ASSESSMENT OF PRODUCTION SYSTEM, EGG QUALITY AND CARCASS CHARACTERISTICS OF VILLAGE CHICKEN IN BENCH MAJI ZONE, SOUTH WESTERN ETHIOPIA

MSc THESIS

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HAWASSA UNIVERSITY COLLEGE OF AGRICULTURE

NOVEMBER, 2016

HAWASSA, ETHIOPIA

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A THESIS SUBMITTED TO THE SCHOOL OF ANIMAL AND RANGE SCIENCES,

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DEDICATION

I dedicated this piece of work for my beloved father Ato Edmew Worku for his ever great hope of my achievement.

DECLARATION

I declare that this thesis work which is submitted to the school of Animal and Range Sciences, Hawassa University College of Agriculture in partial fulfillment of the requirements for the degree of Master Science is my original work which has not been submitted to any University or institution for the award of any degree by me or other scholars. It is also allowable to use the document only in favor of Hawassa University College of Agriculture. In all other instances, permission must be obtained from the author.

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ACRONYMS

ASF ……………………… Animal source food

BMZ……………………… Bench Maji Zone

BMZLFDO………………. Bench Maji Zone Livestock and Fishery Development Office

CSA…...…………………. Central Statistical Agency

EIBC……………………... Ethiopian Institute of Biodiversity Conservation

FAO……………………… Food and Agriculture Organization

HU………………………...Hough Unit

JUCAVM…………………Jimma University College of Agriculture and Veterinary Medicine

masl……………………… meters above sea level

RIR………………………..Red Island Rhode

SAS………………………. Statistical Analysis of Software

SD…………………………Standard Deviation

SNNPRS ………………… South Nations Nationalities and Peoples Regional State

USDA…………………….. United States Department of Agriculture

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ASSESSMENT OF PRODUCTION SYSTEM, EGG QUALITY AND CARCASS CHARACTERISTICS OF VILLAGE CHICKEN IN BENCH MAJI ZONE, SOUTH WESTERN ETHIOPIA

By

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Major advisor: Prof. Aberra Melesse (PhD)

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ABSTRACT

The study was conducted in three districts of Bench Maji Zone in Southern Ethiopia with the objective of assessing the production system, egg quality traits and carcass characteristics of indigenous chicken. A total of 270 households were selected by multi-stage purposive random sampling technique and interviewed using semi-structured questionnaires. A total of 450 eggs and 45 adult male chickens were also purchased to evaluate the egg quality traits and carcass characteristics, respectively. The results revealed that the flock size per household was 10.4 with cock to hen ratio of 1:2.9. Scavenging with occasional supplementation was the major feeding system (80.7%). Maize (91.1%), sorghum, Taro and Kocho were the types of supplementary feeds used in their order of importance. Seasonal disease outbreak and predation were the most challenges of village chicken productivity. The average age of cockerel at first mating and pullet at first egg laying was 5.9 and 6.4 months, respectively. The average number of eggs per clutch and the annual egg number of local chicken in the study area were 14.8 and 54.6, respectively. The mean number of eggs incubated by local hen was 11.8 with 82.2% hatchability and 48.8% survivability of hatched chicks. The purpose of rearing chicken and the egg produced was primarily for selling as a source of cash income followed by hatching and home consumption. The average egg weight and shape index of local chickens was 43.9 g and 72.7%, respectively. The average shell thickness of local chickens was about 0.33 mm. The respective average albumen height and the HU score was 3.4 mm and 61.2. The average yolk height and yolk color were 14 mm and 10.9, respectively. The average slaughter weight of local male chicken was about 1449 g. The edible carcass yield was 966 with 66.7% dressing. The proportions of breast meat, thigh, drumstick and wing were 25.4%, 19.5%, 15.4% and 10.2%, respectively. The study revealed variations in different production traits which might be due to management difference and genetic dissimilarities of local chicken ecotypes in the studied districts. Further research is recommended to evaluate their performance potentials under improved feeding and management systems.

Key words: Bench Maji; indigenous chicken; production system; egg quality; carcass components;

1 INTRODUCTION

Ethiopia has a huge livestock resource in its different agro ecologies playing considerable role to the national economy as well as annual export revenue (EIBC, 2014). The total chicken population in the country is estimated about 56.9 million of which 95.86% are indigenous chicken while the rest 1.35% and 2.79% are hybrid and exotic breeds, respectively (CSA, 2014). The major system of chicken production in the country is traditional scavenging which is characterized by small flock, low inputs, poor management, periodic flock devastation with short lifecycle, quick turn over and unorganized marketing system (Aberra, 2014; Mammo and Wude, 2011). The most adaptive and dominant chicken types for this rearing system are local ecotypes with a large phenotypic and genetic variation (Aberra and Tegene, 2011; Aberra, 2000; Halima, 2007).

