ASSESSING THE EGG PRODUCTION AND EGG QUALITY TRAITS OF SASSO CHICKEN BREED REARED UNDER TRADITIONAL HUSBANDRY PRACTICES IN MIDLAND AND LOWLAND AGROECOLOGIES OF ALETA CHUKO DISTRICT, SIDAMA REGION

MSC THESIS

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HAWASSA UNIVERSITY

COLLEGE OF AGRICULTURE

HAWASSA, ETHIOPIA

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DEDICATION

I dedicated this thesis manuscript to my beloved families and best friends who wished me all the best and success in my expedition.

STATEMENT OF THE AUTHOR

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LIST OF ABBREVATIONS

ACWLFDO	Aleta Chuko Woreda Livestock and Fishery Development Office
AH	Albumen Height
ANOVA	Analysis of Variance
AW	Albumen Weight
CSA	Central Statistics Agency
DB	Dominant Black
BN	Bovan Nera
DD	Dekalb Delta
EL	Egg Length
EW	Egg Weight
FAO	Food and Agricultural Organization
FGD	Focus Group Discussions
GDP	Gross Domestic Product
HU	Haugh Units
RCF	Roche Color Fan
ST	Shell Thickness
SPSS	Statistical Social Package System
YC	Yolk Colour
YH	Yolk Heigth
YW	Yolk Weight

TABLE OF CONTENTS

LIST OF TABLES

Tables **Page**

LIST OF FIGURES

LIST OF TABLES IN THE APPENDIX

LIST OF FIGURES IN THE APPENDIX

ASSESSING THE EGG PRODUCTION AND EGG QUALITY TRAITS OF SASSO HICKEN BREED REARED UNDER TRADITIONAL HUSBANDRY PRACTICES IN MIDLAND AND LOWLAND AGROECOLOGIES OF ALETA CHUKO DISTRICT, SIDAMA REGION

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ABSTRACT

This study was conducted to assess egg production and egg quality traits of Sasso chicken breed reared in two agroecologies under traditional management system. For the assessment of the egg production practices, 165 households were purposively selected from lowland and midland agro ecologies who had three and above Sasso chicken. The egg quality traits were assessed from Sasso chicken breed reared by the households in both agro ecologies. A total of 200 eggs were used to determine the external and internal egg quality traits from sampled households. The collected data were analysed by SPSS Version 26. The results indicated that average age at first egg laying(160) days, average clutch length (22.9) and eggs/hen/year(214)were in lowland agroecology. Average age at first egg laying(149) days, average clutch length(23.9) and eggs/hen/year(232) were midland. Agro ecology had highly significant effect on all external egg quality traits except on egg width. Egg weight(57.58g) and egg length(57.46mm) of Sasso chickens was higher($p<0.05$) in the lowland than(53.58g) and (55.80mm) in midland. Dry shell weight and shell thickness in the lowland agroecology was higher($p<0.05$) than in midland. Shape endex was higher($p<0.05$) in the midland than in lowland agro-ecology. Agro-ecology had also highly significant effect on most internal egg quality traits such as: yolk height, albumen height, albumen weight and haugh unit were higher($p<0.05$) in lowland than in midland. The yolk ratio in lowland was lower($p<0.05$) than in midland agro-ecology. However, albumen ratio was lower($p>0.05$) in lowland than in midland agroecology. In conclusion, the Sasso chickens in the midland agroecology were superior in egg production than lowland. However,the Sasso chickens in the lowland agroecology were superior on most external and internal egg quality traits under traditional production system. It is thus recommended to rear the Sasso chicken hens in the midland agroecology for enhanced egg production and lowland for enhanced egg quality traits.

Keywords: Agro-ecology; Egg Production; Egg quality; Sasso chicken.

1. INTRODUCTION

1.1. Background of the Study

Ethiopian poultry is an estimated total population of 57 million. Poultry includes cocks, cockerels, pullets, laying hens, non-laying hens and chicks. Most of the poultry are lying hens (34.26 percent), followed by poultry are chicks (32.86 percent). Pullets are estimated to be about 6.47 million in the country. Cocks and cockerels are also estimated separately, and are 6.38 million and about 3.27 million, respectively. The others are non-laying hens that make up about 4.59 percent (2.61 million) of the total poultry population in the country. With regard to breed, 78.85 percent, 12.02 percent, 9.11 and percent of the total poultry were reported to be indigenous, hybrid and exotic, respectively(CSA, 2021). Local chicken breeds are better to adapt the harsh environment, disease tolerance and good brooders, they are poor in the reproductive performance. Therefore, to improve the performance of the local chickens, the exotic chickens were imported to the country and crossed with local chicken (Nigussie, 2011).

Exotic poultry (Rhode Island Red, New Hemisphere, and White Leghorn) were introduced to Jimma and Alemaya College of Agriculture in different years under a USAID project to increase meat and egg productivity (Sisay, 2017). To increase the potential of indigenous poultry, extra exotic breeds were introduced like (White Leghorn and Bovans Brown, Rhode Island Red, New Hemisphere, etc.) hybridizing with indigenous poultry (Chaimiso, 2018). In addition, there are legally introduced chicks to Ethiopia for commercial purposes, such as BB (hybrid of RIR(cock)and Light Sussex (hen)), Isa Brown (hybrid of Rhode Island Red(hen)) and Rhode Island White (cock), Babcock and Fayomi were found to survive well. The high adaptability and friendly nature of these birds have created a great demand in Ethiopia

For instance, Tadesse *et al*.,(2013) reported that exotic chicken such as Isa Brown, Bovans Brown and Potchefstroom koekoek were distributed to smallholders of the Oromia region. Aman *et al*., (2017a) also reported that the cockerels and pullets (42-day old chicken) were distributed by the private chicken farms (Ethio-chicken poultry farm) to the Wolaitta Zone in SNNPR State and they also reported that the egg production and overall productive performances of exotic (Sasso) chickens were better than the indigenous chickens. Aklilu *et al*., (2013) also reported that the Potchefstroom koekoek breeds chicken were reared and showed good performance better than indigenous chickens under village production system of Afar region. Tadesse *et al*., (2013) reported that the exotic chicken such as Isa Brown, Bovans Brown and Potchefstroom koekoek showed good productive performance under farmers' management conditions in Oromia region. Dirsha (2009) also reported Rhode Island Red (RIR) chickens showed better production performance in Cheha Woreda, Ethiopia. Haftu, (2016) also concluded that exotic breed and cross breed chickens can produce a large number of eggs in the presence of adequate amount of feed. The most important inputs have been the introduction of improved (exotic) breed, improved feed, vaccine and medicaments and credit aiming at increased productivity (Fessiha, 2015).

Mostly dual purpose and layer chicken breeds were distributed in the last two decades. Among the dual purpose breeds of chicken, Sasso is one of the chicken breeds found in Ethiopia. Sasso chickens are slow growing, robust, easy to manage, multi-coloured birds which can be grown under different rearing systems from traditional to intensive production system. Sasso chicken consume more feed for every unit of egg produced. According to Osei Amponsah *et al*. (2015) average feed intake of Sasso is 145.1g/bird/day and feed conversation (FCR) 2.87. The body weight gain was higher than the local chicken. According to Richard *et al*. (2012), Sasso chicken had significantly higher weights (2.6-3.2 kg at 28 weeks) than the local chicken (1.2-1.7 kg) on the same duration. The body weight of male Sasso chicken at sexual maturity was 2.98 kg and the weight of female Sasso chicken at the age of greater than 20 weeks was 2.73 kg (Aman *et al*., 2017). Egg production performance of Sasso chicken is better than local chicken. The average age at first lay for the Sasso chicken in SNNPRs Region, Ethiopia was 5.95 months and the mean annual egg production was 229.14 under traditional production system (Aman *et al*., 2017).

The survival rate of Sasso chicken was 95- 97% for 19 weeks age, lay at first egg 165 days, laid 197 eggs/hen/year and 2.3 kg feed was consumed to produced 10 eggs, fertility rate of eggs 96.1%, hatching rate 78.8% and feed conversion ratio 2.45 (FAO, 2008). Sasso chicken are sourced from local market and highly distributed to smallholder farmers through the government agriculture office in Aleta Chuko district. As a result, systematic study is required to assess the egg production performance and egg quality traits of Sasso chicken breed under village chicken production system in Aleta Chuko district.

1.2 Statement of Problem

There are no detailed studies conducted in the Aleta Chuko district on the assessment of egg production and quality of Sasso chicken breed. Due to this there are limited information and no recorded data on the egg production and quality of Sasso chicken breed reared under the traditional production system makes it difficult to assess their importance especially the contributions of previous projects to improve the poultry production under small holder settings. Thus, information is extensively needed to know the production performance and quality traits of eggs under farmer's management condition to take any remedial measures to improve the production and productivity of chicken breed. Therefore, the commencement of egg laying, annual egg production and egg quality traits in this district has not been studied yet under traditional production system.

1.3 Scope and Limitation of the Study

The study was focused on the assessing egg quality traits and husbandry practices in Aleta Chuko district however, this study was limited to one district in four sampled kebeles and It was also focused only on the egg production and egg quality traits of sasso chicken breed in Aleta Chuko due to the time and budget constraints.

1.4 Objectives

1.4.1 General objective

- To assess the egg production practices and evaluation of egg quality traits of Sasso chicken breed under traditional husbandry practices in Aleta Chuko district.

1.4.2 Specific objectives

- To assess egg production and husbandary practice of Sasso chicken breed under traditional husbandry practice in Aleta Chuko district.
- To evaluate the external and internal egg quality parameters of Sasso chicken breed under traditional husbandry practices in Aleta Chuko district.

2. LITERATURE REVIEW

2.1. Chicken Production Systems in Ethiopia

2.1.1. Traditional chicken production system

Chicken production in Ethiopia for the most part, is a backyard operation that uses a few scavenging birds that are of low productivity. Traditional chicken production is production system practiced in most rural areas of the country with the objectives of the households" consumption and a source of additional income for the households. It covers 95-98% of the chicken production system of the country and it is not profitable since it is not market oriented. It contains a small flock size (5-20 chickens per household) which was indigenous breed types mostly depend on the scavenging feed sources and have low level of management practices such as feeding, watering, chicken health, housing and agricultural extension services (Afras, 2018).

In terms of bio-security, the backyard chicken producers use inputs with little or minimum external inputs, which includes poor quality feed, mixed cereals, local breeds some time combined with improved breeds obtained from extension services or other farmers, minimal veterinary services from bureau of agriculture and traditional housing systems (Aila *et al*., 2012). Even though, the productivity of village chicken production is low as a result of the above characteristics, little output obtained from keeping poultry contributes to household income and provides access to high quality protein, which is generally in short supply (FAO, 2010).

2.1.2. Small-scale commercial chicken production system

Small-scale chicken production systems have been integrated with human livelihoods for thousands of years, enhancing diet, income, and food and nutrition security of the rural poor (Alders and Pym, 2009). It is characterized by a medium level of feed, water and veterinary service inputs and minimal to low bio-security and strong impact on the most vulnerable sectors of society and plays a role in the sustainable development of communities (Gutu, 2018). Most small-scale chicken farms obtain their feed and foundation stock from large scale commercial farms (Nzietchueng, 2008). It contains a flock size of 50-200 improved breeds of chickens per household (Afras, 2018).

2.1.3. Large-scale/Commercial chicken production system

The large-scale/commercial chicken production system is highly intensive production system that involves kept under indoor conditions with a medium to high bio-security level. This system heavily depends on imported exotic breeds that require intensive inputs such as feed, housing, health, and modern management system. It characterized by higher level of productivity where chicken production is entirely market-oriented to meet the large chicken demand in major cities and also provides employment for a range of workers from chicken attendants to truck drivers to professional managers (Afras, 2018).

2.2. Introduction of Exotic Chicken Breeds to Ethiopia

It is believed that the improved breeds of chickens were introduced to Ethiopia by the missionaries sometimes in the mid decades of the last century (Meseret, 2010). Four breeds of exotic chicken (Rhode Island Red, Australop, New Hampshire and White Leghorns) were imported to Jimma and Haromaya in 1953 and 1956, respectively under USAID project (Solomon, 2007). Matawork (2016) also reported that due to the low performance of indigenous chicken, the introductions of highly productive breeds of exotic chicken were done in urban, peri-urban and rural areas in the country.

