta districts. Shorter average age at first egg laying was reported by (Getachew *et al*, 2016) which ranges from 5.82 to 5.92 months in Bench Maji Zone, South Western Ethiopia. Similarly, average age at first egg for local breeds ranged from 24 to 28 weeks (Alem, 2014). On the other hand, (Endale *et al.* 2017) reported in Mezhenger, Sheka and Benchi-Maji zones in which the first egg laying of pullets were 5.59, 5.19 and 5.14 months, respectively. Chickens in this study area reach sexual maturity earlier than results reported by (Getachew *et al*, 2016) and (Alem *et al* (2014). Age at first mating was significantly shorter for chickens reared in Chena (5.34 months) district and longer in Bita (5.82 months) and Cheta (5.73 months) districts respectively. (Endale *et al.* 2017) reported that, in Mezhenger, Sheka and Benchi-Maji zones, the first mating age of cockerels were 5.00, 4.90 and 5.28 months, respectively. Chickens in this study area reach sexual maturity earlier than that reported by (Endale *et al*. 2017).

An average number of eggs produced per hen per year were significantly higher for chickens reared in Bita (49.27) district than in Chena (46.65) and Cheta (46.8) districts, respectively. The variations of egg productions among districts particularly in bita district the higher egg production might be due to feed types grown in the area was mostly wheat, barley and sorghum which is very important feed types for productiveness of chickens. Addisu et al (2013) reported that mean annual egg production/hen in north Wollo were 49.5 which was in agreement with current result. The average egg production per year per hen in three districts of Bench maji zone were 56.4, 58.5 and 48.8 in south bench, Sheko and North bench which is higher than the current study, (Welelaw E. *et al*., 2018). (Melkamu *et al* 2014) reported 65eggs/hen/ year at Enebsie Sar Midir woreda, Eastern Gojjam which is significantly higher than the current report. (FAO, 2004) also reported, the average egg production of native chicken was 34 eggs per year per hen under village condition annually.

Average number of eggs per hen per clutch in the present study was 14.1, 13.81 and

13.6 eggs in Chena, Bita and Cheta districts, respectively in which chickens reared in Chena district produced significantly higher number of eggs/hen/year than in Bita and Cheta districts. Average number of eggs laid per hen per clutch was 13.6 for local hens in central Tigray, of northern Ethiopia reported by (Alem, 2014). This result also was comparably with current results. The average egg number per hen/clutch was 14.8 in bench maji zone southwest Ethiopia, which is higher than the current results. (Welelaw E. *et al*., 2018). (CSA 2016) stated that the mean egg number per hen per clutch was 12.92 and 12 national average. The average clutch number per hen per year in Chena (3.34) district was significantly shorter than Bita (3.63) district but similar value with Cheta (3.3) district respectively. The average number of clutches per year in bench maji zone southwest Ethiopia was 3.7which is higher than the current results (Welelaw E. *et al*., 2018). The report of (CSA 2015/16) shown national average of Ethiopia 4 per hen per year and higher mean than the current result and (Welelaw E. *et al*., 2018).

The mean numbers of eggs set per broody hen in current study area were 11.7, 11.72, and 11.46 in Chena, Bita and Cheta districts respectively. For which chickens reared in Chena and Bita districts were relatively similar values but significantly higher eggs incubated per single incubation than in Cheta district. This lower egg set per broody hens in Cheta districts was might be due to the implications of lower hatchability, body size; or simply the interest of owner. The average number of eggs incubated per hens was 12.8 reported by (Aberra *et al.* 2013) which finding is slightly higher than the current results. The hatchability percentages of chickens reared in Chena, Bita and Cheta districts were 83.2, 79.09 and 78.53% respectively. Current study report showed that significantly higher hatchability in Chena district and followed by Bita district but lower in Cheta district respectively. This lower hatchability percent in Cheta district was due to the lower egg set per broody hen; lack proper management during incubation period. The report of (Halima *et al*. 2007) showed that the hatchability percentage ranging from 60.7 to 82.1 was lower hatchability.

The survivability of chickens reared in Chena, Bita and Cheta districts were 65.1, 64.8 and 64.4% with the overall mean of 64.8% respectively. This report showed that there is a consistency between Chena and Bita districts, whereas, lower survivability in Cheta districts. The mean survival rate of chicks to marketable age (48.8%) in the current study

was higher than the value reported by (Meseret, 2010) but lower than that reported by (Melese and Melkamu 2014) in other parts of Ethiopia. Low survival rate of chicken in the current study suggests high chick mortality due to disease and predation. This variation might be due to the variation in hatchability and management. Brooding length of the indigenous hens in the area was 2.8, 3.02 and 2.84 months in Chena, Bita and Cheta districts respectively. Brooding length in brooder hen in Bita district was significantly longer than Cheta and Chena districts.

Table 5Productive and reproductive Performance of indigenous chicken's among districts and (mean ± SD).

| **Parameters** | **District's** | | | **Overallmean** |
|---|---|---|---|---|
| | **Chena** | **Bita** | **Cheta** | |
| | **N = 90** | **N = 97** | **N=68** | **N= 255** |
| Age at first eggs (months) | 6.4 [a] ±0.55 | 6.27 [b] ±0.64 | 6.4 [a] ±0.98 | 6.35±0.72 |
| Age at first mating (months) | 5.34 [c] ±0.55 | 5.82[a] ± 0.46 | 5.73 [b] ±0.7 | 5.63±0.57 |
| Eggs per y/r per hen | 46.65[c]±7.43 | 49.27 [a] ±7.69 | 46.8 [b] ±7.12 | 47.57±7.41 |
| Eggs per clutch per hen | 14.1 [a] ±1.99 | 13.81[b] ±0.89 | 13.6 [c] ±1.2 | 13.83±1.36 |
| Clutch No. per year | 3.34 [b] ±0.48 | 3.63 [a] ±0.50 | 3.3 [c] ±0.49 | 3.42±0.49 |
| Clutch length/single Clutch | 19.0[b]±5.1 | 21.0[a]±5. | 21.0 [a] ±5.5 | 20.33 ±5.5 |
| Eggs incub/single incubat/hen | 11.7[a] ±0.95 | 11.72 [a] ±1.73 | 11.46 [b] ±1.76 | 11.62±1.48 |
| Chicks hatch/sing/incubat/ hen | 9.73 [a] ±0.95 | 9.27 [b] ±1.2 | 9 [c] ±1.36 | 9.33 ±1.2 |
| Hatchability (%) | 83.2 [a] ±1.0 | 79.09 [b] ±0.6 | 78.53 [c] ±1.6 | 80.27±1.06 |
| Survivability of chickens | 7 [b] ±1.0 | 6.63 [c] ±0.74 | 7.86 [a] ±1.6 | 7.16 ±1.06 |
| Survivability (%) | 65.1[a] ±1.0 | 64.8 [b] ±0.74 | 64.4 [c] ±1.6 | 64.8±1.06 |
| Brooding length(month) | 2.81[b] ±0.8 | 3.02 [a] ±1.3 | 2.84[b] ±0.7 | 2.90±1.0 |

N= number of observations, abc, means within row with different superscript letters are significantly different at (P > 0.05).