Village chickens are reared in the country for basic social and economic needs including cash income, hatching for replacement, home consumption as well as for socio-cultural and/or religious ceremonies (Aberra, 2014; Fisseha *et al*., 2010; Wondu *et al.*, 2013). According to Aberra (2014), chicken production plays a major role by improving the nutritional status and the income of many smallholder farmers. Production of both egg and chicken meat is fundamental measure to reduce animal protein deficiency in human nutrition (Aberra, 2014; Dhuguma, 2009; Samson and Endalew, 2010). These authors also reported that poultry egg and meat enrich and contribute to a well balanced diet. However, the amount of egg and chicken consumed by rural households is below the required level for animal protein. Chicken production is thus vital to meet food security by producing a huge animal source protein and being income source to most of the rural populations (Nigussie, 2011).

Despite its importance, village chicken production system in Ethiopia is caught up by poor performance of local chicken in terms of egg production, small egg size, slow growth rate, late maturity and instinctive inclination to broodiness and high mortality of chicks (Aberra, 2000; Fisseha *et al.*, 2010). However, it is not absolutely true to consider local chickens as poor in their genetic potential without counting the existing poor level of management. Native chickens arealso attributed by the merits of their ability to resist disease, thermo-tolerance, good egg and meat flavor, hard eggshells, high fertility and hatchability traits (Aberra *et al.*, 2005; Mammo, 2012; Nigussie, 2011). There is also a great variation in body weight and egg productivity of indigenous birds that implies the genetic potential of such chicken ecotypes and the chance for selection and genetic improvement of indigenous chicken for meat and egg production (Aberra and Tegene, 2011; Nigussie, 2011). Moreover, indigenous chickens are good scavengers, suit to the existing system of production, have high levels of disease tolerance, possess good maternal qualities and are adapted to harsh conditions and poor quality feeds as compared to the exotic breeds (Aberra, 2007; Aberra, 2011).

According to Aberra (2014), native chicken breeds in most African countries are little studied and the existing reports lack consistency due to various reasons. Lack of recorded data on the characteristics of chicken products and other aspects of management makes difficult to assess the importance and contributions of the past attempts to improve the sector (Fisseha *et al.*, 2010; Mammo, 2013). Aberra and Tegene (2011) investigated some phenotypic and morphological characteristics of indigenous chicken populations in Bench Maji Zone (BMZ) together with the counter Zones in Southern region of Ethiopia. Getachew *et al.* (2015) also studied the phenotypic characteristics of indigenous chicken ecotypes in BMZ. However, there is a research gap on the existing village chicken production system and chicken product characterization i.e. egg quality and carcass yield of indigenous chickens in the study area.

1.1 Objectives of the study

General objective:

To assess the husbandry practices, egg quality traits and carcass characteristics of local chickens reared under traditional management system.

Specific objectives:

- To assess the prevailing management practices of indigenous chicken populations under traditional production system;
- To evaluate the external and internal qualities of eggs from indigenous chickens and
- To investigate the carcass characteristics of indigenous chickens in the study area.

2 LITERATURE REVIEW

2.1 Village Chicken Production in Ethiopia

Ethiopia within its diversified agro-ecology is endowed with different local chicken ecotypes that have a great potential for genetic improvement (Mammo and Wude, 2011). With a total number of 56.9 million estimated chicken populations, Ethiopia has large population of chicken (CSA, 2014). Flock size per household in most rural communities of the country seems to be variable according to different scholars at different time. An average flock size of 7.9 birds per household was reported in northwestern Amhara region, Ethiopia (Worku *et al*., 2012), while Halima (2007) report shows 7.13 average flock sizes per household which varies between seasons mainly due to the availability of feed, the occurrence of diseases, the presence of predators as well as the economic status of the owners. Aberra and Tegene (2011) also reported a flock size of 9.6 in southern Ethiopia. Much smaller average flock size of 4 ranging from 2.5 to 7.4 chickens per household was reported in different Ethiopian indigenous chicken ecotypes (Aberra and Tegene, 2011; Nigussie et al., 2010). The dominant chicken production system in the country is characterized by extensive production system holding a majority of local chicken ecotypes mainly on scavenging system with seasonal supplementation of homegrown grains and household food leftovers (Addisu, 2014; Fisseha *et al*., 2010; Mammo and Wude, 2011).

2.1.1 Feeding management

Free scavenging is the common feeding system in most African developing countries on the basis of low input low output principle in which chickens are free to search different types of scavenge feeds throughout the whole day (Aberra, 2014). Similarly, the prevailing system of feeding in different parts of Ethiopia is mainly based on free scavenging with some seasonal supplementation of home grown grain feeds (Addisu *et al*., 2013; Nebiyu, *et al*., 2013; Nigussie *et al*., 2010; Worku *et al*., 2012). Aberra (2014) stated that scavenging feeding system is insufficient to satisfy the nutritional requirement of birds to their maximum production potential, which have to receive great attention. According to Etalem *et al*. (2009) most production and reproduction traits of chicken can be affected by nutritional management.