2.3. Productive Performances of Chicken

2.3.1 Local chicken breeds

Rural small-scale farmers use local chickens under poor management practices in poultry production, and the output from this outdated production sector is low compared to the contribution of exotic and hybrid chicken populations (Hinsemu *et al*., 2018).

According to Abebe *et al*. (2017) both male and female chicken in the Guji Zone of Oromia regional state reached age at sexual maturity at 5.98±0.2 months. The average age first egg lay of indigenous pullets in Yeki woreda of southwest Ethiopia was 6.8 months (Adam and Teshome, 2016). A study at the Assela livestock farm showed that the mean production potential for indigenous birds in Arsi under scavenging conditions was 34 eggs per hen yearly, with a mean egg weight of 38 g.

According to Tadesse (Getu and Birhan, 2015), the poor productivity of indigenous chicken under the household management system is characterized by high chick mortality before they reach around 8 weeks of age. Local chicken is the consequence of uncontrolled breeding between various indigenous poultry ecotypes, lacking organized breeding methods.

The mean egg weight of indigenous poultry around Arsi district, Ethiopia, was 38 g (Kassa *et al*. ,2021).In Southern Ethiopia, there are 4.6 clutches per hen/year and 15.4 eggs per clutch per hen. Consistent with Alemu (2020), the typical length of one egg-laying period per hen is expected to be about 21 days for local breeds.

2.3.2. Improved chicken breeds

The egg production is one of the important traits of chicken production. The average number egg laid/hen/year was 276.1 ± 11.03, 266.32 ± 8.7 and 187.04 ± 13.49 for Isa Brown, Bovan Brown and Koekoek (Dasalew *et al.*, 2013) under village production system in East Shewa of Ethiopia. According to Tesfa and Usman (2018) Koekoek were produced 213± 12.4 eggs per year in Adami Tullu Research Center. Aman *et al.* (2017) reported average number eggs laid/year/bird was 229.14±52.49 for Sasso breed under village production system in SNNPR of Ethiopia.

The average weight of Koekoek at 20 weeks of age under farmers' management condition was 1.5k and 1.1kg for male and females (Aman *et al*., 2017) in SNNPR of Ethiopia.The age at first lay egg and weight egg weight were important traits in laying hen. The average age of first lay was 142 days and 4.76 months for Koekoek and Sasso respectively (Aman *et al*., 2017) in SNNPR of Ethiopia.

Report of Alem (2014) indicated average egg production per clutch per hen for RIR was 45.2 in central Tigray. As reported by Geleta *et al*. (2013), egg weight of Fayoumi chicken at Adami Tulu Research center was 44.3g. Abraham and Yayneshet (2010) reported weight for egg of Fayoumi (43 g), for Rhode Island Red egg (52.5g) and for White Leghorn egg (52.1 g) in north Ethiopia.

2.4. Husbandry Practices of Traditional Chicken Production

Despite a large number of chickens population, the productivity per unit of animal and the contribution of this sector to the national economy is relatively low. This may be due to different factors such as poor nutrition, the prevalence of diseases, lack of appropriate breed and breeding strategies and poor understanding of the production system as a whole (Fisseha *et al*., 2010 and Negussie, 2011). Provision of inputs such as housing, additional feed and health care for village chicken production varies considerably among and within regions depending on the socioeconomic circumstances of the farmers (Melkamu and Andargie, 2014 and Zemelak *et al*., 2016).

2.4.1. Feed resources and feeding practices

Supplementation of feed has been reported as a common practice to promote chicken productive performance (Gutu, 2018). In Ethiopia, 99%, 97.5% and 98% feed supplementation by chicken owners were reported by Fisseha *et al*. (2010); Mamo *et al*. (2011), respectively. According to Addisu *et al*. (2013) in Northern Wello, the major objective of providing supplementary feed is for healthiness and maintenance of their chickens, to increase egg production and meat yield. Similarly, Aberra (2014) reported that although the supplementary feed is not satisfactory in terms of quality and quantity still supplementing their chicken was done in order to improve the productive performance of chickens.

The amount and type of supplementation were dependent on the type and size of crop production in different agro climatic zones (Worku *et al*., 2012; Ermias *et al*., 2015). For example, in the lowland agro ecology, sorghum and maize are one of the major grown crops that used for chicken feeding (Ermias *et al*., 2015). However, in the highland and midland agro ecologies of central Oromia, the widely used supplementary feeds are maize and wheat. Regarding frequency of feeding, 81.1% and 76.7% of the respondents in Ada‟a and Lume districts were feed their chicken three times per day respectively, while 18.9% and 23.3% provide two times per day in the same order (Desalew, 2012). According to Alemayehu (2017), frequency of supplementary feeding practiced by chicken owners is reported as three times per day (Morning, afternoon and evening) nearly 46%, twice a day (Morning and afternoon) (34%) and once a day (Morning) to be 8%

2.4.2. Source of water and watering of chickens

Water plays an important role for feed digestion and metabolic activity of chickens (Addis and Malede, 2014). According to Ahmedin (2014), all village chicken owners (100%) provided water to their chickens in Gorogutu district, east Hararghe zone, Ethiopia. Concerning the frequency of watering, most of chicken producers (55.6%) make water available all the time, twice a day (20%), once a day (20%) and every other days (4.4%) in Gorogutu district of east Hararghe zone (Ahmedin, 2014). According to Desalew (2012), about 96% of respondents in both Ada‟a and Lume districts provide water with free access. In the study of Alefa district in North Gondar Zone, 19.8% of the respondents provide water to their chickens only during the dry season and the remaining (79.2%) offered throughout the year (Addis and Malede, 2014). However, all respondents together with equal proportion from Quara and Tache Armacheho districts of North Gondar Zone, Ethiopia, provided water for their chicken both in dry and wet season (Addis and Malede, 2014).

The major sources of provided water in Alefa district is obtained from river (56.67%), spring (26.67%), locally constructed underground water (3.33%) and hand operated pipe water (13.33%). In the study of Quara district, the water sources were river (26.67%), spring (16.67%), locally constructed underground water (10%) and hand operated pipe (46.67%). Whereas, in Tache Armacheho district river (33.33%), springs (20%) and hand operated pipe water (46.67%) were the major sources of water that households supplied for their chickens (Addis and Malede, 2014). According to Ahmedin (2014), the major sources of water for village chicken in the study area of Gorogutu district were:- spring water, well water, river water and pond water. The most widely used types of watering troughs in the study area were broken home utensils, broken gourd and locally made watering trough from wood.

2.4.3. Housing

Housing is one of the important chicken management practices to increase their productivity. Family housing and sheds are the major housing systems used by farmers to shelter chicken during the night (Zemelak *et al*., 2016). There is no separate chicken house and the chicken lives in family dwellings together with human in the traditional chicken production system in Ethiopia (Solomon, 2008). According to Fisseha (2014), about 88.5% of village chicken producers do not have separate chicken house and they keep inside the family dwelling at night in Enkulal

Watershed and Dera district of Amhara region. In Ethiopia, sheds are made from locally available materials (Mekonnen *et al*. 2010; Desalew *et al*. 2013).

2.4.4. Chicken health management

The availability of vaccine was not the main problem in our country, but the major constraint was there is no organized linkage between the technology participants and agricultural offices(Ermias, 2015). Similarly, in Gomma district of Jimma zone all of the chicken owners have no habit of health care programs such as vaccination and de-worming, as well as there is no formal training schedule on poultry husbandry.

In the survey report of Hunduma *et al*. (2010), about 44% of respondents in Rift Valley of Oromia usually treat sick chickens using traditional medicine whereas others (41%) do nothing. Only 11% of the respondents consult veterinarians when their chickens get sick; this is as a result of veterinary service insufficiency.

The chickens share the family dwellings as a night shelter and roam around the family dwelling for feeding materials; this in turn caused the high mortality of chickens by disease and predators and there is a transmission of disease from infected chickens to the health ones (Meseret, 2010)

Lack of awareness about the presence of chicken vaccines (71.4%), lack of attention to village birds (13.6%) and low availability of vaccines (15%) were the major reasons of village chicken owners for lack of vaccination against diseases in Bure district (Fisseha *et al*., 2010). The result revealed that farmers have limited access to regular veterinary services.

2.4.5. Agricultural extension services

Village poultry production often encounters problems related to lack of organization, which implies that local inputs such as feed, medication, veterinary services and training are rarely available locally. In most extensive production systems, chicken production receive limited institutional support services such as extension services, credit, veterinary services, training and marketing of the products (Justus *et al*., 2013). According to Justus *et al*. (2013) less than half of the farmers in western Kenya have access to extension (42.5%) and veterinary services (34.2%) during the survey period. Desalew (2012) report showed that 58.8% in Ada‟a and 46.6% respondents in Lume districts did not use agricultural extension services to improve their poultry productivity. Agricultural extension services are used by 41.2% in Ada‟a and 53.4% of the respondents in Lume districts to improve the productivity of their flocks. Regarding training provided to respondents in two districts, 28.9% in Ada‟a and 37.8% respondents in Lume were provided training on improved poultry production practices.

2.5. Major Constraints of Traditional Chicken Production in Ethiopia

2.5.1. Feed shortage both in quality and quantity

Availability, quality, and price of feed ingredients are the main constraints on poultry production, no matter the system of production and geographical location. The main constraints on chicken production are poor nutrition and health problems. Poultry production is similarly inhibited by reduced contact with goods, markets, and services, poor institution commitment, and absence of skills knowledge (Ahiwe *et al*., 2018)

In the lowland agro-ecology, both white and yellow sorghums were mainly used chicken feeds for supplementation (Etuk *et al*., 2012) and maize was one of the majorly used feed supplements because the maize price was low and chickens-like maize compared to other cereal grains(Ermias, 2015).

2.5.2. Presence of disease

Based on Chaimiso (2018) it is reported as a disease (mainly New Castle Disease, locally referred to as 'Sombe/Fengil') and predator cause death for village chickens in the valley of Oromia, Ethiopia. Field experiments among village poultry have been successful, and research has discovered interesting advances in NCD vaccine development. In many poor countries, however,NCD immunization is not currently included in local poultry extension programs. New castle diseases are wreaking havoc in our rural areas these days (Terfa *et al*., 2018).

2.5.3 Predators

Predators like birds of prey (34%), dogs and cats (16.3%), and wild animals (15%) cause the death of household poultry in the basin of the Oromia region, Ethiopia. Predators (snakes, rats, dogs, cats, and foxes) caused losses, especially in young birds, within the southern neighborhood of Ethiopia (Bekele and Shigute 2019a). Similarly, Tadesse (Sonnino 2017) reported wild birds (eagles, hawks, etc.) and wild cats (locally referred to as 'Shelemetmat') as dangerous predators in the southern part of Ethiopia.

2.5.3. Lack of capital and labor

According to interviewed chicken keepers, the major constraint of adoption was lack of capital (Heaven-light, 2013). Improved management intervention is required to achieve increased productivity of Local Chicken for mitigating constraints such as diseases, poor feedings, and housing. The management intervention package designed to improve the productivity of local chicken (LC) includes housing, feed supplementation, vaccination, brooding, and chick-rearing (Olwande *et al*., 2010). The management interventions require more labor and capital input than the extensive production system and make greater demands on family labor (Ngeno *et al*., 2010). Due to the large amounts of input required many farmers shy away from adopting the management intervention package because of lack of enough capital (Ochieng *et al*., 2011). Access to capital has been a severe constraint to the utilization of local chicken production technology (Olaniyi *et al*., 2008).

2.6. Egg Quality and their Relative Importance

Egg is one of the most essential cheap sources of protein in human diet all across the globe; egg quality is composed of those characteristics of an egg that affects its acceptability to consumers such as cleanliness, freshness, egg weight, shell quality, yolk index, albumen index, Haugh unit and chemical composition (Song *et al.*, 2000). Quality of an egg ascertains the success of a poultry business because it is associated with the acceptability among the consumers (Rajkumar *et al.*, 2009).

Egg quality is factor which contributes for better economy price of fertile and table eggs. In general, the characteristics of egg quality have genetic basis (Scott and Silversides, 2001)**.** Egg quality was defined by Stadelman (1977) as characteristics important for consumers. Economic success for a production flock is measured with total number of produced eggs (Monira *et al.*, 2003). A wide range of physical and chemical properties make up a total egg quality (Shanawany, 1988). The avian egg is an excellent source of nutrient which is widely accepted for human consumption. Egg production is one of, if not the major performance parameter of a laying bird. Egg production is believed to be a complex qualitative trait which is influenced by several factors e.g. breed, nutrition, age, weight of birds, level of production, management practices and environmental factors. (Williamson and Payne, 1982; Oluyemi and Roberts, 2000).Certain traits of economic importance in egg production include the egg number, egg quality traits, and other egg indices (Oluyemi and Robert, 2000).