The productive and reproductive performances for indigenous chickens in different agro-ecologies of the study area are shown in Table 11. The result shown that chickens reared in mid-land and low-land areas achieved significantly ($p<0.05$) shorter age at first egg

laying than high-lands the reasons for longer age at first egg in high-land area might be due to cooler climatic conditions which influences the development and feed conversions of the chickens.. This result was significantly shorter age than the outcomes of (Meseret *et al*., 2010) who reported that the female local chicken of Gomma woreda Jimma Zone reached sexual maturity at 6.47 months. Similarly, (Solomon *et al*. 2013) also reported shorter (5.2 months) average age at sexual maturity for indigenous pullets in Metekel zone of North West Ethiopia than the current results.

The average age at first mating of current study areas in three agro-ecology types were relatively comparable values. But age at first mating of cockerel at high- land area was slightly longer than mid and lowland areas. The findings of (Melkamu *et al* 2013) reported age at first mating of cockerels (4.7 month) was early attaining (shorter age) sexual maturity than the current result. Similarly, shorter age at first mating of cockerels was reported by (Andargie *et al.* 2013) than the current findings. The results reported by (Tsegay *et al*. 2016) were also in agreement with the current results where the age at sexual maturity of were (5.9, 5.9), (5.5, 5.2) and (5.5, 5.4) months for male and female chickens at highland, midland and lowland agro-ecologies in Wolaita zones of southern Ethiopia,

The result of current study shown that average egg produced per hen per year were not significantly different ($p>0.05$) at different agro-ecologies. Mean annual eggs production of indigenous chicken per hen per year was 47.1, 45 and 46.05 at highland, midland and lowland agro-ecologies, respectively. The current results imply that eggs produced at high land were significantly higher in number than eggs produced/hen/year at mid and low-land agro-ecologies even if the mean age at first egg was longer but mean number of eggs high at high land areas might due to feed types in which high land areas were mostly grown and feeds their chicken with wheat and barley grains which is highly productive feed types. The number of eggs/hen/year from indigenous chickens of western Tigray was 54.2, 54.87 and 48.98 at highland, midland and lowland areas (Shishay *et al*. 2015); 60, 61 and 59 at highland, midland and lowland agro-ecologies, respectively in Bure district (Fisseha *et al*. 2010) which were higher than the current findings.

The average number of eggs per clutch (13.7, 14.2 and 13.8), number of clutches per year per hen (3.4, 3.3 and 3.36) and the clutch length was 21, 21and 20 days at high,

mid and low-land areas, respectively were observed in the current report. (Welelaw E. *et al*., 2018), founded average number of eggs per clutch (14.8), number of clutches per year (3.7) and the mean clutch length was 20.7 days respectively. These results are slightly higher than current report for these parameters. Similarly, a higher average egg produced per clutch than the current study was 16.7, 16.1 and 14.4, at highland, midland and lowland agro-ecologies, reported by (Fisseha *et al.* 2010a) in Bure district. The current result indicated that the mean number of eggs incubated (11.63, 11.6 and 11.6) and hatchability 9.3(80.2%), 9.3(80.2%) and 9.4 (80.2%)) were observed at high, mid and low land areas respectively. A very higher hatchability (98.6%) value than current result was reported by (Matiwos *et al.* 2015). However, very low hatchability value (22%) was reported in Gomma Woreda, southwestern Ethiopia (Meseret, 2010).

Table 6Productive and reproduction performances of indigenous chickens under three agro-ecology types (mean ±SD).

| Variables | Agro-ecology | | | Grand total (Mean±SD) |
|---|---|---|---|---|
| | High-land (Mean±SD) | Mid-land (Mean± SD) | Low-land (Mean±SD) | |
| Age at first eggs (months) | 6.2 [a] ± 2.48 | 5.76 [b] ±0.34 | 5.8 [c] ±0.33 | 5.92±1.05 |
| Age at first mating (months) | 5.62 [a] ±2.42 | 5.46 [b] ±0.4 | 5.46 [b] ±0.4 | 5.51±1.07 |
| Eggs per year per hen | 47.13[a]±5.25 | 44.96[c]±23.9 | 45.4 [b] ±6.5 | 45.83±11.9 |
| Eggs per clutch per hen | 13.7 [b] ±1.3 | 14.16 [a] ±5.2 | 13.8 [c] ±1 | 13.9±2.5 |
| Clutch No./year/hen | 3.4 [a] ±1.3 | 3.26 [c] ±0.39 | 3.36 [b] ±0.4 | 3.34±0.7 |
| Clutch length | 21 [a] ±1.13 | 21 [a] ±0.62 | 20[b]±1.03 | 20.7±0.92 |
| No of eggs incubated/hen | 11.63[a]±1.66 | 11.6 [b] ±1.0 | 11.6 [b] ±1.1 | 11.61±1.25 |
| Chicken hatched/single incubate/hen | 9.3 [b] ±3.5 | 9.4 [a] ±0.95 | 9.4 [a] ±1 | 9.4±1.8 |
| Hatchability (%) | 80.2% | 80.96% | 81.3% | 80.82% |

[abc] Row means with different subscript letters are significantly different at p>0.05; SD = standard deviation

### 4.3.1. Carcass yield characteristics

The slaughter weight and dressed weight of indigenous chicken in current study area are presented in Table12. An average live weight at 6-month age was 1436.6, 1396.9

and 1413.8gm in Chena, Bita and Cheta districts with overall mean of 1415.8g respectively. The mean dressed carcass weight of the current finding were 1003g (69.97%), 966g (68.5%) and 980g (68.8%) in Chena, Bita and Cheta districts with the overall mean of 983.3g (69.09%) respectively. The highest live weight and carcass weight of indigenous chicken were reported from Chena followed by Cheta district, whereas, lowest carcass weight observed were Bita district respectively. Thus, these slight differences between districts might be due to chicken management practices, disease and production environments of the area.