The common types of supplementary feeds are home grown cereal grains such as maize, wheat, sorghum, barley, and finger millet which are available good during crop harvesting season as such grains are annual crops (Fisseha *et al*,. 2014; Fisseha, 2009; Meseret, 2010). These grain supplementary feeds are obviously grown for household consumption that poultry feeding is highly competitive with human stable foods. As a result, chicken are usually provided with such grain supplements if there is surplus, usually during crop harvesting season (Mammo, 2013). According to the reports of Aberra (2014) and Takele and Oli, (2013) household leftovers, insects, worms, green plants, fruits and gleanings on crop after math are the major scavenge feed resources throughout the year. Not only feed availability is a problem in extensive production system but also the feeding system of the already available feed. Throwing on the ground without any feeder is the common feeding system, which can result feed wastage and feed contamination by disease causing pathogens (Fisseha *et al*., 2014; Halima, 2007; Worku *et al*., 2012)

The main source of water for chickens is reported to be nearby river water, stream water and underground water using different locally available water troughs such as plastic equipments, broken pots and wood made materials (Nebiyu, *et al*., 2013; Worku *et al*., 2012). According to Matiwos *et al*. (2015) finding, the water provided to village chicken is not necessarily adequate in most cases as the frequency of water provision is variable from location to location and from house to house. Moreover, the hygiene of the provided water and sanitation of water troughs is very poor that needs a serious care (Meseret, 2010). Many scholars in different parts of Ethiopia also stated that local watering troughs are open that can be easily contaminated by dust, chicken droppings and any contaminant that potentially cause disease (Halima, 2007; Melese and Melkamu, 2014; Worku *et al*., 2012).

2.1.2 Housing system

Poultry housing is required to protect chickens from environmental stressors as well as from different types of predators (Aberra, 2014). Separate house construction for chicken is not much adopted in most rural areas of Ethiopia (Nigussie *et al*., 2010; Solomon, 2008). Thus, the majority of village chickens are kept in various night sheltering places including perches inside the house, in kitchen, together with other farm animals as well as on the floor covered by different local materials that can potentially put village chicken production at high risk of bio-security (Fisseha *et al*., 2010; Halima, 2007; Worku *et al*., 2012). Melese and Melkamu (2014) also stated that the existing poultry housing system in the traditional chicken management is inappropriate for the welfare of chicken as well as product handling which results poor egg hygiene and breakage. Furthermore, Fisseha (2009) reported that lack of attention, lack of construction materials, lack of knowledge and awareness, risk of predators and thefts and shortage of labor and time as the major reasons affecting construction of separate chicken houses.

2.1.3 Chicken health management

Indigenous chicken ecotypes are resistant to poor management, tolerant to diseases as well as alert to escape from predators (Mammo, 2012; Nebiyu, *et al*., 2013; Nigussie *et al*., 2010). Aberra (2011) and Aberra *et al*. (2010) also stated that indigenous chickens possess desirable traits of thermo-tolerance and well adapted to high ambient temperature in the tropical environment that can help to resist against diseases. The problems of disease and predation for the poor adaptation of exotic chicken ecotypes in northwestern Amhara region of Ethiopia is also an evidence to the superiority of indigenous chicken over exotic breeds in disease resistance and ability to escape from predators (Simegnew *et al*., 2015). However, different studies revealed that disease is the most challenging constraint of village chicken production. The major cause of death for birds in most parts of the country is seasonal outbreaks of diseases, specifically Newcastle disease (Addis, 2014; Halima, 2007; Wondu *et al*., 2013). In general, the health status of the backyard chicken production system is very poor and risky since scavenging birds live together with people and other farm animals (Solomon, 2008).

Farmers do not properly perceive their chicken wellbeing to provide health care activities for their chicken (Fisseha *et al*., 2014; Halima, 2007). Aberra (2014) reported that vaccination service is the way to mitigate the out breaks of disease particularly Newcastle disease. However, veterinary service is absent or insufficient in most rural areas of Ethiopia that makes the challenge of disease outbreak the most worst (FAO, 2010; Fisseha *et al*., 2014; Halima, 2007; Samson and Endalew, 2010). Some farmers adopt to treat their chicken by traditional medicines while others sell chickens immediately when get diseased as a risk aversion measure which is on the other hand disseminating disease to disease free area (Hunduma *et al*., 2010). The other challenge that makes difficult to control disease transmission in the free range system of production is that chickens of different flocks in the neighbors are scavenging together resulting high rate of disease transmission (Meseret, 2010; Yakubu, 2010).

2.2 Role of Village Chicken Production

Village chickens play social, economical and nutritional role in most developing countries including Ethiopia (Aberra, 2014; FAO, 2011; Kondombo, 2005). Livestock in general and chicken production in particular are the means to alleviate malnutrition especially protein deficiency even in small amount if incorporated in the diet of the poor (Randolph, 2006; FAO, 2011; Nabarro and Wannous, 2014). According to Aklilu *et al*. (2007) report, chicken products remain the only affordable sources of animal source food (ASF) in rural household since they cannot inquire the cost of small and large ruminants' price. However, the trend of poultry product consumption is governed by the income level of the rural farmer, that farmers tend more selling live birds and eggs for income generation (Fisseha *et al*., 2010; Nigussie *et al*., 2010). Usually rural dwellers consume poultry products in celebrating religious and national holidays that show how much limited ASF in the diet of such rural farmers (Aklilu *et al*., 2007).