The management and nutrition of the hen do play a role in internal egg quality, egg handling and storage practices do have a significant impact on the quality of the egg reaching the consumer. The interior of hen´s egg consists of the yolk and white or albumen. Interior characteristics such as yolk index, haugh Unit, and chemical composition are also important in egg product industry as the demand for eggshell colour has always received more attention from the consumer than it deserves (Gerber, 2012).

Eggshell colour does give an indication of the breeding history of the hen. White eggs are produced commercially by lines derived principally from the White Leghorn breed, whereas brown eggs are produced by hens derived from a number of dual-purpose breeds, including Barred Plymouth Rock, Rhode Island Red, Rhode Island White, Australorp, New Hampshire, Oravka, and others. These dual-purpose breeds were kept in farm flocks in the last century, and brown eggs have been perceived by the consumer to be more natural or healthy than white eggs (Scott and Silversides, 2000).

2.7. Egg Morphometric Analyses

Morphometric in general refers to measurements of the body parts. The knowledge and information on morphometric parameters is therefore essential for understanding an animal and its reproductive biology in particular (Danilov, 2000). Egg morphometric parameters such as egg weight, egg width, albumen and yolk weights are very important in poultry because these factors influence egg quality and grading (Farooq *et al.*,2001), reproductive fitness of the chickens and embryonic development (Onagbesan *et al.*,2007). Effects of feed (Shapira, 2010) and housing system (Wang *et al.,* 2009) on egg composition and its quality have been reported. Internal egg quality parameters such as albumen weight and yolk weight are very important from nutritional and cholesterol content for human consumption (Sparks, 2006).

Economically important egg morphometric parameters such as weight, size, albumen and yolk contents are quantitative traits that show continuous variability (Chatterjee *et al.,* 2007; Islam & Dutta, 2010). It is also an established fact that the weight of an egg is a direct proportion of shell, albumen and yolk that it contains and this varies significantly between strains of the bird species (Jones *et al.*, 2010; Momoh *et al.*, 2010).

2.8 Egg Quality Characteristics

The overall quality of an egg can be discussed under two broad categories namely "external" and "internal" quality (Monira *et al.*, 2003). The external quality of the egg is determined by features such as the size and shape of the egg as well as the structure, thickness and strength of the shell (Bain, 2005). The internal quality is measured on the basis of the quality of the albumen as indicated by the Haugh Units (HU), the relative size of the various internal components and the integrity of the shell membrane. Several studies have looked at this egg quality assessment in chickens (Tona *et al.*, 2002; De Ketelaere *et al.*, 2004; Bain, 2005). Among many quality characteristics, external factors including cleanliness, freshness, egg weight and shell weight are important in consumers acceptability of shell eggs (Adeogun and Amole, 2004; Dudusola, 2010).

Egg quality characteristics are of high importance. In analyzing egg quality, different internal and external egg quality characteristics have to be analyzed; egg quality is presented by its weight, percentage of eggshell, thickness and strength of eggshell (Silversides and Scott, 2001). Of the internal egg quality characteristics, thick albumen is quite an important measure for the freshness of an egg.

It is obvious that beneficial egg quality traits are of immense importance to poultry breeding industries (Bain 2005). In addition, the interior of hen´s egg consists of the yolk and white or albumen. Interior characteristics such as yolk index, Haugh Unit, and chemical composition are also important in egg product industry as the demand for liquid egg, frozen egg, egg powder and yolk oil increases (Scott and Silversides, 2001).

Table 1: Chemical Composition of Eggs in Percentage

Product	Percent %	Water	Protein	Fat	Ash
Whole Egg	100	65.5	11.8	11	11.7
Albumen	58	88	11	2	8
Yolk	31	48	17.5	32.5	2

Source: USDA

Yolk colour (**YC**) is a quality measure in eggs that is quite variable and easily changed (Zeidler, 2002).The diet of the hen has the greatest influence on YC (Galobart *et al.*, 2004).The YC can be easily manipulated by using synthetic additives, and this is frequently done in many countries (Zeidler, 2002). To achieve the basic yellow colour of a typical egg yolk, yellow xanthophylls are needed because YC is influenced so heavily by the diet, the age and breed of hen has little influence (Galobart *et al.*, 2004).Yolk colour is subjectively determined by the use the Roche colour fan (Vuilleumier, 1968;Stadelman, 1995). Yolk color is a key factor in any consumer survey relating to egg quality (Okeudo *et al.*, 2003). Yolk quality is determined by the colour, texture, firmness and smell of the yolk (Jacob *et al.,*2000).

The determinant of yolk colour is the xanthophyll (plant pigment) content of the diet consumed (Silverside *et al.,*2006). Among feed ingredients, only supplemented maize contributes to improved color intensity of the yolk. Thus, if a hen has access to green grass or supplemented feed ingredients containing carotenoids/xanthophylls, it will be enough to give the yolk the colour preferred by consumer (Zaman *et al.,* 2004). The yolk of a freshly laid egg is round and firm (Jacob *et al*.,2000). However, as the egg ages and the vitelline membrane degenerates, water from the albumen moves into the yolk and gives green grass during scavenging might be responsible for carotenoid deposits in the yolk, which improves the yolk color(Zaman *et al.,*2004)

Albumin Quality is related to the consistency, appearance and the functional properties. It is measured in terms of Haugh Units (HU) proposed by Haugh (1937). Calculated from the height of the albumin and the weight of the egg, however, most eggs leaving the farm should be between 75 and 85 HU (Coutts and Wilson, 1990). (Rajkumar *et al.*, 2009) reported that Age of the hen and season of the year can also affect Haugh unit values brown egg layers produced eggs with higher HU. It is generally accepted that the higher the Haugh unit value, the better the quality of the egg. It is also important that all eggs being evaluated at the same internal temperature.

Albumen Height (AH) Albumen refers to the “white” of an egg and consists of a thick and thin portion. The thick albumen is the portion immediately surrounding the egg yolk, whereas the thin albumen comprises the rest of the white portion. The height of the albumen indicates the freshness of the egg and can be measured using a tripod micrometer. Once the egg is broken onto a flat surface, a tripod micrometer is placed over the thick albumen. The centre pin is lowered until it “kisses” the albumen and the height, typically in mm, can be observed. The thicker the albumen, the better the quality of the egg, with heights of 8 to 10 mm being considered superior interior quality (Zeidler, 2002).While AH can be measured directly, an additional measure of AH, HU, which accounts for WT, can be calculated (Haugh, 1937; Williams, 1992). The calculation forHU is as follows: HU = 100 log $(AH – 1.7EW)^{0.37} + 7.57$

Where AH the height of the albumen in mm and EW is is the weight of the egg in g. Since the relationship between EW and AH is not constant across breeds of birds, the HU is not appropriate for comparing eggs across breeds (Silversides, 1994)

Egg shell Thickness and Color (EST) The egg shell quality is given throw the weight and the percentage of shell, thickness and the strength. The differences in eggshell quality depend on the environmental conditions and the feed quality and also of strain of layers (Zita *et al.,* 2009). On the other hand, (Khan *et al.*, 2004) reported no significant effect of breed on eggshell thickness under semi scavenging condition.

Eggshell thickness is also an important external quality trait for hatchability. And it should be between 0.33 and 0.35 mm and few eggs with a shell thickness less than 0.27mm will hatch Thickness measurements are typically taken along the midline of the egg and done using a micrometer and can only be evaluated after an egg has been broken. (Khan *et al.,*2004).An eggshell thickness of at least 0.33 mm has been estimated to be necessary for the egg to have at least a 50% chance of withstanding normal handling conditions without breaking (Stadelman, 1995).

Eggshell colour has always received more attention from the consumer than it deserves. Eggshell colour does give an indication of the breeding history of the hen. White eggs are produced commercially by lines derived principally from the White Leghorn breed, whereas brown eggs are produced by hens derived from a number of dual-purpose breeds, including Barred Plymouth Rock, Rhode Island Red, Rhode Island White, Australorp, New Hampshire, Oravka, and others (Silversides, 2000)

Egg Weight (EW); Egg weight is a very simple measurement to collect and therefore is frequently analyzed simply by placing an unbroken egg on a scale and recording the value

(Zeidler, 2002). Genetics and environment greatly influence egg weight. (Scott and Silversides, 2001)**.** Weights of eggs are divided into 6 size categories. Minimum weight requirements in the United States for these categories are: jumbo (68.6 g), extra-large (61.5 g), large (54.4 g), medium (47.3 g), small (40.3 g) (Zeidler, 2002).Egg weight is also one of the important phenotypic traits that influence egg quality and reproductive fitness of the chicken parents (Islam *et al.,* 2001; Farooq *et al.,* 2001). (Anderson, 2002) provided detailed information on the differences in egg production and quality between different white and brown egg strains and reported the egg weight from brown hens (61.1g) was more than that of white hens (58.3g). (Tixier Boichard *et al.,* 2006) recorded weight of 42.8 g for Fayoumi eggs

Higher weight of egg from commercial strains is not a surprise since such strains submitted to important breeding pressure for egg weight improvement (Hocking *et al*., 2003). Further, under smallholder farmers condition in northern Ethiopia, egg weight was recorded as 52.5g, 52.1g and 43 g for Rhode island Red, White Leghorn and Fayoumi, respectively (Lemlem and Tesfaye, 2010).

Egg Shape Index (ESI) is a measurement of the overall shape of an egg. The three shapes most prevalent in production are classified as sharp (SI of < 72), normal (SI of 72-76), and round (SI >76). Egg shape is important in commercial systems, as shapes outside thenormal range do not fit well into pre-made packaging. Also, sharp eggs are not as resistant to the shipping and handling processes, as are their normal counterparts (Altuntas and Sekeroglu, 2007). To calculate shape index, the EW and EL of the egg are measured in cm using calipers. The EW is then divided by the EL and that ratio multiplied by 100 (van den Brand *et al.,* 2004).

Since SI is important for commercial industry, when considering pre-made packaging, normal shaped eggs are ideal for fitting into containers. Normal shaped eggs also provide more strength to the eggshell, compared to sharp eggs, making them more resistant to breakage during shipping and handling (Altuntas and Sekeroglu, 2007). Additionally, uniformity in egg shape is important, as the market for further processed eggs continues to grow. The efficiency of this market is based on the use of automatic breakers, and conformity in egg shape to the characteristics ofthis machinery is essential. The findings of (van den Brand *et al.,* 2004), lead us to anticipate a decrease in SI, from sharp to normal, as hen’s age.

3. MATERIALS AND METHODS

3.1. Description of the Study Area

The study was conducted in Aleta Chuko district in the two agroecologies and in four kebeles namely; Checho-Weyama and Loko-Dama as Lowland and Gure and Korke as Midland agroecology, Sidama Region, Ethiopia. Aleta Chuko is located in the Sidama Regional State at, 330 KM south of Addis Ababa and 62 KM south of Hawassa, the capital of Sidama Regional State. Its geographical location extends from $6^{0}46'$N to $7^{0}01'$N and $38^{0}04'$E to $38^{0}24'$E.Administratively the district is divided into 26 rural Kebele and 7 urban Kebeles. According to CSA annual sample survey report, 2016/2017, the total population of Aleta Chuko district is 209,886, of which 102,215(48.7%) is male and 107,671(51.3%) female. The district has an estimated land area of 32.2 square kilometers. Altitude varies between 1400 and 2000m above sea level and the area is characterized by lowland agro-ecological zones (CSA, 2010). Livestock are reared by many people living in the rural in extensive or semi- intensive production system. The Livestock reared in the area are cattle (87771), sheep (11246), goat (18760), and poultry (68276), horse (272), and mule (892) (ACWLFDO, 2012). The dominant crops are "Enset", Coffee, Fruit (Pineapple, Banana, Mango, and Avocado), and Annual crop includes Maize and Vegetables like Potato, Tomato and Cabbage etc.