The average live weight of male local chickens in Cheta district were weighted (1541g), followed by Chena district (1535.5g), whereas, Bita district recorded relatively lower (1479.3g) value and female chickens weighed high in Chena districts (1338.7g) while, Bita (1307g) and Cheta (1302.2g) districts were recorded lower for these parameters. The live weight of matured male chicken in the current study was in good agreement with the body weight findings by (Negesse, 2011) in southern Ethiopia. Similarly report comparable with current findings was noted by (Melesse, *et al*. 2011) in southern Ethiopia. (Raphulu *et al*. 2015) reported 1531 g body weight for mature Venda scavenging chickens in South Africa, which is slightly higher than present results. The slaughter weights ranging from 1045 g to 1292 g for different local male chickens in northwestern Amhara of Ethiopia, which is lower than the results result reported by (Halima .2007).

The outcomes of current study shown for carcass weight characteristics chickens reared in chena district were significantly higher average weights in most carcass component than bita and Cheta districts respectively. Whereas chickens from chena and Cheta districts were similar heart weight value but slightly higher than bita district. Therefore, generally the district variation was significantly influenced on the mean weights of most carcass components. This might be due to variations in management practices, feed types grown in the districts, production environment and production experiences of the area. The dressing percentage of 66.7 was observed in the current study, which is consistent with the finding of (Halima 2007), who reported 64 %, 65.3% and 66.8% for Melo Hamusit, Mecha and Gelila indigenous chicken ecotypes, respectively. (Tadelle, 2000) also reported 65.5% of dressing in hens reared in central highlands of Ethiopia which are in good agreement with the current results.

Table 7Live and carcass weights along with proportions of carcass yield (%) (Mean±SD).

| Parameters | Districts | | | Overall mean |
|---|---|---|---|---|
| | Chena | Bita | Cheta | |
| Live weight (g) | 1436.6 [a] ±34 | 1396.9 [b] ±40.7 | 1,413.8 [a] ±26.8 | 1415.8±33.8 |
| Dressed weight (g) | 1003 [a] ±43 | 966 [c] ±39.6 | 980.8 [b] ±21.9 | 983.3±34.8 |
| Dressing percentage (g) | 69.97 [a] ±4.7 | 68.5 [b] ±1.3 | 68.8 [b] ±1.2 | 69.09±2.4 |
| Breast (g) | 27.3 [a] ±0.5 | 25.6 [c] ±1.7 | 26.1 [b] ±0.7 | 26.3±0.97 |
| Thigh *2(g) | 22.4 [a] ±1.9 | 20.5 [b] ±0.5 | 20.9 [b] ±0.8 | 21.29±1.07 |
| Drumstick*2 (g) | 16.4 [a] ±0.7 | 15.6 [b] ±0.4 | 15.9 [b] ±0.7 | 15.97±0.6 |
| Back (g) | 12.5 [a] ±0.6 | 12.1 [b] ±0.3 | 12.4 [a] ±0.6 | 12.3±0.5 |
| Wings *2(g) | 14.5 [a] ±0.6 | 10.3 [b] ±0.3 | 10.8 [b] ±0.4 | 11.9±0.43 |
| Neck (g) | 5.8 [a] ±0.3 | 5.6 [c] ±0.2 | 5.7 [b] ±0.27 | 5.7±0.26 |
| Skin (g) | 7.9 [a] ±0.3 | 7.7 [b] ±0.4 | 7.7 [b] ±0.2 | 7.77±0.3 |
| Gizzard (g) | 2.6 [a] ±0.1 | 2.3 [b] ±0.07 | 2.4 [b] ± 0.1 | 2.43±0.09 |
| Liver (g) | 2.4 [a] ±0.1 | 2.2 [b] ±0.1 | 2.2 [b] ±0.07 | 2.27±0.09 |
| Heart (g) | 0.7 [a] ±0.06 | 0.65 [b] ±0.05 | 0.7 [a] ±0.03 | 0.7± 0.05 |

[abc] Row means with different subscript letters are significantly different at p>0.05; SD = standard deviations.

The average live weight of indigenous chickens in current study area of different agro-ecology (high- land, mid-land and low-lands) were 1408.9g, 1418g and 1441.4g with the overall mean of 1422.8g respectively. Average carcass weight for chickens kept across different agro-ecology types (High-land, Mid-land and low-land) were 974.6g, 968.9g and 1006.4g with overall mean of the 983.3g respectively. This result shown that highest result was observed from low land than mid-land and high-land areas respectively. The dressing percentage of 69.2%, 68.3% and 68.8% with over all mean 69.1% was observed in different agro-ecologies (High- land, Mid-land and low-land) of current study area in which high land area were slightly high dressing percentage than mid and low lands respectively. The higher dressing percentage from high land might be due to types feed grown which is best for carcass weight and climate types. The report of (Halima, 2007), (64 %, 65.3% and 66.8% for Melo Hamusit, Mecha and Gelila indigenous chicken ecotypes) which is lower dressing percentage than current results. Similarly (Tadelle 2000) reported 65.5% of dressing percentage in indigenous

chickens kept in central highlands of Ethiopia was lower dressing percentage than current findings. According to current findings carcass weight characteristics of chickens reared in low land were significantly higher average weights in most carcass component than mid land and high land areas respectively. However, chickens from Mid-land and high-land area were relatively similar average weight values in most carcass component. Generally, the higher in most carcass weight characteristics from low-land and the lower carcass weights reported from high land. This result variation might be due to management types and feed type variations.

Table 8Live and dressed weights of indigenous chickens across agro-ecologies of the study area (mean ± SD).

| | Agro-ecologies | | | |
|---|---|---|---|---|
| **Parameters** | **High-land (Mean± SD)** | **Mid-land (Mean± SD)** | **Low-land (Mean± SD)** | **Overall (Mean± SD)** |
| Live w/t (g) | 1,408.9 [c] ± 51.8 | 1,418 [b] ±76.8 | 1,441.4 [a] ±62.4 | 1422.8±63.7 |
| Dressed w/t(g) | 968.9 [c] ±51.8 | 974.6 [b] ±27.3 | 1,006.4 [a]±59.03 | 983.3±40.0 |
| Dressing percentage (g) | 68.8 [b] ±0.67 | 68.7 [c] ±1.8 | 69.8 [a] ±1.76 | 69.1±1.4 |
| Breast (g) | 26.3 [b] ±0.73 | 26.5 [b] ±1.7 | 27.2[a] ±1.5 | 26.7±1.3 |
| Thigh (g) | 20.6[c] ±1.3 | 21.3 [b] ±4.8 | 21.96 [a] ±1.5 | 21.3±2.53 |
| Drumstick (g) | 15.7[b] ±0.93 | 15.8 [b] ±11.8 | 16.4[a] ±0.96 | 15.96±4.6 |
| Back (g) | 12.1[b] ±4.5 | 12.2 [b] ±0.35 | 12.6[a] ±0.73 | 12.3±1.86 |
| Wings (g) | 11.6 [b] ±0.63 | 11.8 [b] ±0.49 | 12.2[a] ±0.65 | 11.86±0.59 |
| Neck (g) | 5.6 [b] ±0.25 | 5.63 [b] ±0.36 | 5.9[a] ±0.33 | 5.71±0.3 |
| Skin (g) | 7.7 [b] ±0.22 | 7.7 [b] ±0.98 | 7.96[a] ±0.53 | 7.8±0.6 |
| Gizzard (g) | 2.4[b] ±0.13 | 2.43 [b] ±0.45 | 2.5[a] ±0.12 | 2.44±0.23 |
| Liver (g) | 2.2 [b] ±0.1 | 2.2 [b] ±0.17 | 2.33[a] ±0.22 | 2.24±0.16 |
| Heart (g) | 0.66 [b] ±0.04 | 0.71[a] ±0.056 | 0.72 [a] ±0.073 | 0.69±0.056 |