Chicken production is also a means of income for immediate household expenses in rural household life as their cash income source is limited (FAO, 2010). Chicken and egg selling for cash income generation is the major purpose of keeping chickens by smallholder farmers in most rural areas to cover the expense of purchasing different food items, clothing, student school fee, etc. (Fisseha *et al*., 2010; Halima, 2007). The role of chicken extended far as a means of barter in rural markets facilitating market activity without cash involvement (Aklilu *et al*., 2007). However, the level of income from poultry product sell is affected by market demand and structure as well as seasonal price fluctuation (FAO, 2010; Aklilu *et al*., 2007). Halima (2007) and Meseret (2010) also reported seasonal market fluctuation, which influences the level of chicken owners' income from the sector. Chicken production also plays social and cultural role since chicken are used as gift, to celebrate cultural ceremonies and to honor relatives and guests (Aklilu, 2007; Fisseha *et al*., 2010). For such sociocultural purpose the plumage color and the comb type of chicken are factors that influence chicken marketing (Nigussie *et al*., 2010; Mammo, 2012).

2.3 Production Performances of Village Chicken

The productivity of indigenous chickens under the existing traditional production system is characterized by low production of small number of eggs, small sized egg, low growth rate and low survivability of chicks (Solomon, 2008; Alem, 2014). Moreover, Solomon (2004a) reported that local hens perform poor comparing with leghorn layers in egg production at different management regimes from scavenging to intensive system of production and argue to use indigenous chicken ecotypes for egg production. Contrarily, Halima revealed the comparative performance of different local chicken ecotypes with that of Red Island Red (RIR) exotic breed under similar confined management. Low productivity of local scavenging hens is in fact not only because of their low genetic potential but also the prevailing traditional chicken production which is characterized by poor nutritional and housing management as well as high risk of disease and predator resulting high chick mortality before they reach marketable age (Addis, 2014; Ysuf *et al*., 2014). Though the performance of village chickens is relatively low, they are still good producers in low input production system in most developing countries (Aberra, 2011; Aberra, 2014). Alem (2014) and Mammo (2012) also revealed the suitability of local chicken ecotypes for the prevailing extensive chicken management in rural households of Ethiopia.

2.3.1 Egg production and reproductive performance

Indigenous chicken ecotypes are not good layers characterized by short clutch length, long brooding period and small sized egg resulting low annual egg production (Solomon, 2004a; Yakubu, 2010). Different chicken ecotypes exhibited better egg production performance ranging from 91.7 to 154.2 eggs per year under intensive management in northwestern Amhara region, Ethiopia (Halima, 2007). Disease, poor housing facility and feed scarcity are the major hindering factors to exploit the egg production potential of local chicken ecotypes (Alem, 2014; Dunya *et al*., 2014). As shown in Table1 different scholars investigated the production performances of local ecotype chickens in different parts of the country under free range management. Even though local chickens are low in production, the egg produced from indigenous chicken is known to possess some preferred traits like strong shell thickness and deep yellow yolk color as well as a peculiar tasty nature that can influence the market demand and value of egg produced from local scavenging chickens (Fisseha *et al*., 2010; Mammo, 2012; Nigussie *et al*., 2010).

Village chicken ecotypes are the only option to incubate hatching eggs and to brood the hatched chicks due to their brooding behavior in extensive production system where modern incubators and accessories are not affordable (Aberra, 2014; Fisseha *et al*., 2010; Mesret, 2010). The hatchability of eggs as presented in Table 1 shows relatively better values compared to other parameters, while the survivality of hatched chicken is very low with a great difference from location to location which is attributed to high prevalence of disease and predation. Fisseha *et al.* (2010) and Worku *et al*. (2012) in northwestern Amhara region, Nebiyu *et al.* (2013) in Halaba district of SNNPRS and Meseret (2010) in Gomma Wereda, Jimma Zone of Oromia region, Ethiopia, revealed performances of local chicken ecotypes as described in Table 1.

Table 1. Flock performance of village chicken in different parts of Ethiopia.