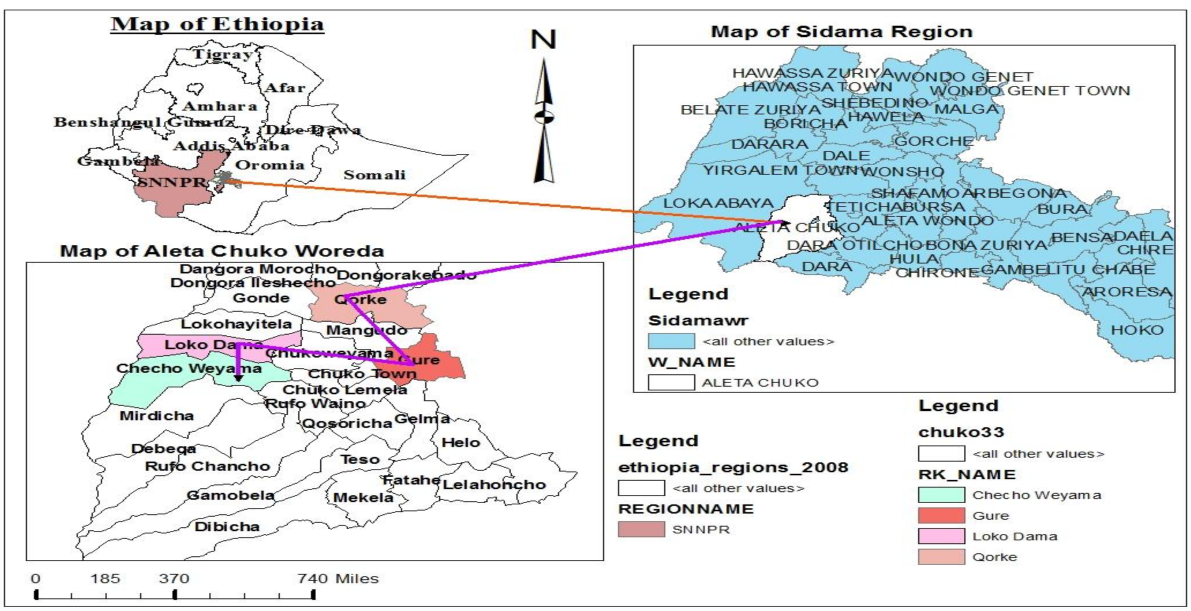

Figure 1: Map of Aleta Chuko district

3.2 Sampling Techniques and Sample Size Determination

The study consisted of a survey and laboratory part. The survey part was conducted in Aleta Chuko district in two agroecologies. In order to collect well-built data needed to achieve the objectives of the study, a multi-stage purposive sampling technique was used for the study.

In the first stage, the district was purposely selected mainly with the considerations of the potential of Sasso chicken distribution and accessibility. In the second stage, from the total 31 kebeles found within the district stratified in to two groups based on the lowland and midland agro-ecology. In the third stage, four kebeles (two kebeles from each agro-ecology) was selected purposely sampling based on their access to Sasso chicken distribution. Two kebeles namely: - Checho-Weyama and Loko-Dama from lowland and two kebeles namely: - Gure and Korke from midland agro-ecology was purposively selected based on the distance from the district and Sasso chickens availability. From two Agroecologies there were 280 households that have a minimum of 3 Sasso adult chickens. From the total 280 households, 165 sample sizes were selected in study area by using the following formula. (Yamane. T, 1967).

$n = N/ (1+N (e)^2)$

$n= 280/ (1+280(0.05)^2)$

$n=164.705=165$

Where, N= population size

n = sample size e= error term

Therefore by using method of proportional allocation under the size of samples

$\mathbf{n}i=\mathbf{n}*\mathbf{P}i$ or $\mathbf{n}i=\mathbf{n}*(\frac{\mathbf{pi}}{\mathbf{N}})$ where, **n**i= sample size

n=total sample size

Pi=the proportion of population

N=total population size

n=165, N=280, Population size of Checho-Weyama (N1) was=74, Population size Loko-Dama (N2) was =66, Population size of Gure (N3) was =72 and Population size of Korke (N4) =68

Source: ACWLFDO, 2022

Then, N1= 74 is $n_1=165(\frac{74}{280})=44$, N2= 66 is $n_2= 165(\frac{66}{280})=39$

So, Sample size of lowland agroecology was= 83

N3= 72 is $n_3= 165(\frac{72}{280})=42$ and N4= 68 is $n_4= 165(\frac{68}{280})=40$

So, Sample size of midland agroecology was= 82

3.3. Methods of Data Collection

The survey data were collected as primary and secondary data. Primary data was collected from household interviews, field observation, focus group discussion and key informant interviews. Secondary data was collected from district and woreda agriculture offices like, poultry population and way of chicken management system by reviewing different document.

3.3.1. Inreview using a semi-sturctured questionnaire

The questionnaires were pre-tested before the actual data collection. In addition to questionnaire data collection, general inspection regarding housing, feeding and health of poultry were carried out. A cross sectional survey was carried out for each household to collect information focusing on source of Sasso breed chicks, average number of hens and cocks, management system such as chicken housing system, feed and feeding practices, watering, use of extension packages, production training, health management system, major constraints and options suggested by farmers to improve chicken production. Moreover, the productive performances interms of number of egg produced/hen/year, age at first egg laying, number of eggs per clutch and husbandry practices were also the core points considered in the process. Average number of eggs were taken from farmers' estimation of eggs laid/hen/year.

3.3.2 Focus Group Discussions

Regarding the focus group discussion, based on the following parameters such as, age groups, sex and socio economic status in village of the district including the livelihoods, socio economic conditions of the community, model farmers and the elder farmers was identified and included in the discussion. Type of participants in focus discussion majorly were women.

One focus group discussions at each kebeles was conducted and each focus group comprised eight to twelve individuals. This was guide us to get data about the performance of Sasso chicken breed and to obtain opinions, attitudes and views from the group discussion participants and to clarify and crosscheck ideas and experiences that was gathered through household survey.

3.3.3. Key informants

This was employed, to gather in-depth data which related with the study objectives. Those key informants are from district sector of agriculture and livestock resources office, concerned with the study issue was participating in availing required information or data that the researcher need. Thus, experts from different sectors, such as livestock resources in general and poultry resources development as well as veterinary experts in particular, and development agents (DAs) from each kebeles' was included as a key informant interview

3.4 Evaluation of External and Internal egg quality parameters

A total of 200 fresh eggs were collected from adult laying hens in lowland and midland agroecologies in Aleta Chuko district during the survey for evaluating egg quality traits of Sasso Chicken breeds. Laboratory tests were performed at the Poultry Laboratory of the School of Animal and Range Sciences, Hawassa College of Agriculture, Hawassa University, Ethiopia. The eggs were first coded and then weighed with an electronic balance to the nearest 0.001 g. Then egg length and width were measured by electronic digital caliper sensitive to 0.001 mm and egg shape index was calculated as a ratio of egg width to egg length multiplied by 100. Next the eggs were broken on to a glass covered table and the albumen and yolk heights were measured using Tripod Micrometer, calibrated in mm whereas yolk width was measured by using an electronic digital caliper. The yolk colour was determined using the Roche Colour Fan with a standard colorimetric system ranged from 1 to 15 (1 = very pale to 15 = deep orange). The average grading for egg color made by four different persons by the Roche Color Fan was used. Following this, the yolk was carefully separated from the albumen and weighed. Then, the cleaned egg shells were dried in the open air for 24 hours and weighed together with the shell membrane. Finally, the egg shell thickness was measured from the two ends and middle position of the egg using an electronic digital caliper and the average of the three was used. In addition, egg shell ratio was calculated as a shell weight to egg weight multiplied by 100. Shape index ratio was calculated as egg width to egg length multiplied by 100. The albumen weight was calculated by subtracting yolk weight and dry shell weight from the gross egg weight. Yolk weight ratio (%) was calculated as a ratio of yolk weight to egg weight multiplied by 100. Albumen weight ratio (%) was calculated as a ratio of albumen weight to egg weight multiplied by 100. Shell weight ratio was calculated as a ratio of shell weight to egg weight multiplied by 100 (Khan *et al*., 2004; Anderson *et al*., 2004). Individual Haugh Units (HU) was calculated from the two parameters; height of albumen in mm (AH) and egg weight in g (EW) HU=100 log (AH–1.7 EW 0.37 + 7.6) (Haugh, 1937)

3.5. Methods of Data analysis

Both quantitative and qualitative data were analyzed using Statistical Package for Social Sciences (SPSS Version. 26). Independent Sample T-test and Chi-square test were used to analyze the quantitative data and qualitative data, respectively. Descriptive statistics was used to present the overall and siginificant values were considered statistical significant at $p<0.05$. Difference in productive and egg quality traits were compared using statistical tools such as mean, frequency, percentage, standard deivation and pearson square correlation and present by Tables. A priority index was also used to rank the constraints of poultry production according to their severity using the following formula:

Priority index = (F1*6) +(F2*5) + (F3*+4) + (F4*3) + (F5*2)+(F6*1)/Ftotal F1= Frequency of the first rank; F2= Frequency of second rank; F3 = Frequency of third rank; F4= Frequency of fourth rank; F5= Frequency of fifth rank; F6= Frequency of sixth rank FT= Frequency of total respondents. The variable with the highest index value was the highest economically important trait (Kosgey, 2004).

The following model was used for analysis of egg production and egg quality traits.

$Yij = \mu + \alpha i + eij$

Where: Yij = the response variable, μ = overall mean, αi = the effect of i^{th} agro-ecologies (i=1-2), and eij =random error

4. RESULTS

4.1. Survey Results

4.1.1. Average number of hens and cocks per respondents

According to the survey result, the number of hens was more than the number of cocks per respondents in both agroecoligies in Table 2. The average number of hens was 3 in both agroecoligies and average number cocks was 1 in both agroecologies. The hen to cock ratio was 3.0

Table 2**:** Average number of hens and cocks per respondents reared in the study agro ecology (Mean±SD)

Number of chickens	Lowland(N = 83)	Midland (N=82)	Overall mean (N = 165)
Hen	3.0±0.6	3.0±0.7	3.0±0.6
Cock	1.0±0.5	1.0±0.5	1.0±0.5
Total	4.0±0.6	4.0±0.6	4.0±0.6
Hen to cock ratio	3.0±1.0	3.0±1.3	3.0±1.4

N= number of respondants ,SD = standard deviation.

The survey result showed that there was no significant variation in flock size between the studied agroecologies.

4.1.2 Source of Sasso breed chicks

Table 3: Source of Improved Sasso breed chicks in lowland and midland agroecologies

Sources of chicks	Agro-ecology			
	Lowland(N=83)		Midland(N=82)	
	Frequency	%	Frequency	%
Purchased from local market	62	74.7	56	68.3
Purchased from private hatcheries	-	-	3	3.7
From government	21	25.3	23	28.0

N= number of respondants.

However, only 25.3% and 28.0% respondents purchased chicks from govermaent in lowland and midland agro-ecoligies, respectively. None of the respondents purchased chicks from private hatcheries in lowland agroecology and only 3.7% of respondents purchased chicks from private hatcheries in midland agroecology.

4.1.3 Chicken housing system and facilities

The results of chicken housing and facilities assessment are presented in table 4. The highest proportion of the respondents, 85.5% in lowland was share the same house with their chicken and The highest proportion of the respondents, 65.8 % in midland agro-ecology was constructed a separate house with cattle, whereas from total respondents who constructed separate chicken house was only 2.4 % and 9.8 % in lowland and midland, respectively.

No respondents were provided electricity in lowland agroecology in chicken house and 26.8% respondents was provided electricity in chicken house midland. Adequate ventilation facilities in chicken house were provided by 90.4 and 87.8% in lowland and midland agroecology, respectively. Only 8.4% and 12.2 % of the respondents in midland and lowland agroecology, respectively, used litter for rearing chicken.

Table 4: Chicken housing system and facilities used in lowland and midland agro-ecology

Chicken housing system and facilities	Agro-ecology					
	Lowland N=83		Midland N=82		Overall Mean	
Poultry Housing system	Freq	%	Freq	%	Freq	%
Separate house constructed for chicken	2	2.4	8	9.8	10	6.1
Share the same house with people	71	85.5	20	24.4	91	54.95
Separate house with cattle	10	12.1	54	65.8	64	38.95
Housing facilities						
Provision of electricity	-	-	22	26.8	22	13.4
Provision of adequate ventilation facility	75	90.4	72	87.8	147	89.1
Litter material used	7	8.4	10	12.2	17	10.3

N= number of respondants.