[abc] Row means with different subscript letters are significantly different at p>0.05; SD = standard deviation.

### 4.3.2. Egg Quality Traits of Indigenous Chickens

The mean effects of different districts and agro-ecologies on external (egg-weight, egg

length and egg-width) and internal (yolk height, albumen height, albumen weight, yolk weight and a yolk color) egg quality trait is presented on table14 and 15. Generally, there was significant different ($P < 0.05$) among different districts and agro-ecologies measured mean values of external and internal egg quality parameters (egg-weight, egg-length, egg-width, yolk-height, albumen-height, albumen-weight, yolk-weight and yolk-colors) of indigenous chickens.

#### 4.3.2.1.External egg quality Traits

The mean effects of different agro-ecologies on Egg weight, Egg width and egg length of the indigenous chicken were shown in table-9. The mean egg weight, egg width and egg length of the current study was (40.97g), (41.59g) and (43.37g), (4.22), (4.17) and (4.02) and (5.24), (5.14) and (5.08) at high-land, mid-land and Low-land. The mean egg weight value from low-land was significantly higher than high-land and mid-lands ($P < 0.05$) whereas, the mean values of egg width of low-land were significantly lower than high-land and mid-land ($P < 0.05$) and eggs from high-land were significantly higher mean values at ($P < 0.05$) for egg length, than mid-land and low-lands receptively. This result shown that different agro-ecology had significantly affect ($P<0.05$) on egg weight, egg width and egg-length. Thus, the differences in egg width were due to might be the different in egg shape among agro-ecologies.

The mean egg weight in the current study was in good agreement with the findings of (Getachew et al. 2016), who reported egg weight and egg width value of (41.1 g) and (4.14cm) for indigenous chicken reared in western Shewa zone of Oromia region, Ethiopia. Similarly, equivalent outcome was reported by (Yakubu et al. 2008), who stated egg weight of 43.04, 40. 83g and egg width of 3.84, .3.54 cm, for Nigerian native chickens of naked necks and normal feathered, respectively. Similarly, the mean egg weight reported by (Melesse et al. 2010) was (43.9 g) which is in agreement with the current study results. In line with the current study, (Getachew et al. 2016) also reported equivalent egg weight value of (41.1 g) for local chicken in western Shewa zone of Oromia region, Ethiopia reported. Contrary to the current finding, (Halima et al. 2007) also reported lower egg weight values of (34.1 g to 41.7 g) for different chicken ecotypes in northwestern part of the country.

The current result shown eggs from Cheta district was significantly higher (5.323 cm) mean egg-length values at ($P < 0.05$) than eggs from Chena and Bita districts. The

mean egg length of present study values ranges 4.98 to 5.323cm was shorter than the values reported by (Kgwatalala et al. 2016), who reported 5.27 and 5.31cm egg length for naked neck and normal strains of Tswana chickens of Botswana. Similarly, the value of egg length reported by (Welelaw et al. 2018) were 37.8 mm in Bench maji zone south west Ethiopia which is shorter than current study. On the other hand, the mean effects of district on egg width of the current study were (4.23, 4.10 and 4.08) in Chena, Bita and Cheta districts respectively. Not in line with the current study, higher mean values of egg width (52.1 mm) reported by (Welelaw et al. 2018).

Table 9 Mean effect of agro-ecologies on E. weight, E. width and E. length

| **Parameter** | **Agro-ecologies** | | | **LSD (5%)** | **P value** | **CV (%)** |
|---|---|---|---|---|---|---|
| | HL | MI | LL | | | |
| E. weight | 40.97[b] | 41.59[b] | 43.37[a] | 0.98 | 0.0002 | 0.98 |
| E. width | 4.22[a] | 4.17[a] | 4.02[b] | 0.05 | 0.0001 | 0.05 |
| E. length | 5.24 [a] | 5.14 [b] | 5.08 [b] | 0.09 | 0.0003 | 1.09 |

Means within row with different superscript letters are significantly different (P < 0.05); CV = Coefficient of variation; LSD = Least significance difference; HI = High land; MI = Midland; Ll = Lowland.

Table 10Mean effect of districts on E. weight, E. width and E.length

| **Parameter** | **Districts** | | | **LSD (5%)** | **P value** | **CV (%)** |
|---|---|---|---|---|---|---|
| | **Chena** | **Bita** | **Cheta** | | | |
| E. weight | 41.93 [a] | 41.98 [a] | 41.98 [a] | 0.98 | 0.0002 | 2.36 |
| E. width | 4.23[a] | 4.10[b] | 4.08[b] | 0.05 | 0.0001 | 1.3 |
| E. length | 5.24 [a] | 5.12 [b] | 5.10 [b] | 0.05 | 0.0001 | 1.09 |

Means within row with different superscript letters are significantly different (P < 0.05); CV = Coefficient of variation; LSD = Least significant differences

#### 4.3.2.2.Internal egg quality traits

According to current study results eggs from Cheta district was significantly higher mean values at (P < 0.05) in yolk-height, albumen-weight and yolk-color, (4.29, 25.213cm and 10.97) than chickens from Chena and Bita districts. On the other hand, yolk weight from Chena district was significantly higher at (P < 0.05) average of (14.72g) than Bita and Cheta Districts. The current report indicated that mean effects of

district on albumen height were (6.42, 6.57 and 6.72cm) in Chena, Bita and Cheta districts respectively. With regards of agro- ecology, significantly higher mean values ($P < 0.05$) were recorded in high-land agro-ecology for some parameters of yolk height and yolk weight than eggs from mid-land and LL agro- ecologies. However, eggs from LL were significantly higher mean values at ($P < 0.05$) for yolk weight and yolk color than HL and ML agro-ecologies respectively.