	Literature sources			
Production traits	Worku *et al*. (2012)	Nebiyu *et al.* (2013)	Fisseha *et al.* (2010)	Meseret (2010)
Age at first mating (months)	6.14	-	6.15	6.47
Age at first egg lay (months)	6.6	6.5	6.87	6.33
Clutch number/hen/year	3.24	3.8	3.83	3.43
Egg production/hen/clutch	14.1	13.3	15.7	12.92
Egg production/hen/year	45.7	-	60	43.84
Number of eggs incubated/hen in one incubation cycle	12.8	12	13	10.13
Number of chicks hatched/hen in one incubation cycle	10	10.1	11	8.03
Number of chicks survived/hen in one brooding cycle	5.5	-	-	2.82
Hatchability%	79.1	83.7	82.6	-
Survivality%	58.25	52.3	60.5	-

2.3.2 Meat production potential

Local chicken ecotypes are late maturing and the body weights of such chicken ecotypes are also relatively low with great variations among ecotypes (Nigussie, 2011; Solomon, 2004b). For this reason, the carcass yield of local chicken ecotypes is relatively lower when compared with the exotic breeds (Halima, 2007; Yousif *et al*., 2014). However, different scholars reported good dressing percentage and great difference in body weight and other carcass related traits that indicate the opportunity for selection and genetic improvement for meat production (Deneke *et al*., 2014; Kondombo, 2005; Solomon, 2008; Halima, 2007; Mammo and Wude, 2011). Aberra and Tegene (2011) also indicated a variation in shank length and other body weight related traits which might be a good indicator of skeletal development and meat production potential of indigenous chicken ecotypes.

An average slaughter weight of 1358 g and 65.1% dressing percentage was reported by Shishay *et al*. (2014) in local scavenging chicken ecotypes in the western Tigray region, Ethiopia. Taddele and Ogle (2000) also investigated 65.5% dressing percentages for local scavenging hens in central highlands of Ethiopia. According to Halima (2007), the dressing percentages of two local chicken ecotypes, Gelila (67.3%) and Mecha (73.3%) were higher than that of the counterpart RIR chicken dressing percentage (60.0%) in similar intensive management that indicate the relative potential of village chicken for meat production in their production environment. However, the prevailing traditional system particularly nutritional management is influencing the production of chicken to exploit their genetic potential (Addis, 2014; Asrat *et al*., 2009). Nutritional management affects not only the growth rate but also the carcass characteristics, the meat quality and the portions of valuable carcass cuts (Kefyalew, *et al*., 2015; Magala *et al*., 2012).

2.4 Egg Quality Traits

External and internal egg quality traits such as egg weight, yolk and albumen weights and shell thickness are the determinant factors for the embryonic development of an egg and latter the viability of the new hatched chick (Aberra *et al*., 2005; Onagbesan *et al*., 2007). For this reason valuable egg quality traits are very important reproductive parameter in poultry production and breeding strategies (Aberra, 2000; Bain, 2005). According to Desalew *et al*. (2015), most of such internal and external egg quality parameters are subjected to the level of chicken management and egg handling activity. Egg storage technique and storage duration influences most of egg quality parameters such as shell weight, albumen weight and height as well as yolk height (Aberra, 2007; Meseret, 2010). Studies reveal that such egg quality traits are also significantly influenced by agro-ecology and season of the year in which the egg is laid which might be related with the differences in ambient temperature, humidity and the available feed resources in different season (Aberra *et al*., 2013a; Islam *et al*., 2001).

Hatchability and chick quality are highly influenced by different factors including age and breed of the laying hen, egg weight as well as storage and incubation temperature and humidity for appropriate gas exchange (Aberra, 2007; Onagbesan *et al*., 2007). Eggshell thickness is an important factor that influences hatchability and handling of eggs during transportation (Aberra *et al*., 2005; Khan *et al*., 2004). As the hen advances in age, eggshell quality decrease due to an increase in egg weight without an increase in the amount of calcium carbonate deposited in the shells gland (Aberra *et al*., 2005; Zita *et al.,* 2009). Besides to genetical variation, the differences in eggshell quality also depend on the environmental conditions and the nutritional management specially the dietary content of calcium (Aberra *et al*., 2010, 2013a). Leyendecker *et al.* (2005) investigated a thicker egg shell in free range rearing systems than in conventional cage and intensive systems which might be attributed to the mineral deficiencies particularly calcium in confined management.

Yolk color is one of the internal egg quality parameter that influences consumer preference (Fisseha, 2009; Okeudo *et al.,* 2003). Ethiopian consumers have a strong preference for eggs with deep yellow yolk colour and small sized eggs from the scavenging local chicken with deep yellow yolk colour fetch much higher prices compared to larger eggs of improved strains with pale yolk color (Aberra 2000; Tadelle *et al.,* 2003). The determinant factor of yolk colour is the xanthophyl plant pigment from the diet consumed (Aberra, 2007). Green grass during scavenging might be responsible for carotenoid deposits in the yolk to improve the yolk color like Ethiopian scavenging chicken (Zaman *et al*., 2000).

2.5 Major Constraints of Village Chicken Production

Despite its social, economical and cultural contribution, the performance of village chicken production is low due to inter linked constraints like frequent diseases outbreak, predation, lack of proper health care, poor feeding and poor marketing information (Aberra, 2014; Addis 2014; Hunduma *et al.,* 2010; Mapiye *et al*., 2008; Meseret, 2010). According to Magala *et al*. (2012), the drumstick meat from scavenging chickens exhibited less tender and less juicy than the counter chickens managed in intensive production system hence, the quality of chicken products might be subjected to the prevailing nutritional management. Similarly, most of egg quality traits can be influenced by the management system particularly nutritional management (Shalaei *et al*, 2014; Desalew *et al*., 2015). Accordingly, poor nutritional management is one of the major constraints of village chicken production in most developing countries (Aberra, 2014; Addisu *et al*., 2013).