4.1.4 Feeds and feeding practices

Table 5**:** Chicken feeds and feeding practices in lowland and midland agro ecology

Feeds and feeding practices	Agro-ecology					
	Lowland N=83		Midland N=82		Overall N=165	
Feeding system	Freq	%	Freq	%	Freq	%
Only scavenging	6	7.2	3	3.6	9	4.8
Scavenging with additional supplement	77	92.8	79	96.4	156	94.6
Purchased feed	3	3.6	5	6.1	8	4.9
Additional feed type: Wheat and maize	78	94.1	81	98.8	159	96.45
Kitchen waste	34	41.1	55	67.1	89	54.1
Wheat bran	3	3.6	5	6.1	8	4.85
Frequency of feeding: Three times a day	8	9.6	7	8.5	15	9.05
Two times a day	40	48.2	52	63.4	92	55.8
One times a day	35	42.2	23	28.1	58	35.15

N= number of respondants.

A few respondents, 3.6% in lowland and 6.2% in midland agroecologies provide wheat bran as supplement. Regarding frequency of feeding, 48.2% and 63.4% of the respondents in low land and mid land agro ecologies, feed their chicken two times per day respectively, while 42.2% and 28.0% provide one times per day in the same order. A few respondents, 9.6% in lowland and 8.5% in midland agroecologies feed their chicken two times per day.

4.1.5 Watering

Information recorded for frequency of watering (Table 6) revealed that about 97% of respondents provide water with free access in both agro-ecologies. 1.1% in midland and none of the respondents in lowland agro-ecology provide water in morning only. A few respondents 2.2 % and 4.4% in lowland and midland agro-ecology provide water both in morning and evening. Regarding source of water, tap water was a major source in midland (72.2%) than in lowland agro ecology (37.8%), whereas borehole accounts for the rest of the proportion as water source in midland agro-ecology. Other sources of water in lowland agro-ecology include, canal water (13.3%) and river water (1.1%), lowland agro-ecology, 1.1% used pond water and none of the respondents used canal and river water.

Table 6**:** Frequency and source of water used for chicken in lowland and midland agroecologies

Source and frequency of watering	Agro-ecology

Frequency of watering	Lowland (N=83)		Midland (N=83)	
	Frequency	%	Frequency	%
Free access	81	97.6	79	96.3
Morning only	-	-	-	-
Morning and evening	2	2.4	3	3.7
Water sources				
Tap water	5	6.0	69	84.2
Borehole water	-	-	3	3.6
Pond water	66	79.5	4	4.9
River water	2	2.4	6	7.3
Canal water	10	12.1	-	-

N= number of respondants.

4.1.6 Use of agricultural extension services

The data analyzed for use of agricultural extension services for the development of poultry production in two agroecologies (Table 7) showed that 67.5% in lowland and 59.8% respondents inmidland agroecologies did not use agricultural extension services to improve their poultry productivity.

Table 7**:** Use of agricultural extension services in chicken production in lowland and midland agroecologies

Agro-ecology	N	Agricultural extension services	
		Used	Not Used
Lowland	83	27(32.5%)	56(67.5%)
Midland	82	33(40.2%)	49(59.8%)
Overall	165	60(36.36%)	105(63.63%)

N= number of respondants.

Agricultural extension services were used by 30.5% in lowland and 40.2% of the respondents in midland agroecologies to improve the productivity of their flocks.

4.1.7 Chicken production training

Information collected on training and credit services provided to respondents on chicken production in two agroecologies disclosed that 7.2% in lowland and 9.8% respondents in midland agroecology.

Table 8**:** Training and credit services provided in lowland and midland agroecologies

Training and frequency to see DA's	Agro-ecology			
	Lowland(N=83)		Midland(N=82)	
	Freq	%	Freq	%
Training provided	6	7.2	8	9.8
Before starting chicken production	6	7.2	6	7.3
After starting chicken production	-	-	2	2.4
Training not provided	77	92.8	76	92.7
Credit service provided	-	-	4	4.9
Purpose of credit service				
To buy day old chicks	-	-	4	4.9
To buy house equipment	-	-	-	-
To buy chicken feed	-	-	-	-

From those respondents who received training, 7.2% and 7.3% of respondents provided chicken production training before starting poultry rearing in lowland and midland agroecoligies ,respectively. However, 92.8% in lowland and 92.7% of the respondents in midland agroecologies did not get any training on poultry production. Credit service was provided to only 4.9% in midland agroecology solely to buy day old chicks while credit service was not provided for any purpose in lowland agroecology

4.1.8 Chicken health management

4.1.8.1 Use of vaccination

The data analyzed for health management (Table 9) revealed that majority of the respondents (80.7%) in lowland agroecology did not vaccinate their chicken, however most of the respondents (65.9%) in midland agroecology vaccinated their chicken against Newcastle disease and other diseases.

The chi-square analysis indicated a statistical in use of vaccines against chicken diseases between the two agroecologies.

Table 9**:** Use of vaccines to control chicken diseases in lowland and midland agroecologies

Variable	N	Vaccinated	Not vaccinated	$\chi 2$	P
Agro-ecology				36.63	<0.05
Lowland	83	16(19.3%)	67(80.7%)		
Midland	82	54(65.9%)	28(34.1%)		
Total	165	70(42.4%)	95(57.6%)		

N= Number of respondants, $\chi 2$= chi-square.

4.1.9. Egg productive performances

Information on egg production performance of Sasso chicken reared in the two agroecogies is presented in Table 10. There was statistically significant difference on average number of eggs laid under tradional husbandry production system

Table 10: Age at first egg laying, average clutch length and eggs/hen /year

Parameters	Lowland(N=83)	Midland(N=82)	P-Value
Age at first egg laying(d)	160±5.9	149±4.2	0.000
Average clutch lenght	22.9±1.7	23.9±1.5	0.000
Eggs/hen/year	214±33.6	232±35.1	0.001

N= Number of respondants.

The average age at first egg laying in lowland was significantly higher than midland agroecology. However, the average clutch length and number of eggs per hen per year reared in the midland was significantly higher than lowland agroecology.

4.1.10 Major Constraints to chicken production in lowland and midland agroecologies

The major constraints, raised by the respondents, in the study area are presented in table 12. The respondents ranked prevalence of disease (1^{st}) and shortage of feed (2^{nd}) in both agroecologies. However, respondents ranked poor veterinary service(3^{rd}), predators (4^{th}), lack of capital (5^{th}) and thieves(6^{th}) in lowland agro-ecology as the major constraints affecting their chicken protection and productivity.

Table 11**:** Major constraints of chicken production in lowland and midland agroecologies

Constraints	Lowland			Midland		
	Overall	Index	Rank	Overall	Index	Rank
Prevalence of diseases	443	0.265	1^{st}	457	0.265	1^{st}
Shortage of feed	442	0.264	2^{nd}	433	0.251	2^{nd}
Predatory	235	0.141	4^{th}	97	0.056	6^{th}
Lack of capital	264	0.158	5^{th}	243	0.141	4^{th}
Thieves	12	0.007	6^{th}	293	0.170	3^{rd}
Poor veterinary service	275	0.165	3^{rd}	199	0.116	5^{th}

*Priority index = (F1*6)+ (F2*5) + (F3*+4) + (F4*3) + (F5*2)+(F6*1)/Ftotal F1= Frequency of the first rank; F2= Frequency of second rank; F3 = Frequency of third rank; F4= Frequency of fourth rank; F5= Frequency of fifth rank; F6= Frequency of sixth rank FT= Frequency of total respondents. (Kosgey, 2004).*

4.1.11 Options suggested by farmers to improve Chicken productivity

In order to improve the existing state of chicken productivity farmers' suggested (Table 12) getting day old chicks at affordable price from government, continued provision of vaccination against major diseases, getting training on improved poultry production, supply of electricity and to be organized as association of poultry farmers. Majority of the respondents 42.2% in lowland and 41.5% in midland agroecologies suggested that government should supply day-old chicks at affordable price. Others seek provision of annual vaccination for their chicken. Getting training on modern poultry rearing technologies was suggested as an option to improve chicken productivity. Some other respondents indicated that there is a need for a supply of electricity and clean water for efficient chicken production at a village level.

Table 12: Options to improve chicken productivity in lowland and midland agroecologies

Suggested options	Agroecologies			
	Lowland, N=83		Midland, N=82	
	Frequency	%	Frequency	%
Cost of improved chicks should be affordable	35	42.2	34	41.5
Government should provide vaccination	33	39.8	30	36.6
Training on chicken rearing practices	10	12.0	15	18.3
Supply of electricity and clean water	5	6.0	2	2.4
Chicken farmers associations(Cooperatives)	-	-	1	1.2

N= Number of respondants.

4.2 Egg Quality Evaluation

4.2.1 Evaluation of external egg quality traits

Different external egg quality traits were measured and are presented in Table 13. The measured parameters (egg weight, egg length, egg width, shell thickness and shape index). Agro-ecology differences had highly significant effect on all external egg quality traits except on egg width .The mean of egg weight and egg length of Sasso chickens was significantly higher in the lowland than in midland (Table 13).

Table 13: The mean(±SD) of external egg quality trait of Sasso chicken breed

External trait	Lowland(L) (N=100)	Midland(M) (N=100)	P-value
Egg weight (g)	57.58±5.91	53.58±6.14	0.000
Egg length (mm)	57.46±2.43	55.80±2.66	0.000
Egg width (mm)	42.24±2.32	41.65±1.93	0.052
Shell weight (g)	5.19±0.63	4.70±0.81	0.000
Shell thickness (mm)	0.31±0.03	0.26±0.04	0.000
Shape index (%)	73.54±4.09	74.71±3.39	0.029

SD = standard deviation, N=Number of eggs.

However, the mean egg width was non significantly higher in the lowland than in midland agroecology. The mean shell weight and shell thickness in the lowland agroecology was significantly higher than the midland. The mean of shape endex was significantly higher in the midland than in lowland agroecology.

4.2.2 Evaluation of internal egg quality traits

Different internal egg quality traits were measured and are presented in Table 14. The measured parameters (yolk height, albumen height, yolk diameter, yolk weight, albumen weight and yolk colour and haugh unit).

Agro ecology differences had also highly significant effect on most internal egg quality traits such as: yolk height, albumen height, albumen weight and haugh unit was significantly higher in lowland than in midland. The yolk diameter was non significantly lower in the lowland than in midland. The yolk weight and yolk colour was non significantly higher in the lowland than in midland. The yolk ratio in lowland was significantly lower than in midland agroecology. However, albumen ratio was non significantly sligthly lower in lowland than in midland agroecology.

Table 14: The mean(±SD)of internal egg quality traits of Sasso chicken breed

Internal traits	Lowland (N=100)	Midland (N=100)	P-value
Yolk height (mm)	17.84±1.25	16.89±1.39	0.000
Albumen height (mm)	6.87±1.32	6.18±1.21	0.000
Yolk diameter(mm)	42.14±2.47	42.36±2.25	0.504
Yolk weight (g)	19.07±2.47	18.77±2.61	0.403
Albumen weight (g)	30.62±4.58	28.73±4.46	0.003
Yolk colour (RYCF)	9.93±1.71	9.75±1.77	0.465
Haugh unit	82.85±8.65	78.83±8.09	0.001
Yolk ratio	33.24±4.06	35.24±4.74	0.002
Albumen ratio	53.32±6.94	53.66±5.93	0.705

SD=Standard deviation, N=Number of eggs, RYCF =Roche yolk colour fan.

4.2.3 Correlation between external egg quality traits

The correlation between external egg qualities traits is shown in Table 15. They were statistically significant and positively correlated between egg weights with external egg quality traits such as egg width, egg length, shell weight and shell thickness. These were a negative correlation between egg weight and shape index and a significant difference. Egg width showed significant difference and positively correlated among egg length, shell weight and shape index. There were a positive correlation between shape index and egg width and a significant difference.

Table 15: Correlation between external egg quality traits

Parameter	Egg weight	Egg width	Egg length	Shell weight	Shell thickness	Shape Index	Shell Ratio
Egg weight	1	0.741*	0.535*	0.396*	0.199*	-0.140*	0.023
Egg width		1	0.444*	0.265*	0.041	0.582*	0.026
Egg length			1	0.311*	0.180*	-0.464*	0.072
Shell weight				1	0.234*	-0.030	0.248*
Shell thickness					1	-0.136	-0.028
Shape index						1	-0.041
Shell ratio							1

**. Correlation is significant at the 0.05 level.*

4.2.4. Correlation between internal egg quality traits

The correlation between internal egg qualities traits is indicated in Table 16. In the current study were statistically significant and positively correlated between Yolk height with internal egg quality traits such as albumen height, albumen weight, yolk colour, Haugh unit and albumen ratio. Yolk height and yolk diameter no showed significant, but positively correlated. In this study were the albumen height statistically significant and positively correlated with albumen weight, Haugh unit and albumen ratio. In the current study, yolk weight was highly significant and positively correlated with yolk ratio. Albumen ratio was negatively correlated with all internal egg quality traits except yolk weight and yolk diameter.