Table 11Mean effect of different districts on Alh, Al.wt, Yh, Ywt and Yc

| **Parameter** | **Districts** | | | **LSD (5%)** | **P value** | **CV (%)** |
|---|---|---|---|---|---|---|
| | **Chena** | **Bita** | **Cheta** | | | |
| Alh | $6.42^{c}$ | $6.57^{b}$ | $6.72^{a}$ | 0.11 | 0.0001 | 0.11 |
| Al.wt | $21.29^{b}$ | $22.62^{a}$ | $22.3^{b}$ | 0.70 | 0.0023 | 3.20 |
| Yh | $3.9^{b}$ | $3.84^{c}$ | $4.04^{a}$ | 0.14 | 0.0001 | 3.69 |
| Y.wt | $14.1^{c}$ | $13.18^{b}$ | $13.48^{a}$ | 0.28 | 0.0001 | 2..08 |
| Y.c | $10.37^{c}$ | $10.48^{b}$ | $10.69^{a}$ | 0.26 | 0.0011 | 2.56 |

Means within row with different superscript letters are significantly different ($P < 0.05$); CV = Coefficient of variation; LSD = Least significant differences.

Table 12Mean effect of interaction of agro-ecologies and districts on E.wt, E.wd, E.l, Al.h, Yh, Al.wt, Ywt, and Yc.

| **Parameter** | **AgEc** | **Districts** | | | **LSD (%)** | **P value** | **CV (%)** |
|---|---|---|---|---|---|---|---|
| | | **Chena** | **Bita** | **Cheta** | | | |
| **E.weight** | HL | **$41.02^{b\,c}$** | **$41.63^{ab}$** | **$40.25^{cc}$** | **1.09** | **0.0002** | **2.36** |
| | ML | **$41.93^{ab}$** | **$41.13^{c\,c}$** | **$41.71^{bb}$** | **1.09** | **0.0002** | **2.36** |
| | LO | **$42.85^{ca}$** | **$43.28^{b\,a}$** | **$43.98^{aa}$** | **1.09** | **0.0002** | **2.36** |
| **E.width** | HL | **$4.31^{a\,a}$** | **$4.14^{cb}$** | **$4.2^{b\,a}$** | **0.71** | **0.0001** | **1.30** |
| | ML | **$4.25^{ab}$** | **$4.16^{b\,a}$** | **$4.1^{cb}$** | **0.71** | **0.0001** | **1.30** |
| | Lo | **$4.13^{a\,c}$** | **$4.01^{b\,c}$** | **$3.9^{cc}$** | **0.71** | **0.0001** | **1.30** |
| **E. length** | HL | **$5.317^{a}$** | **$5.14^{cd}$** | **$5.323^{a}$** | **0.09** | **0.0003** | **1.09** |
| | MI | **$5.265^{ab}$** | **$5.183^{bc}$** | **$4.98^{e}$** | **0.09** | **0.0003** | **1.09** |
| | LO | **$5.16^{c}$** | **$5.05^{de}$** | **$5.047^{de}$** | **0.09** | **0.0003** | **1.09** |
| Al.h | HL | $6.47^{b\,a}$ | $6.44^{b}$ | $6.8^{a\,a}$ | 0.94 | 0.0001 | 1.72 |
| | MI | $6.3^{cb}$ | $6.59^{bb}$ | $6.64^{ab}$ | 0.94 | 0.0001 | 1.72 |
| | LO | $6.47^{b\,a}$ | $6.66^{a\,a}$ | $6.67^{ab}$ | 0.94 | 0.0001 | 1.72 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Yh** | **HL** | **4.06$^{ab}$** | **3.58$^{d}$** | **4.29$^{a}$** | **0.24** | **0.0001** | **3.69** |
| | **MI** | **3.92$^{bc}$** | **3.98$^{bc}$** | **4.23$^{a}$** | **0.24** | **0.0001** | **3.69** |
| | **LO** | **3.74$^{cd}$** | **3.98$^{bc}$** | **3.613$^{d}$** | **0.24** | **0.0001** | **3.69** |
| **Alwt** | **HL** | **19.88$^{d}$** | **22.123$^{b}$** | **20.136$^{d}$** | **1.21** | **0.0005** | **3.20** |
| | **MI** | **21.65$^{bc}$** | **20.726$^{cd}$** | **21.56$^{bc}$** | **1.21** | **0.0005** | **3.20** |
| | **LO** | **22.36$^{b}$** | **25.05$^{a}$** | **25.213$^{a}$** | **1.21** | **0.0005** | **3.20** |
| **Ywt** | **HL** | **14.72$^{a}$** | **14.04$^{bc}$** | **14.45$^{ab}$** | **0.48** | **0.0024** | **2.08** |
| | **MI** | **14.17$^{bc}$** | **13.79$^{cd}$** | **14.06$^{bc}$** | **0.48** | **0.0024** | **2.08** |
| | **LO** | **13.42$^{d}$** | **11.73$^{e}$** | **11.97$^{e}$** | **0.48** | **0.0024** | **2.08** |
| **Yc** | **HL** | **10.30$^{bc}$** | **10.27$^{bc}$** | **10.33$^{bc}$** | **0.46** | **0.0110** | **2.56** |
| | **MI** | **10.15$^{c}$** | **10.93$^{a}$** | **10.83$^{a}$** | **0.46** | **0.0110** | **2.56** |
| | **LO** | **10.67$^{ab}$** | **10.27$^{bc}$** | **10.97$^{a}$** | **0.46** | **0.0110** | **2.56** |

Means within rows and parameters with different superscript letters are significantly different ($P < 0.05$); AgEc = Agro-ecology; HI = High land; MI = Midland; LO = Lowland; CV = Coefficient of variation; LSD = Least significant difference.

# 5. CONCLUSSION AND RECOMMENDATION

Under the scavenging production system indigenous chickens have shown moderately good quality in most egg quality traits. Also the carcass yield characters of indigenous chickens were relatively good with moderately high dressing percentage along with better shares of valuable carcass components under the scavenging production system. The current study result shown that significant differences between the studied districts and agro-ecologies in their production and reproduction performance, egg quality traits and carcass characters of the indigenous chickens under scavenging production system. Generally eggs collected from low-land agro-ecology were higher mean egg weights and higher in most internal and external egg quality traits. Similarly chickens reared from Chena districts and low-land study areas were higher average live weights with most carcass yield components. This might be due to production environments of the study areas, feed types grown and agro-ecology types, that shown variations between the all-inclusive results of the local chickens in the study area.

Therefore, the following recommendations are stated:

Further detailed studies would be accompanied to assess more about the effects of different agro-ecologies and districts on indigenous chickens under scavenging production system which were not covered in this study.