Studies conducted in different locations showed that disease is the major constraint of village chicken production that cause high chicken mortality followed by predation (Hunduma *et al.*, 2010; Fisseha *et al*., 2010; Kondombo, 2005). Among the infectious diseases, Newcastle disease, coccidiosis, fowl pox, cholera, Marek's disease and botulism are the most economically important diseases (Meseret, 2010; Takele and Oli, 2013). Despite the fact that disease is causing the major damage for village chicken production, the veterinary service does not address the issues of chicken production in rural areas (Takele and Oli, 2013). On the other hand reports by Nebiyu *et al*. (2013) in Halaba district of southern Ethiopia and Worku *et al.* (2012) in northwestern Amhara region of Ethiopia shows that the challenge of predation is very serious problem than disease outbreak. Lack of well designed house and poor house sanitation might be potential source of diseases and chicken lose by predation in extensive production system (Halima, 2007). Marketing constraint is also pronounced to influence the income level of farmers from village chicken (Aklilu *et al*., 2007).

Local chickens stand alone to be suitable under scavenging system of production with their innate merits where exotic breeds failed to adopt (Mammo, 2012; Simegnew *et al*., 2015; Nebiyu *et al*., 2013; Nigussie *et al*., 2010). Genetic deterioration of such adoptive breeds due to indiscriminate cross breeding and unplanned introduction of exotic chicken breed is becoming a long term constraint which put the sector at risk (Hunduma *et al.*, 2010). Halima *et al*.(2007) also reported that the local chicken genetic resources is seriously endangered owing to the high rate of genetic erosion due to the unplanned and random distribution of exotic chicken both by governmental and non-governmental organizations, since they are believed to perform better than the indigenous types. Due to such indiscriminate cross breeding with a little attention to the conservation of indigenous genetic resource not only genetic potential is eroded but also the proportion of indigenous native chickens in the country is declining (Mammo and Wude, 2011). In the year 2011, 2013 and 2014 the proportion of indigenous chicken was reported as 97.3% (CSA, 2011), 96.9% (CSA, 2013) and 95.86% (CSA, 2014) which show a decreasing scenario. This indicates that the introduction of exotic chickens has been increased resulting in reduced number of the indigenous chicken populations. The introduction of exotic poultry breeds for commercial purpose in the urban areas can be justifiable as there is a huge ever increasing demand for poultry products. However, the distribution of such breeds to the rural community shall be planned and minimized to avoid the genetic erosion of the existing local chicken ecotypes which have adaptive potentials to tropical environments (Aberra and Tegene, 2011; Kefyalew, 2013; Halima *et al*., 2007).

3 MATERIALS AND METHODS

3.1 Description of the Study Area

The study was conducted in three selected districts of Bench Maji Zone (BMZ) in Southern Nations, Nationalities and People Region State (SNNPRS), consisting ten districts and one town administration. Mizan Teferi, the capital of BMZ, is located at a distance about 561km from Addis Ababa in southwest direction and 842 km from the regional capital city, Hawassa. BMZ is bordered with Keffa Zone in North, South Omo zone in North East, Sheka Zone in South West, while in South it is bordered with Gambela regional state and South Sudan Republic ((BMZLFDO, 2015).

Agro-ecologically, BMZ consists of 52 % lowland (500-1500 m a.s.l), 43 % intermediate highland (1500-2300 m a.s.l) and 5 % highland (> 2300 m asl). It lies between $5^{o}40'$ and $7^{o}40'$ North Latitude and $34^{o}45'$ and $36^{o}10'$ East Longitude. The annual temperature ranges from 20°C to 40°C and the annual rainfall from 1,200 to 2,000 mm (BMZLFDO, 2015). The main crops grown in the study area are coffee, tubers such as taro (*Colocasia esculenta*), cassava (*Manihot esculenta*) and sweet potato. Maize, sorghum, teff (*Eragrostis teff*), barley and wheat are cereals crops cultivated in the area. Pulses (pea and bean), Enset (*Ensete ventricosum*), fruits (banana, papaya, orange, avocado and mango) and spices (ginger, cardamom and turmeric) are also valuable crops BMZ while rice is a new crop introduced in the area.

The total area of Bench Maji zone is 19,252 km^2 and has a total population of 652,531, of whom 323,348 are men and 329,183 women with a population density of $33.89/km^2$. The main livestock species reared in the zone are cattle, sheep, goats and poultry (CSA, 2014).