Table 16: Correlation between internal egg quality traits

Parameter	YH	AH	YD	YW	AW	YC	HU	YR	AR
Yolk height	1	0.555*	0.013	0.276	0.485*	0.328*	0.476*	-0.133	0.198*
Albumen height		1	-0.155*	-0.155*	0.458*	0.12*	0.960*	-0.366*	0.353*
Yolk diameter			1	0.596*	0.075	0.065	-0.234*	0.340*	-0.177*
Yolk weight				1	0.023	0.043	-0.240*	0.634*	-0.349*
Albumen weight					1	0.352*	0.297*	-0.501*	0.694*
Yolk colour						1	0.170*	-0.189*	-0.194*
Haugh unit							1	-0.255*	0.361*
Yolk ratio								1	-0.247*
Albumen ratio									1

*. Correlation is significant at the 0.05 level.

4.2.5 Correlation between internal and external egg quality traits

Correlation occurred between external and internal egg quality traits either positively or negatively as indicated in Table 17.

Table 17: Correlation between internal and external egg quality traits

Parameter	Egg Weight	Egg length	Egg Width	Shell weight	Shell thickness	Shape index
Yolk height	0.469*	0.525*	0.351*	0.286*	0.183*	-0.122
Albumen height	0.255*	0.280*	0.260*	0.062	0.079	0.007
Yolk diameter	0.306*	0.236*	0.169*	0.136	-0.029	-0.052
Yolk weight	0.419*	0.356*	0.263*	0.198*	0.057	-0.063
Albumen weight	0.619*	0.632*	0.444*	0.250*	0.140*	-0.130
Yolk colour	0.272*	0.321*	0.094	0.164*	-0.032	-0.195*
Haugh unit	0.022	0.106	0.125	-0.012	0.040	0.030
Yolk ratio	-0.423*	-0.266*	-0.182*	-0.154*	-0.121	0.058
Albumen ratio	-0.124*	0.136	0.079	-0.034	-0.004	-0.043

*Correlation is significant at P<0.05 level.

In the current study, the correlations between eggs weight with internal egg equality like yolk height, albumen height, yolk diameter, yolk weight, albumen weight and yolk colour were positive and highly significant. There were positive correlations between eggs length with yolk height, albumen height, yolk diameter, yolk weight, albumen weight and yolk colour were positive and highly significant, but negative correlations observed with yolk ratio.In addition, eggs width showed positive correlation with yolk height, albumen height, yolk weight and albumen weight.

With regarding to egg shell thickness, significantly and positively correlated with yolk heigth and statistically significant and positively correlated with albumen weight, but non significantly and negatively correlated with yolk diameter, yolk colour, yolk ratio and albumen ratio. According to the current study, there were no statistically significant between haugh unit with all external egg quality traits and negatively correlated with shell weigth.

5. DISCUSION

5.1 Average Number of Hens and Cocks Per respondents

There was also a no significant variation in flock size among the studied agroecology. The average number of hens in studied agroecologies was 3.0 in this study lower than 3.7 reported by Fisseha Moges *et al*., (2009).The cock to hen ratio in this study was 1:3.0 lower than 1:3.7 reported by Fisseha Moges *et al*., (2009). The reason for having more hens than cocks in both agroecoligies required for getting of income for daily personal money requirement.

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 average cock to hen ratio was similar with the reports of Deneke *et al*. (2014) who reported cock to hen ratio of 1:2.9 in southeastern Oromia region of Ethiopia. However, it was higher than the value reported in southern Ethiopia (Nebiyu *et al*., 2013).These variations could be due to differences in the conception of the farming communities for poultry rearing and availability of feed resources and access to market the products.

5.2 Source of Sasso Chicks

As improved layer chicken, most of the respondents used Sasso chicken breed in both agroecoligies. In both agroecologies , majority of the respondents purchased layer chicks from market; this could be due to lack of self-replacing and brooding/mothering ability of such hybrid layers. However, in the past decades, chicken productivity in Ethiopia mainly focused on use of imported temperate breeds such as White and brown Leghorns, Rhode Island Red, New Hampshire, Cornish, Australoup and Light Sussex (DZARC, 1991). The present change to the type of chicken used in these study areas could be due to the availability of hybrid layer chicks.

5.3. Chicken Housing System and Facilities

The lowest proportion of the respondents, 2.4 % in lowland and 9.8% in midland agroecologies, constructed a separate house entirely for chicken, which is significantly lower than the findings of Moges *et al*. (2010a) and Mengesha *et al*. (2011) who reported 22.1% and 21.2% village chicken owners provided separate poultry house in Bure district, North West Ethiopia and Jamma district, South Wollo, respectively. This significant variation might be due to farmers' awareness to the importance of chicken housing in lowland and midland agroecologies. Similarly, Khandait *et al*. (2011) in Bhandara district of India, reported 90% of backyard chicken owners provided separate poultry house. Generally, it was also observed that few households residing near the town and main road provided electricity and litter material in poultry house. The majority of respondents did not follow the recommended housing based on extension packages, claimed poor economic status as a reason for not having a separate chicken house and wished to have it when their economic status permit.

5.4. Feeds and Feeding Practices

Feeds are a major input in chicken production systems, in both agroecoligies , 94.6% of the respondents provided additional feed supplements to their chicken. Similarly, 99%, 97.5% and 98% feed supplementation by chicken owners were reported by Halima (2007); Moges *et al*., (2010a); Mengesha *et al*., (2011), respectively. In India, 97.25% backyard chicken owners provide additional supplement (Khandait *et al*., 2011). Approximately, 56% of the respondents in both agroecologies provided maize and wheat as feed supplements at frequency of two times/day at morning and evening. As scavenging laying hen can find approximately 60 to 70% of their feed requirement Rahman *et al*. (1997); providing supplementary feeds three times/day could help to express the laying potential of chickens at village level. while, 41.1% and 67.1% were used Kitchen waste as supplement in lowland and midland agroecologies, respectively.

5.5. Watering

In both districts, farmers well understood the importance of providing water for productivity of their chicken and about 97% of respondents in the present study areas provided water to their chicken with free access. Majority of respondents used tap (clean water) in midland to their chicken, whereas pond was the major water source in lowland agroecology. Higher number of respondents used tap water in midland than in lowland agroecology; this could indicate the availability of better water infrastructure development in midland agroecology than lowland agroecology. Similar, watering practices were reported by Moges *et al*. (2010a); Mengesha *et al*. (2011).

5.6. Use of Agricultural Extension Services

In both agroecoligies the most respondents did not use agricultural extension service to improve chicken productivity. This might be due to drawback fear of farmers to the technology disseminated as it is also reported by Dana *et al*. (2006). Limitation in providing extension services was also reported by ILRI (2005). Collectively, (35.4%)o f the respondents used agricultural extension services; this is in agreement with Mengesha *et al*. (2011) who reported comparable use of agricultural extension services by chicken owners in Jamma district. A good extension service is not only getting acceptance by farmers, rather it needs a regular follow up of farmers and discuss problems raised in using extension system.

5.7. Chicken Production Training

Providing credit to the farmers to procure chicken production inputs could help to enhance chicken productivity in these study areas. However, a few proportion of respondents provided credit facility only in midland agroecology. Even though, the farmers' interest to get credit service has been reported by Aklilu *et al*. (2007); Moges *et al*. (2010a) and Takele and Oli (2011), but still availability of credit service is limited for village chicken owners.

5.8. Chicken Health Management

5.8.1. Use of vaccination

A few proportion of respondents has been practiced vaccination in both agroecologies. In both agroecologies, about only 15 % of respondents used prophylactic measures against chicken diseases. None of the chicken owners practiced vaccination and prophylactic measures against poultry diseases in studies conducted by Moges *et al*. (2010a); Leta and Endalew (2010); Mengesha *et al*. (2011) and Takele and Oli (2011).

5.9. Egg Production Performances

The average age at first lay for the Sasso chicken in the study district was 160±5.9 and 149±4.2 days in lowland and midland Agro-ecologies, respectively) with ($P<0.05$) among the two agro-ecologies in the study area. Maturity of Sasso chicken was late in lowland than in midland agro-ecology. This might be attributed due to the difference in management practices like: feeding, housing and health care of the farmers and environmental factors between the two Agro ecologies of the study area. Relatively better feeding and housing management was observed in midland agroecology, so that Sasso chicken performed well in midland agro ecology than lowland. This study result is closely similar with the study result of Alem (2014) who reported the age at first lay for the Sasso chicken as 6.02 and 5.86 months in lowland and midland agro ecologies, respectively with the average age at first lay of 5.93 months in Central Tigray, Northern Ethiopia.

The average number of eggs/hen/year for Sasso chicken was 214±33.6 and 232±35.1 in lowland and midland agro-ecologies, respectively) with highly significant difference between the two agro ecologies in the study area. The total number of eggs collected per hen/year from midland agro ecology was higher than that of lowland. This might be attributed due to the difference in management practices and environmental variation among the two locations.

The present study result is in line with the average annual egg production result of Aman *et al*. (2017a) and Aderaw (2019) those reported the annual egg production results of 229.14±52.49 and 239.63±4.3 eggs/hen/year, respectively in three agro ecologies of SNNPR, Ethiopia and under small scale chicken producers in Urban and Peri-Urban Areas of Bahir dar City, Ethiopia. The average number of eggs produced per hen/year for the eggs collected from exotic chicken (Sasso T44 breed) was higher than that of Ahmedin (2014) reported the average number of eggs/hen/year of 150.2±4.07 and 174.27±1.12 for exotic and Sasso crossbred chickens, respectively.

According the finding of Alem Tadesse (2015) the average number of clutches per year per hen was 3.2 for local hens ranged from 2 to 5 with an average clutch length of 21.6 days ranged from 15 to 28 days, 3.1 for cross breed hens ranged from 2 to 4 with an average clutch length of 31.6 days ranged from 18 to 40 days and 3.2 for exotic breeds with average clutch length 44.4 days.

5.10. Constraints to Chicken Production in Lowland and Midland Agro-ecologies

In the present study areas, diseases were reported as first major problem in both agroecologies. The major causes of death for traditional poultry production were commonly disease (mainly New Castle Diseases locally known as ("Fengil"). High incidence of chicken diseases, mainly Newcastle Disease (NCD), is the major and economically important constraint for traditional chicken production system (Fisseha *et al*., 2010).

According to Tadelle and Ogle (2001), the primary problem cited by the village poultry farmers was high mortality of chicks. Similarly, Moges *et al*. (2010a) reported NCD as economically important diseases in North West Ethiopia. However, there was a problem in identifying the real causes and the type of diseases that led to chicken deaths since most of the veterinary services given to the farmers were not supported with laboratory investigation.

Shortage of feed was second major constraints in lowland and midland agroecologies in study areas particularly in none harvesting season. According to (Hunduma *et al*.,2010) feed shortage mostly occurs from June to August time of the year for village poultry as it is not harvesting season of cereal crops. Even the quantity and quality of grain given to the chicken were not enough to fulfill the requirement of the chicken. In traditional chicken production system, chickens get their feed by scratching on the ground and small supplement with cereals at home.

According to respondents view, the third major constraint claimed was predator at village level in lowland agro-ecology as it is common problem in other parts of Ethiopia such as Central highlands of Ethiopia (Dessie and Ogale, 2001), North west Ethiopia Moges *et al*. (2010a), Walaita Zone of Southern Ethiopia (Takele and Oli, 2011). Poor of veternairy service, lack of captal and thieves were the other constraints in both agro-ecologies as it is also reported by Moges *et al*. (2010a) in Ethiopia and Khandit *et al*. (2011) in India.

Limited veterinary services for village chickens were also reported by Moges *et al*. (2010a); Leta and Endalew (2010); Takele and Oli (2011) and Mengesha *et al*. (2011) in different parts of Ethiopia.