Indigenous chickens generally can best fit with low management inputs under scavenging production systems in terms of their productive and reproductive performances. Therefore, additional studies should be conducted to evaluate more about the productive and reproductive performance under different agro-ecologies and districts.

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# 7. APPENDIX

**APPENDIX 1: Lists of ANOVA table**

Appendix table I ANOVA table for Egg weight, Egg width, Egg length, and Albumen height.

| Parameters | Source of variation | DF | SS | MS | F value | P value |
|---|---|---|---|---|---|---|
| **Egg weight** | **AgEc** | 2 | 28.03 | 14.01 | 14.23*** | 0.0002 |
| | **DiS** | 2 | 0.03 | 0.02 | $0.02^{NS}$ | 0.9844 |
| | **AgEc*DiS** | 4 | 5.79 | 1.45 | $1.47^{NS}$ | 0.2523 |
| | **Error** | 18 | 17.73 | 0.98 | | |
| | **Total** | 26 | 51.59 | | | |
| **Egg width** | **AgEc** | 2 | 0.20 | 0.1 | 34.42*** | 0.0001 |
| | **DiS** | 2 | 0.12 | 0.06 | 21.05*** | 0.0001 |
| | **AgEc*DiS** | 4 | 0.02 | 0.007 | $2.51^{NS}$ | 0.0786 |
| | **Error** | 18 | 0.05 | 0.003 | | |
| | **Total** | 26 | 0.40 | | | |
| **Egg length** | **AgEc** | 2 | 0.14 | 0.07 | 22.20*** | 0.0001 |
| | **DiS** | 2 | 0.09 | 0.04 | 15.05*** | 0.0001 |
| | **AgEc*DiS** | 4 | 0.12 | 0.03 | 9.55*** | 0.0003 |
| | **Error** | 18 | 0.06 | 0.003 | | |
| | **Total** | 26 | 0.41 | | | |
| **Albumen height** | **AgEc** | 2 | 0.04 | 0.02 | 1.57NS | 0.2346 |
| | **DiS** | 2 | 0.38 | 0.19 | 15.11*** | 0.0001 |
| | **AgEc*DiS** | 4 | 0.14 | 0.03 | 2.75NS | 0.0602 |
| | **Error** | 18 | 0.23 | 0.013 | | |
| | **Total** | 26 | 0.79 | | | |

*** Significant at $p \leq 0.001$ by LSD; NS= non- significant at $p > 0.05$; DF= Degree of freedom; SS = Sum of square; MS = Mean square; AgEc = Agro-ecology; DiS = District.

Appendix table IIANOVA table for Yolk height, Albumen weight, Yolk weight, andYolk color.

| Parameters | Source of variation | DF | SS | MS | F value | P value |
|---|---|---|---|---|---|---|
| **Yolk height** | **AgEc** | 2 | 0.35 | 0.17 | 8.20** | 0.0029 |
| | **DiS** | 2 | 0.2 | 0.09 | 4.50* | 0.0260 |
| | **AgEc*DiS** | 4 | 0.96 | 0.24 | 11.45*** | 0.0001 |
| | **Error** | 18 | 0.38 | 0.021 | | |
| | **Total** | 26 | 1.88 | | | |
| **Albumen Weight** | **AgEc** | 2 | 62.71 | 31.35 | 62.52*** | 0.0001 |
| | **DiS** | 2 | 8.69 | 4.34 | 8.67** | 0.0023 |
| | **AgEc*DiS** | 4 | 17.31 | 4.33 | 8.63*** | 0.0005 |
| | **Error** | 18 | 9.03 | 0.5 | | |
| | **Total** | 26 | 97.74 | | | |
| **Yolk weight** | **AgEc** | 2 | 20.84 | 10.42 | 130.23*** | 0.0001 |
| | **DiS** | 2 | 3.90 | 1.95 | 24.41*** | 0.0001 |
| | **AgEc*DiS** | 4 | 2.00 | 0.50 | 6.26** | 0.0024 |
| | **Error** | 18 | 1.44 | 0.08 | | |
| | **Total** | 26 | 28.19 | | | |
| **Yolk color** | **AgEc** | 2 | 0.68 | 0.34 | 4.65* | 0.0235 |
| | **DiS** | 2 | 0.53 | 0.27 | 3.66* | 0.0464 |
| | **AgEc*DiS** | 4 | 1.30 | 0.32 | 4.47* | 0.0110 |
| | **Error** | 18 | 1.31 | 0.07 | | |
| | **Total** | 26 | 3.83 | | | |

* Significant at $p \leq 0.05$ by LSD; ** significant at $p \leq 0.01$ by LSD; *** significant at $p \leq 0.001$ by LSD; DF= Degree of freedom; SS = Sum of square; MS = Mean square; AgEc = Agro-ecology; DiS = District.

Appendix table III Mean effect of different agro-ecologies on Egg weight, Egg width and Egg length.

| Parameter | Agro-ecologies | | | LSD (5%) | P value | CV (%) |
|---|---|---|---|---|---|---|
| | **HL** | **MI** | **LO** | | | |
| E. weight | $40.97^{b}$ | $41.59^{b}$ | $43.37^{a}$ | 0.98 | 0.0002 | 0.98 |
| E. width | $4.22^{a}$ | $4.17^{a}$ | $4.02^{b}$ | 0.05 | 0.0001 | 0.05 |
| E. length | $5.24^{a}$ | $5.14^{b}$ | $5.08^{b}$ | 0.09 | 0.0003 | 1.09 |

Means with in row and column with different superscript letters are significantly different (P< 0.05); CV = Coefficient of variation; LSD = Least significance difference; HI = High land; MI = Midland; LO = Lowland.

Appendix table IV Mean effect of different districts on Egg weight, Egg width and Egg length

| Parameter | Districts | | | LSD (5%) | P value | CV (%) |
|---|---|---|---|---|---|---|
| | Chena | Bita | Cheta | | | |
| E. weight | 41.93 [a] | 41.98 [a] | 41.98 [a] | 0.98 | 0.0002 | 2.36 |
| E. width | 4.23[a] | 4.10[b] | 4.08[b] | 0.05 | 0.0001 | 1.3 |
| E. length | 5.24 [a] | 5.12 [b] | 5.10 [b] | 0.05 | 0.0001 | 1.09 |

Means within row and column with different superscript letters are significantly different ($P< 0.05$); CV = Coefficient of variation; LSD = Least significant difference.