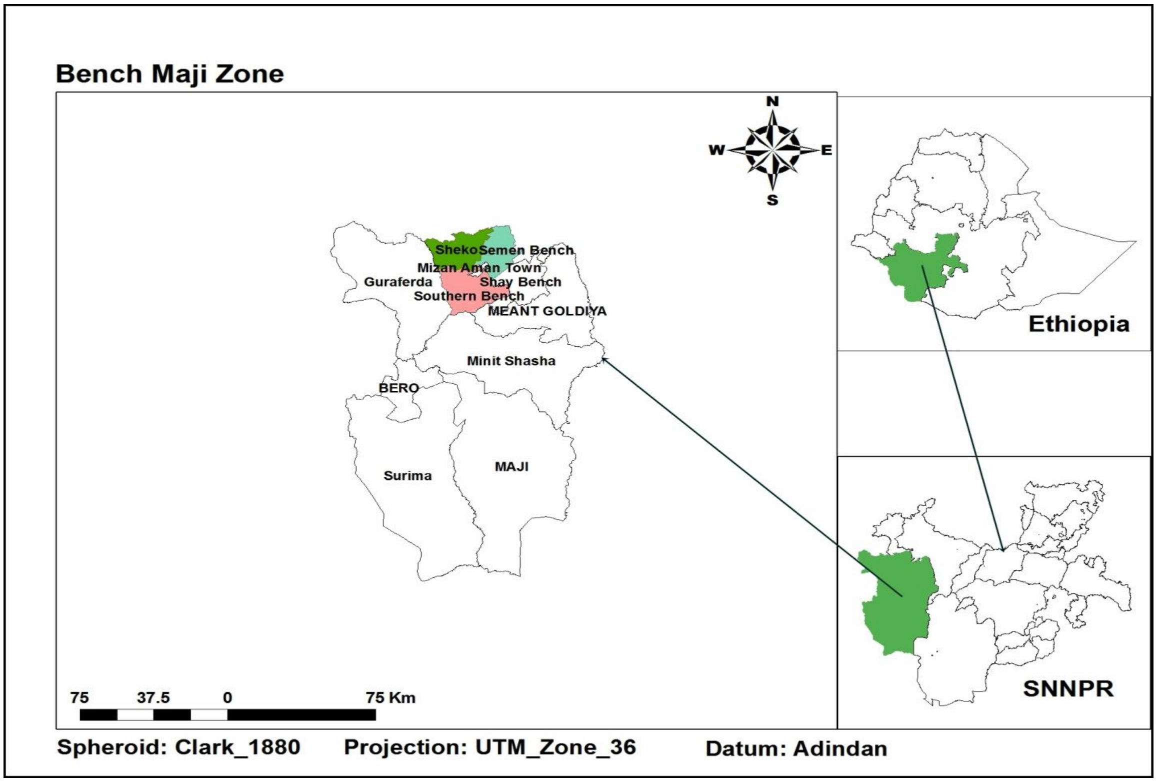

Figure1.Map of the Bench Maji zone along with the study districts

3.2 Sampling Methods and Data Collection

Multi-stage sampling technique was employed to select the study areas. Accordingly, three districts from the zone namely Sheko, South Bench and North Bench were purposively selected based on their potential for chicken production and accessibility. Then three kebeles from each district with a total of nine kebeles were purposively selected where exotic breeds were not distributed. From each kebeles, 30 households (with a total of 270 households) who possess at least 5 indigenous adult chickens were selected in purposive randomization and were interviewed using semi-structured questionnaire. Data were then collected on management practices, flock size and composition, use patterns of products, constraints in chicken production, feed resource, chicken feeding and housing practices, age at sexual maturity, age at first egg laying, average number of eggs per clutch, number of clutches/hen per year, clutch length, average number of eggs per set, number of chicks hatched per clutch, chick survival rates and other related issues of poultry production.

Secondary data have been also collected from various sources mainly from Bench Maji Zone Livestock and Fishery Development Office (BMZLFDO). Direct observations were also made to assess the available chicken feed resources, chicken feeding and housing practices, egg incubation and brooding procedures and egg handling and storage practices. Focal group discussions were held with selected community elders, women and extension agents at each kebele. Members of the focal groups included were people believed to have a good knowledge about past and present social and economic status of the area. Discussions were focused on the main issues of chicken production including importance and current status of village chicken, over all chicken production and management system as well as major constraints village chicken production in the study area.