5.11. Options Suggested by Farmers to Improve Chicken Productivity

As an option to enhance chicken productivity respondents seek to get affordable cost of improved chicks, regular vaccination, training and electricity supply. Majority of the respondents in both agroecologies purchased improved chicks from market at high cost and majority of respondents seek to get improved chicks at affordable price. Significant number of respondents consider as an option to get regular vaccination of chicks against important diseases at village level for increasing the productivity and profitability of their chicken, as it is suggested by Dessie and Ogale (2001). In addition, respondents seek to get adequate training on different aspects of modern poultry rearing. Some other respondents consider supply of electricity as a heat source with other improved management practices as an important option to enhance survival and growth of day old chicks during brooding. Very few respondents in midland agroecology consider working in association, with the objective to access easily chicken production inputs and other facilities from providers.

5.12. Evaluation of Egg Quality Traits

5.12.1 Evaluation of external egg quality traits

The average egg weight of Sasso chickens was significantly higher in the lowland than in midland. These differences might be due to different management practices, age of production stage and agro ecological factors.. The mean of egg lengths were higher significance difference than midland agroecology. Present study result was not similar with Aberra *et al.* (2012), the eggs collected from midland had significantly higher length and width than those of highland and lowland agro ecological zones. In addition, the egg width in lowland agrocology showed higher significance difference than midland agroecology. Shell thickness of an egg in lowland agroecology was greater than in midland agroecology. It showed highly statistically difference.The difference might be due to agro-ecological variation as well as feed type which affects egg shell thickness; because as the temperature level increased the chicken feed intake decreased, the consequence not getting enough calcium for egg shell formation. This result was not agreement with the report of Sinha *et al*. (2017) .These variations might be due to breed and feeding management. The egg shell quality is given throw the weight and the percentage of shell, thickness and the strength. The differences in eggshell quality depend on the environmental conditions and the feed quality and also of strain of layers (Zita *et al*., 2009).

5.12.2 Evaluation of internal egg quality traits

In the present study, significant differences were recorded among two agroecologies on yolk height. Yolk heights in the current study were higher in lowland than midland agroecology. The result was comparable with the report of Desalew (2012) reported that the mean yolk heights for Bovans Brown and for Isa brown under village production system. This indicated that comparable yolk height in the present study with the previous finding might be due to the freshness of eggs during analysis.The average height of albumen in lowland agroecology was 6.87±1.32 mm which was slightly higher than the mean of albumen height in midland(6.18±1.21mm).This might be due to agro ecological difference among the agroecologies which could be the factor for albumen height difference. Compareble with the present study, Nebiyu (2016) reported that the mean albumen height was 7.1±0.08 mm for

Bovans brown breed. Albumen weight showed significant ($P<0.05$) difference between two agroecologies. The mean albumin weight recorded in this study was 30.62g in lowland and 28.73 g in midland agroecology.

It is accepted that the lesser the surface of egg white dense and the more its height, the better is the egg. The height of egg white (albumen) in fresh egg should not be less than 0.5cm (Maria and Dmowski 2005).The thicker the albumen, the better the quality of the egg, with heights of 8 to 10 mm being considered superior interior quality (Zeidler, 2002). The height of the inner thick albumen when the egg is broken onto a flat surface has largely defined the quality of sound eggs for many years because it is easily measured and relates well to the freshness of the egg. The Haugh unit (Haugh, 1937) exemplifies measures of albumen height. A study by Solomon (1991) confirmed the known fact that egg quality deteriorates with the age of hens. The average yolk weight of the Sasso chicken breed in this study was significantly different. This finding was in agreement with report of Tulin and Ahmet (2009) for eggs produced under village management system. The average mean yolk colour was 9.93 and 9.75 in lowland and midland agroecologies, respectively. There were no significant differences in yolk colour in two aroecologies according to Roche yolk colour fan assessment. The yolks colour during laboratory analysis was range from (7-15) colour. The lower yolk colour might be due to chicken feed household leftover feed type. Whereas high yolk colour (deep in yellowish colour) was due to the chicken were feed green plant and grain feed. In agreement with the present finding, Duman *et al*. (2016) reported that yolk colour analysis was 11.2. However, the result in this study was higher than the report of Desalew (2012), Niraj *et al*. (2014), Taddesse *et al*. (2015) and Nebiyu (2016) in different breeds and in different areas. Yolk colour is subjectively determined by the use the Roche colour fan (Stadelman, 1995; Vuilleumier,1968). And is influenced so heavily by the diet, the age and breed of then hen has little influence (Galobart *et al*., 2004). Egg yolk color is a very important factor in consumer satisfaction and influences human appetite (Amerine *et al*., 1995), with a preference for golden yellow to orange yolk color (Hasin *et al*., 2006). Similarly.(Jacob *et al*.,2000) noted that yolk color is a key factor in any consumer survey relating to egg quality. consumer preferences for yolk colour are highly subjective and vary widely from country to country. Yolk color is used as a quality determination factor but is nearly entirely dependent on the diet and is easily manipulated (Hunton, 1995). Haugh unit did show significant difference among the two study agroecologies. Average means of Haugh unit (HU) in lowland and midland agroecologies were 82.85 and 78.83, respectively. The present finding was in line with the report of Niraj *et al*. (2014) reported that the value of Haugh unit of Bovans brown breed was 82.15±3.39 and Rhode Island Red was 83.67±3.78. Taddesse *et al*. (2015) also reported that Haugh unit value of Bovans brown breed was 87.45±6.35 for East Shewa, Ethiopia. Haugh unit is the measure of albumin quality which determines the quality of the egg. and in this study environment had significant effect on Haugh unit . A Haugh Unit value of 79 and above is an indication of good quality, Brandt *et al*., (1991) also reported that eggs of inferior quality have Haugh Unit of less than 40%.The higher the value of the Haugh unit, the better the quality of eggs, which are classified according to the United States Department of Agriculture (USDA) as AA (100 to 72), A (71 to 60), B (59 to 30) and C (below 29) (USDA, 2000), in which the refrigerated eggs are classified as AA. Oluyemi and Robert (2000) also reported that unit score of 72 and above has been graded as the best quality.

Average yolk ratio was 33.24 and 35.24 in lowland and midland agroecologies, respectively. Yolk ratio showed significant difference among the two agroecologies. The result of the current study was nearly in line with the finding of Sinha *et al*. (2017) the yolk ratio was 33.85 for intensive production system. On the other hand, average albumen ratio was 53.32 and 53.66 in lowland and midland agroecologies, respectively. However, the albumen ratio in both agroecologies showed no significance difference.This result was less than with the finding of Nebiyu (2016) who reported that average albumen ratio of Bovans brown layer strain was 58.7.

5.12.3 Correlation between external egg quality traits

They were statistically significant and positively correlated between egg weights with external egg quality traits such as egg width, egg length, shell weight and shell thickness. Similarly, Ukwu *et al*. (2017) reported that the correlations between egg weight with egg length, egg width, egg shell weight were highly positive and significant. In the current study there were strong positive correlation between egg weight with egg length. These were a negative correlation between egg weight and shape index and a significant difference, this result was in agreement with the report of Simeon and Babatope (2017). Egg width showed significant difference and positively correlated among egg length and shell weight. Significant difference and negative correlation was observed between shape index and egg lengths which are consistent with the finding of Nebiyu (2016). There were a positive correlation between shape index and egg width and a significant difference.

5.12.4. Correlation between internal egg quality traits

Yolk height had positive correlation with albumen height, albumen weight, yolk colour, Haugh unit and albumen ratio and this result was in line with the previous report of Nebiyu (2016). Albumen height and Haugh unit showed significant and strong positively correlated. The result in the current study was similar with the finding of Bobbo *et al*. (2013). In this result the albumen height and Haugh unit were strongly correlated because an increase in albumen height value might be increased.The Haugh Unit (HU) is an expression relating the height of thick albumen and egg weight. Haugh unit value during calculation because of albumen height the determinate factor of Haugh unit quality. As result good albumen storage condition high albumen value correspondingly high standard Haugh unit value which inducted good quality egg. In the current study, yolk weight was highly significant and positively correlated with yolk ratio, but albumen ratio was negatively correlated with yolk weight. This result was comparable with the report of Nebiyu (2016). This implied that yolk weight is directly proportional with yolk ratio, and albumen ratio is directly proportional with albumen weight. Nobakht and Moghaddam (2012) reported a positive correlation between Haugh unit and quality of egg components (yolk and albumin) this goes in line with our findings. Egg albumen height and egg weight are indices for evaluation of Haugh unit. The Haugh units reported for this study are in disagreement with Chatterjee *et al*. (2006) who reported lower Haugh unit values; (59.62 to 71.62) for the White Leghorn strains.

5.12.5 Correlation between internal and external egg quality traits

Correlation occurred between external and internal egg quality traits either positively or negatively. This result was supported by the report of Islam and Dutta (2010) noted that correlations existed for both external and internal egg quality traits.

In the current study, the correlations between eggs weight with internal egg equality like yolk height, albumen height, yolk diameter, yolk weight, albumen weight and yolk colour were positive and highly significant, which showed similarity with the finding of Debnath and Ghosh (2015).This implied that an increase egg weight resulted increase in yolk height, albumen height, yolk diameter, yolk weight, albumen weight and yolk colour.

There were positive correlations between eggs length with yolk height, albumen height, yolk diameter, yolk weight, albumen weight and yolk colour were positive and highly significant , but negative correlations observed with yolk ratio.In addition, eggs width showed positive correlation with yolk height, albumen height, yolk weight and albumen weight.

These were in agreement with the report of Sari *et al*. (2016) who reported that significant and positive relationships were observed between egg length with yolk ratio, yolk and albumen weight. With regarding to egg shell thickness, significantly and positively correlated with yolk heigth and statistically significant and positively correlated with albumen weight, but non significantly and negatively correlated with yolk diameter, yolk colour, yolk ratio and albumen ratio. According to the current study, there were no statistically significant between haugh unit with all external egg quality traits and negatively correlated with shell weigth.

6. SUMMARY, CONCLUSION AND RECOMMENDATIONS

6.1 Summary and Conclusion

The study was assessed the egg production and evaluation of egg quality traits of Sasso chicken breed under traditional husbandry practices.165 households were purposively selected from lowland and midland agro-ecologies of Aleta Chuko district.. A total of 200 Sasso chicken breed eggs were used to determine the external and internal egg quality traits from sampled households. Laboratory tests were performed at the Poultry Laboratory, College of Agriculture, Hawassa University.

Under traditional production system egg production performances of Sasso chicken are different in different agro-ecology. The average age at first egg laying in lowland was significantly higher than midland agroecology. However, the number of eggs laid per clutch and number of eggs per hen per year reared in the midland was significantly higher than lowland agroecology. Current finding showed that, prevalence of chicken diseases shortage of feed, predators, lack of capital and poor veterinary service was main constraints affecting Sasso chicken production in the study area. Agro ecology differences had highly significant effect on all external egg quality traits except on egg width such as: egg weight and egg length of Sasso chickens was significantly higher in the lowland than in midland. However, egg width was non significantly higher in the lowland than in midland agroecology. Shell weight and shell thickness in the lowland agroecology was significantly higher than in midland. Shape endex was significantly higher in the midland than in lowland agroecology. Agro ecology differences had also highly significant effect on most internal egg quality traits such as: yolk height, albumen height, albumen weight and haugh unit was significantly higher in lowland than in midland. The yolk diameter was non significantly lower in the lowland than in midland. The yolk weight and yolk colour was non significantly higher in the lowland than in midland. The yolk ratio in lowland was significantly lower than in midland agroecology. However, albumen ratio was non significantly sligthly lower in lowland than in midland agroecology. In conclusion, the Sasso chickens in the midland agroecology were significantly superior in egg productive performance traits than lowland agroecology. However, the Sasso chickens in the lowland agroecology were significantly superior in most external and internal egg quality traits under traditional production system.

6.2 Recommendations

- From the present study, Sasso hens might be recommended for smallholder farmers in the midland area for enhanced egg productivity performance traits. Hoewever, Sasso hens might be suitable for lowland agroecology for enhanced enhanced egg quality traits under traditional production system
- Control of diseases, especially NCD, could be achieved through improvements in veterinary based extension services.
- In the study area, chicken vaccination was very poor as one of disease controlling methods, because of lack of vaccines and lack of awareness. Therefore, Government should focus on providing access amount of vaccines, training of health technicians and community mobilization, so as to reduce chicken losses in the study area.
- The problem of predators could be reduced by convincing farmers to construct predator Proof separate chicken houses and housing chicken.
- Interventions aimed at improving chicken husbandry practices should focus on improved feed, feeding system and improved housing materials (technology) to improve the production and productivity of Sasso chickens.
- Interventions aimed at improving the productivity of Sasso chicken should focus on training and education of women, as most of the chickens are owned and managed by women.
- Finally, to improve egg quality attention should be paid to adequate feed and feeding system in both quantity and quality.