Appendix table V. Mean effect of interaction of agro-ecologies and districts on Egg weight, Egg width, Egg length, Yolk height, Albumen weight, Yolk weight, and Yolk colour.

| Parameter | AgEc | Districts | | | LSD (%) | P value | CV (%) |
|---|---|---|---|---|---|---|---|
| | | Chena | Bita | Cheta | | | |
| **Egg weight** | HL | **41.02[b c]** | **41.63 [ab]** | **40.25[cc]** | **1.09** | **0.0002** | **2.36** |
| | ML | **41.93 [ab]** | **41.13[c c]** | **41.71 [bb]** | **1.09** | **0.0002** | **2.36** |
| | LO | **42.85[ca]** | **43.28[b a]** | **43.98 [aa]** | **1.09** | **0.0002** | **2.36** |
| **Egg width** | HL | **4.31[a a]** | **4.14 [cb]** | **4.2[b a]** | **0.71** | **0.0001** | **1.30** |
| | ML | **4.25 [ab]** | **4.16[b a]** | **4.1[cb]** | **0.71** | **0.0001** | **1.30** |
| | Lo | **4.13 [a c]** | **4.01[b c]** | **3.9 [cc]** | **0.71** | **0.0001** | **1.30** |
| **Egg length** | **HL** | 5.317[a] | 5.14[cd] | 5.323[a] | 0.09 | 0.0003 | 1.09 |
| | **MI** | 5.265[ab] | 5.183[bc] | 4.98[e] | 0.09 | 0.0003 | 1.09 |
| | **Lo** | **5.16[c]** | **5.05[de]** | **5.047[de]** | **0.09** | **0.0003** | **1.09** |
| **Albumen** | HL | 6.47[b a] | 6.44[b] | 6.8[a a] | 0.94 | 0.0001 | 1.72 |
| **Weight** | MI | 6.3 [cb] | 6.59[bb] | 6.64 [ab] | 0.94 | 0.0001 | 1.72 |
| | LO | 6.47[b a] | 6.66 [a a] | 6.67 [ab] | 0.94 | 0.0001 | 1.72 |
| **Yolk** | **HL** | 4.06[ab] | 3.58[d] | 4.29[a] | 0.24 | 0.0001 | 3.69 |
| **Height** | **MI** | 3.92[bc] | 3.98[bc] | 4.23[a] | 0.24 | 0.0001 | 3.69 |
| | **LO** | 3.74[cd] | 3.98[bc] | 3.613[d] | 0.24 | 0.0001 | 3.69 |
| **Albumen** | **HL** | 19.88[d] | 22.123[b] | 20.136[d] | 1.21 | 0.0005 | 3.20 |
| **Weight** | **MI** | 21.65[bc] | 20.726[cd] | 21.56[bc] | 1.21 | 0.0005 | 3.20 |
| | **LO** | 22.36[b] | 25.05[a] | 25.213[a] | 1.21 | 0.0005 | 3.20 |
| **Yolk** | **HL** | 14.72[a] | 14.04[bc] | 14.45[ab] | 0.48 | 0.0024 | 2.08 |
| **Weight** | **MI** | 14.17[bc] | 13.79[cd] | 14.06[bc] | 0.48 | 0.0024 | 2.08 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | **LO** | $13.42^{d}$ | $11.73^{e}$ | $11.97^{e}$ | 0.48 | 0.0024 | 2.08 |
| **Yolk color** | **HL** | $10.30^{bc}$ | $10.27^{bc}$ | $10.33^{bc}$ | 0.46 | 0.0110 | 2.56 |
| | **MI** | $10.15^{c}$ | $10.93^{a}$ | $10.83^{a}$ | 0.46 | 0.0110 | 2.56 |
| | **LO** | $10.67^{ab}$ | $10.27^{bc}$ | $10.97^{a}$ | 0.46 | 0.0110 | 2.56 |

Means within rows and parameters with different superscript letters are significantly different ($P < 0.05$); AgEc = Agro-ecology; HI = High land; MI = Midland; LO = Lowland; CV = Coefficient of variation; LSD = Least significant differences.

Appendix table VI Correlation analysis

| | **Ewt** | **Ewd** | **EL** | **Alh** | **Yh** | **Alwt** | **Ywt** | **Yc** |
|---|---|---|---|---|---|---|---|---|
| **Egg wt** | 1 | $-0.63^{***}$ | $-0.43^{*}$ | $0.01^{NS}$ | $-0.43^{*}$ | $0.86^{***}$ | $-0.66^{***}$ | $0.39^{*}$ |
| **Ewd** | $-0.63^{***}$ | 1 | $0.77^{***}$ | $-0.34^{NS}$ | $0.29^{NS}$ | $-0.85^{***}$ | $0.87^{***}$ | $-0.38^{*}$ |
| **EL** | $-0.43^{*}$ | $0.77^{***}$ | 1 | $-0.23^{NS}$ | $0.16^{NS}$ | $-0.63^{***}$ | $0.63^{***}$ | $-0.39^{*}$ |
| **Alh** | $0.013^{NS}$ | $-0.34^{NS}$ | $-0.23^{NS}$ | 1 | $0.25^{NS}$ | $0.12^{NS}$ | $-0.25^{NS}$ | $0.42^{*}$ |
| **Yh** | $-0.43^{*}$ | $0.29^{NS}$ | $0.16^{NS}$ | $0.25^{NS}$ | 1 | $-0.42^{*}$ | $0.36^{NS}$ | $-0.14^{NS}$ |
| **Alwt** | $0.86^{***}$ | $-0.85^{***}$ | $-0.63^{***}$ | $0.12^{NS}$ | $-0.42^{*}$ | 1 | $-0.89^{***}$ | $0.21^{NS}$ |
| **Ywt** | $-0.66^{***}$ | $0.87^{***}$ | $0.63^{***}$ | $-0.24^{NS}$ | $0.36^{NS}$ | $-0.89^{***}$ | 1 | $-0.17^{NS}$ |
| **Yc** | $0.39^{*}$ | $-0.38^{*}$ | $-0.39^{*}$ | $0.42^{*}$ | $-0.14^{NS}$ | $0.21^{NS}$ | $-0.17^{NS}$ | 1 |

- = Negative correlation; NS = non-significant correlation; * = Significant correlation, ** = Highly significant correlation, *** = Very highly significant correlation.

## **APPENDIX 2.** Survey sample questionnaire


**COLLEGE OF AGRICULTURE AND NATURAL**

**RESOURCES DEPARTMENT OF ANIMAL**

**PRODUCTION AND TECHNOLOGY APPENDIX**

**Dear respondents:**

This research questionnaire is prepared to collect data for my senior research that concern about production and reproduction performance and management practices of indigenous chicken breed under traditional production system in kafa zone Southwest Ethiopia people's region. For the fulfillment of the requirement of the MSc degree in ANIMAL PRODUCTION. Hence you are kindly requested to relevant information needed, the researchers would like to assure you that response will be kept confidential and will be used only particular research purpose, therefore please feel free.

Thank you for your cooperation in advance.

**Addisu Gebreyesus**

**1. General Information**

1.1. Region_____Zone_____District (woreda)_____
PA (Kebele)_____.

1.2. Agro ecology a. high land__ % b. Mid land_____% c. low land_____%

1.3. Altitude_____masl

1.4. Farming system of the area_____a. Livestock production
b. Crop production, c. mixed

1.5. Major crops grown in the area, 1st._____2nd._____3rd._____4th. _____

1.6. Name of Innumerator_____Signature_____Date _____

**2. Background of the respondents**

2.1. Name of Respondent _____

2.2. Gender M._____ F. _____

2.3. Age respondent? 20-30_____ 30-50 >50 _____

2.4. Educational status of respondent? a. Illiterate b. Read and write

c. 1-4 d. 5-8 e. 9-10 f.>10

2.5. Marital status of the respondent? a. Single b. Married c. Divorce d. Widow

2.6. Main occupation of respondents, a. Farmer b. civil servant c. self employed

2.7. Household number of respondents?

2.7.1. . Male ---------- . Female----------

**3. Farm Characteristics**

3.1. Total farm land Size_____ha/Timad/.

**4. Livestock holding Characteristics**

4.1. Did you keep livestock? a. Yes b. No.

4.2. If yes, types and numbers of livestock are owned respectively?

| Cattle | Sheep & goat | Equine | Chicken | | |
|---|---|---|---|---|---|
| | | | Local | Exotic | Crossbreds |
| | | | | | |

4.3. Flock composition of indigenous chickens,

| Breed ecotype | Age and sex category(groups) | | | | | | Total |
|---|---|---|---|---|---|---|---|
| | Chicks (baby) | Pullets | Cockerels | Hens | Cooks | others | |
| | | | | | | | |
| | | | | | | | |
| **Total** | | | | | | | |

**5. Sources, Production system and purposes of chicken production**

5.1. When did you start rearing chicken? Since_____years

5.2. Where do you get your chicken first? a. Market b. Family c. Gift

d. Other (specify) _____

5.3. What type of poultry production system do you practice?

a.Traditional (Scavenging only)

b. Scavenging & Seasonal supplementation

c. Semi scavenging (Scavenging & Regular supplementation)

d. Intensive system

5.4. Type's labor used in keeping chicken, a. Family, b. Hired, c, Others specify _____

5.5. Owner of the chicken, a. Men, b. Women, c. Both,

5.6. Source of replacement stock a. Purchased, b. Inherited/gift, c. Hatched,

5.7. Contribution of Chicken production,

| No. | Purpose of rearing chicken | Rank accordingly |
|---|---|---|
| 1 | Sources of food (Egg and meat) | |
| 2 | Income generation | |
| 3 | For social and religious purpose | |
| 4 | Others specify | |

5.8. If you use chicken eggs and meat for source of food?

| No. | How frequent you use chicken eggs | Rank |
|---|---|---|
| 1 | Usually for homes consumption | |
| 2 | Only holidays | |

5.9. If you Sale eggs, meat and live chicks for Income generation and Accountable to sale?

| No. | Marketing/selling | Sales to | Accountable to sale | | | |
|---|---|---|---|---|---|---|
| | | | Husband | wife | Both | Other HH members |
| 1 | To neighbors | | | | | |
| 2 | To local market | | | | | |
| 3 | Both | | | | | |

HH, house hold

## 6. Production and Reproduction performance of Chickens

### 6.1. Production performance of local chicken:

**6.1.1.** Do you have your own Cock? a. Yes b. No

**6.1.2.** If yes, where is the source of your cock?

a. Market or neighbor's purchase b. Hatched and grown

c. Agricultural Office d. Other (specify) _____

**6.1.3.** If no, where do you get a cock for your hen? a. From neighbors

b. I do not need a cock for my hen c. Other (specify) _____

**6.1.4.** What is the average age of a cockerel at first mating in your management?

| Breeds | Types | Age at 1st mating(month) | Types | Age at 1st laying(month) |
|---|---|---|---|---|
| Local | Cockerel | | Pullet | |
| | | | | |

**6.1.5.** How frequent hens lay eggs until the end of the clutch period?

6.1.5.1. During feed surplus, a. Daily b. Every 3 days c. No eggs laid

6.1.5.2. During feed shortage, a. Daily b. Every 3 days c. No eggs laid

**6.1.6.** Average egg production and fertility of local chickens?

| Breed | Clutch period/ year | No of eggs layed/ clutch | Average egg layed/year/bird | No of eggs Incubated per single incubation | No ofchicken hatched | No ofeggs wasted | No of chicken Weaned | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | No | % |
| | | | | | | | | |

Note: Hatchability % = (No of chicken hatched / No of eggs incubated) *100 =_____% Total ave

**6.1.7.** Do you have any local practices used to avoid broodiness? a. Yes b. No

**6.1.8.** If yes, what type of practices you used? (Put in order of preference and applicability) a_____b._____c. _____

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

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

**6.1.10.** How many times do you incubate eggs per year? _____

**6.1.11.** Do you select size of hens for brooding? a. Yes b. No

c. Do not consider the size since any hen that manifested broody behavior is

allowed to brood.

**6.1.12.** If yes, which one do you prefer? a. bigger b. medium size c. Small

6.1.12.1. State the major causes for failure of hatching in order of importance,

1st---------- 2nd---------- 3rd---------- 4th----------

**6.1.13.** When do you usually incubate eggs (indicate season of incubation)? _____

**6.1.14.** Is there seasonal variability on hatchability? a. Yes b. No

**6.1.15.** If yes, at which season did you have the worst (lowest) hatchability?_____

**6.1.16.** When do you achieve the best results (indicate season)? _____

**6.1.17.** Do you use the mother hen in raising the chicks? a. Yes b. No

**6.1.18.** If yes, how long the hen spends weaning the chicks (in weeks)?_____

**6.1.19.** What is the fate of sick chicken? _____

## 7. Comments, Suggestions and Recommendations

7.1. What do you recommend performances of local chickens in your area?_____

7.2. How do you suggest the erosions of indigenous chicken's breeds in the area?_____

7.3. What are your suggestions to conserve the breeds? a, from society,_____

b, from governments,_____

_____C, from other Stakeholders_____

7.4. What do you think about the necessities of this study?_____

**Thank you for your cooperation!!!**

## APPENDIX 3. List of study pictures


**Picture of group discussion**

**List of study pictures**


**Field and experimental pictures of study area**