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8. APPENDIXES

8.1 Appendix I. Questionnaire for survey part

Questionnaire that was used to collect information from Sasso chicken rears/farmers. This questionnaire was completed by farmers; the respondents were kindly requested to complete this questionnaire.

Name of the enumerator ________________________ Date of Interview _______________

Agro-ecology______________ Kebele_____________________

1.Management Practices

A. Number of chickens owned

- **i.** Number of Hens _____________
- **ii.** Number cooks_________________

B. Breeds Adopted

i. Purchased from Govt. /Pvt. Hatchery ii. Provided from agriculture research center

iii.Provided from NGO's iv. Hatching of eggs naturally at home

C. Housing condition

1. Management system used? i. Backyard ii. Semi-intensive iii. Others___________

2. Available housing condition?

- **i.** Share the same house with people
- **ii.** Provision of night shelter only
- **iii.** Separate house entirely constructed for poultry
- **iv.** Separate house with other animals
- **v.** Provision of electricity
- **vi.** Ventilation facility

3. Did you construct poultry house based on recommended extension packages?

i. Yes ii. No

4. If no in Q.3, specify the reasons_____________,

5. Do you provide litter material in the poultry house? i. Yes ii. No

6. If yes Q.5. What type litter material do you use? i. *Teff* straw ii. Wheat straw iii.If others (specify) ____

D. Feeding and Watering

1. How do you feed your birds? i. Scavenging only ii. Scavenging with supplement iii.Purchased feed iv. Homemade feed (readymade feed)

2. When do you feed your chickens? i. Morning and evening ii. Morning and afternoon iii.Morning, afternoon and evening iv.Only scavenging

3. Do you provide supplementary feed? i. Yes ii. No

4. If yes in Q.3., specify the type of supplement? i. Maize and wheat ii. Furshika iii.If others (specify)________________________________

5. Do you provide water for your bird? i. Yes ii. No

6. If yes Q.5. What is the source of water? i. Hole water ii. River iii.Tap water iv.Pond water v.If others (specify) ____________________________________

7. How frequent do you provide water? i. Free access ii. Morning only iii.Morning and evening only iv. If other (specify) _______________________

E. Egg production Performance

No	**Performance parameters**	**No/%**
1	Number of eggs/clutch	
2	Number of clutches/year	
3	Number of eggs per year	

8. How often do your chicken lay egg?

i. Daily iii. Once in two days iii. Once in three days iv. Daily but sometimes twice in a day

9. What do you think about the trend of egg productivity of your chicken as the age of the chicken increases? i. Increases ii. Decreases iii. Once change

10. Do your hens show gaps once they start laying egg or stop suddenly? i/ Yes ii/ No

13. If yes, for how much period usually they stopped laying eggs

i/ 3 days and more ii/ 5 days and more iii. Other …………………….

14. What do you think is the reason to stop suddenly? i/ Shortage of feed ii/ Disease iii/ I don't know the reason/I didn't consider as it was by any case iv. Other ………………

15. What are signs/symptoms they show when they suddenly stop laying egg?

i/ Normal as before ii/ weight change iii/ abnormal body condition iv. Not eating v. Other____________________

F. Poultry Health

1. Do you practice annual vaccination of your chicken? i. Yes ii. No

2. Against which diseases vaccinate your chicken? i. Newcastle diseases
ii. Marek's Disease iii. Fowl typhoid iv. Gumboro (infectious bursa disease)
v. Infectious bronchitis

3. Do you use anti-ectoparasites? i. Yes ii. No

4. Do you practice deworming? i. Yes ii. No

5. What are the major predators in your area

i.…………………………………………………
ii.………………………………………………...
iii.……………………………………………...
iv.…………………………………………….

G. Extension service

1. Do you have access to the extension service? i. Yes ii. No

2. If you say No for Q.1, state the reasons? i. Have no heard of them ii. Cannot easily reach them iii. There is no need iv. If others (specify) _____________________

3. How frequently do you see the extension agent? i. Once in a week ii. Once in two weeks iii. Once in a month iv. Not Seen

4. Do you discuss your production problems with extension agents? i. Yes ii. No

5. Have you ever got any training on poultry production? i. Yes ii. No

6. If yes, for Q. 5. When? i. Before starting the business ii. After the business started

7. Did you get credit service when you start poultry business? i. Yes ii. No

8. If yes, for what purpose did use the credit? i. Day old chicks ii. Poultry feed

iii. Poultry equipment iv.If others (specify) ___________________________________

H. List Major Constraints

A. What are constraints in adoption of Sasso chicken breeds? (Rank 1-6)

1. Presence of disease
2. Shortage of feed from surrounding
3. Attacks of predators
4. Thieves
5. Lack of capital
6. Lack of veterinary service

I. What do you suggest to improve your poultry business?

____

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____

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8.2. Appendix II. List of Different Tables

Appendix 1: Descriptives table for average number of hens and cocks per respondents reared in the study agroecology

Descriptives

		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
						Lower Bound	Upper Bound		
Number of hens	Lowland	83	2.99	.552	.061	2.87	3.11	2	4
	Midland	82	2.99	.711	.079	2.83	3.14	2	4
	Total	165	2.99	.634	.049	2.89	3.09	2	4
Number of cocks	Lowland	83	1.42	.521	.057	1.31	1.54	1	3
	midland	82	1.29	.458	.051	1.19	1.39	1	2
	Total	165	1.36	.493	.038	1.28	1.43	1	3

Appendix 2: Cross tabulation of practice annual vaccination of Sasso chicken in lowland and midland agroeclogies of study area

Types of agroecology * do you practice annual vaccination of your chicken Cross tabulation

			do you practice annual vaccination of your chicken		Total
			No	Yes	
Types of agroecology	lowland	Count	67	16	83
		Expected Count	47.8	35.2	83.0
	midland	Count	28	54	82
		Expected Count	47.2	34.8	82.0
Total		Count	95	70	165

	Expected Count	95.0	70.0	165.0

Appendix 3: Chi-Square Tests for practice annual vaccination of Sasso chicken in lowland and midland agroecologies of study area

Chi-Square Tests

	Value	Df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	36.634[a]	1	.000		
Continuity Correction[b]	34.752	1	.000		
Likelihood Ratio	38.272	1	.000		
Fisher's Exact Test				.000	.000
N of Valid Cases	165				

a. 0 cells (.0%) have expected count less than 5. The minimum expected count is 34.79.

b. Computed only for a 2x2 table

Appendix 4: Age at first egg laying, number of eggs per clutch and mean annual egg production

Group Statistics

	Types of agroecology	N	Mean	Std. Deviation	Std. Error Mean
Age at first laying	Lowland	83	149.35	4.221	.463
	Midland	82	159.95	5.906	.652
Number of eggs per clutch	Lowland	83	22.9036	1.64994	.18110
	Midland	82	23.9756	1.50698	.16642
Mean annual egg production	Lowland	83	214.83	33.632	3.692
	Midland	82	232.44	35.093	3.875

Appendix 5: ANOVA table for external egg quality traits

ANOVA

		Sum of Squares	Df	Mean Square	F	Sig.
Egg Weight	Between Groups	800.000	1	800.000	22.047	.000
	Within Groups	7184.720	198	36.286		
	Total	7984.720	199			
Egg length	Between Groups	137.730	1	137.730	21.228	.000
	Within Groups	1284.651	198	6.488		
	Total	1422.382	199			
Egg width	Between Groups	17.358	1	17.358	3.820	.052
	Within Groups	899.586	198	4.543		
	Total	916.944	199			
Shell weight	Between Groups	12.005	1	12.005	22.770	.000
	Within Groups	104.390	198	.527		
	Total	116.395	199			
Shell thickness	Between Groups	.128	1	.128	121.635	.000
	Within Groups	.208	198	.001		
	Total	.335	199			
shape index	Between Groups	68.316	1	68.316	4.849	.029
	Within Groups	2789.372	198	14.088		
	Total	2857.689	199			

Appendix 6: ANOVA table for internal egg quality traits

ANOVA						
		Sum of Squares	df	Mean Square	F	Sig.
Yolk height	Between Groups	45.125	1	45.125	25.881	.000
	Within Groups	345.230	198	1.744		
	Total	390.355	199			
Albumen height	Between Groups	24.151	1	24.151	15.181	.000
	Within Groups	314.997	198	1.591		
	Total	339.149	199			
Yolk diameter	Between Groups	2.498	1	2.498	.449	.504
	Within Groups	1101.265	198	5.562		
	Total	1103.762	199			
Yolk colour	Between Groups	1.620	1	1.620	.535	.465
	Within Groups	599.260	198	3.027		
	Total	600.880	199			
Yolk weight	Between Groups	4.500	1	4.500	.701	.403
	Within Groups	1270.220	198	6.415		
	Total	1274.720	199			
Albumen weight	Between Groups	178.605	1	178.605	8.742	.003
	Within Groups	4045.270	198	20.431		
	Total	4223.875	199			
Haugh unit	Between Groups	809.548	1	809.548	11.525	.001
	Within Groups	13907.946	198	70.242		
	Total	14717.495	199			
Yolk ratio	Between Groups	199.760	1	199.760	10.257	.002
	Within Groups	3856.103	198	19.475		
	Total	4055.863	199			
Albumen ratio	Between Groups	5.993	1	5.993	.144	.705
	Within Groups	8249.459	198	41.664		
	Total	8255.452	199			

Appendix 7: Pearson Correlation table between external egg quality traits

Parameter	Egg weight	Egg width	Egg length	Shell weight	Shell thickness	Shape Index	Shell Ratio
Egg weight	1	0.741*	0.535*	0.396*	0.199*	-0.140*	0.023
Egg width		1	0.444*	0.265*	0.041	0.582*	0.026
Egg length			1	0.311*	0.180*	-0.464*	0.072
Shell weight				1	0.234*	-0.030	0.248*
Shell thickness					1	-0.136	-0.028
Shape index						1	-0.041
Shell ratio							1

*. Correlation is significant at the 0.05 level

Appendix 8: Pearson Correlation table between internal egg quality traits

Parameter	YH	AH	YD	YW	AW	YC	HU	YR
Yolk height	1	0.555*	0.013	0.276	0.485*	0.328*	0.476*	-0.133
Albumen height		1	-0.155*	-0.155*	0.458*	0.12*	0.960*	-0.366*
Yolk diameter			1	0.596*	0.075	0.065	-0.234*	0.340*
Yolk weight				1	0.023	0.043	-0.240*	0.634*
Albumen weight					1	0.352*	0.297*	-0.501*
Yolk colour						1	0.170*	-0.189*
Haugh unit							1	-0.255*
Yolk ratio								1
Albumen ratio								

*. Correlation is significant at the 0.05 level.

Appendix 9: Pearson Correlation table between internal and external egg quality traits

Parameter	Egg Weight	Egg length	Egg Width	Shell weight	Shell thickness	Shape index
Yolk height	0.469*	0.525*	0.351*	0.286*	0.183*	-0.122
Albumen height	0.255*	0.280*	0.260*	0.062	0.079	0.007
Yolk diameter	0.306*	0.236*	0.169*	0.136	-0.029	-0.052
Yolk weight	0.419*	0.356*	0.263*	0.198*	0.057	-0.063
Albumen weight	0.619*	0.632*	0.444*	0.250*	0.140*	-0.130
Yolk colour	0.272*	0.321*	0.094	0.164*	-0.032	-0.195*
Haugh unit	0.022	0.106	0.125	-0.012	0.040	0.030
Yolk ratio	-0.423*	-0.266*	-0.182*	-0.154*	-0.121	0.058
Albumen ratio	-0.124*	0.136	0.079	-0.034	-0.004	-0.043

*Correlation is significant at $P<0.05$ level.

8.3. Apendex III. List of Sample Figures

Appendix Figure 1: Sample picture of Sasso Hens

Appendix Figure 2: Sample picture of external and internal egg quality traits.

Appendix Figure 3: Measuring of egg length and width

Appendix Figure 4: Breaking of eggs to release albumen and yolk on glass plate

Appendix Figure 5: Measuring albumen height, yolk height, yolk diameter by tripiod micrometer.

Appendix Figure 6: Measuring of Yolk color