For the evaluation of external and internal egg quality traits, a total of 450 fresh eggs were purchased from the 9 kebeles (50 eggs from each kebele). The collected eggs were then transported to the poultry laboratory of Jimma University, College of Agriculture and Veterinary Medicine using appropriate portable refrigerator to avoid possible quality deteriorations in collection and transport. The whole eggs were collected and evaluated in three consecutive terms to avoid quality deterioration in prolonged storage. Soon after arrival, each egg was individually weighed using sensitive balance. Egg width and egg length were then measured using digital caliper. After external quality trait measurement, each egg was carefully opened on a flat glass plate to measure the most valuable egg quality traits. Shell thickness (in mm) was measured using digital caliper by removing the inner shell membrane. Shell weight (gm), albumen weight (gm) and yolk weight (gm) was measured using a sensitive balance. Albumen and Yolk height (mm) was determined using tripod micrometer. Yolk colour was measured using colour fan of 1–15 15 leveled colour fan. Egg shape index (%) was calculated as:

$$\text{Shape Index \%} = \frac{\text{Egg width}}{\text{Egg length}} \times 100$$

Haugh unit (HU) was also calculated using the formula (Haugh, 1937):

$$HU = 100 \log (H + 7.57 - 1.7 W^{0.37})$$

Where H = albumen height (mm)

W = egg weight (g)

Five local male chickens from each kebele (15 from each district) whose age was between 10 and 12 months were purchased at household level for the evaluation of the carcass characteristics. Before slaughtering, the chickens were deprived of feed and water over night and weighted to get the actual slaughter weight using a digital balance. Each chicken was then slaughtered by cutting the jugular vein for proper bleeding and then immersed to hot water for 1 to 2 minutes and defeathered manually. Carcass weights of breast, two thighs, two drumsticks, back, two wings and neck were measured using sensitive balance and added up to get the dressed carcass yield on a commercial basis according to Meat buyers' guide developed by NAMP (2007). The giblets (heart, liver, and gizzard) are edible in most part of Ethiopia and included in the carcass weight. While the feather, head, shank and visceral organs (gastrointestinal tract, lung, kidney, and reproductive organs) were removed. Dressing percentage and carcass portions were calculated on the basis of the carcass weight.

$$\text{Dressing \%} = \frac{\text{Dressed carcass weight}}{\text{Slaughter weight}} \times 100$$

3.3 Statistical Analysis and Data Management

Variations among the studied districts in the qualitative data were analyzed using chi-square test while the quantitative data were subjected to analysis of variance in General Linear Model procedure of SAS (SAS institute, 2002) version 9.00. Descriptive statistics like mean, range and percentage were used to present the data. Duncan multiple range test was used for multiple mean comparison of the district effect on quantitative traits.

The following linear model was used quantify the district effect on the quantitative data:

$Yi = \mu + bi + ebi$

Where: Yij = response variables (body weight, egg weight, egg qualities, carcass components, etc.) at the i^{th} district

μ = the overall mean

bi = effect of district (i = 3; Sheko, South Bench and North Bench)

ebi = random error.

4 RESULTS

4.1 Respondents Information

As indicated in Table 2, about 65.6% of the interviewed farmers were males while the rest (34.4%) were females. About 65.6% in South Bench, 67.8% in Sheko and 60% in North Bench were males in district wise while the rest 34.4% in South Bench, 40% in Sheko and 32.2 in North Bench were females. From the total respondent farmers 94.8% were married and the rest 4.8% and 0.4% were unmarried and divorced, respectively. The majority (85.1%) of the respondents were between 25 and 55 years age group. From the total respondents only 7% were under 25 years age while the rest 6.7% were above 55 years old. The respondents' level of education was 30.7% illiterate, 7.8% read and write, 23.7% primary first cycle (grade 1-4), 28.2% primary second cycle (grade 5-8) and 7.4% high school.

As shown in Table 3, the average family size of the household in the current study was about 6.7 people. South Bench district was significantly higher than North Bench (6.4) but there was no significant different between Sheko (6.6) and the other two districts. The average livestock holding per household was 2.3 cattle, 1.4 sheep, 0.6 goats, 0.1 horses and 0.1 asses. Among the three studied districts farmers from South Bench hold low numbers of goats while those farmers from Sheko district hold low number of sheep.

Table 2. Respondents' profile from all districts

Variables		South Bench (N = 90)	Sheko (N = 90)	North Bench (N = 90)	Overall mean	X^2
Sex (%)	Male	65.6	60			1.93
	Female	34.4	40	32.2	34.4	2.94
Marital status (%)	Not married	4.4	6.7	3.3	4.8	20.25**
	Married	95.6	93.3	95.6	94.8	1.22
	Divorced	-	-	1.1	0.4	-
Age (%)	<25 year	6.7	5.6	8.9	7	0.83
	26-40 year	62.2	61.1	70	64.4	3.39
	41-55 year	21.1	23.3	17.8	20.7	1.20
	> 56 year	10	10	3.3	6.7	3.9
Level of education (%)	illiterate	32.2	34.4	25.6	30.7	2.41
	Read & write	7.8	4.4	11.1	7.8	2.81
	grade 1-4	27.8	22.2	21.1	23.7	1.66
	grade 5-8	25.6	33.3	25.6	28.2	2.28
	grade 9-10	5.6	4.4	12.2	7.4	4.62
	Above	1.1	1.1	4.4	2.2	3.04

X^2 = chi-square value; **significant at $p < 0.01$; N = number of respondents

Table 3. Family size and livestock holdings in the three districts (Mean±SD)

Variables	South Bench (n = 90)	Sheko (n = 90)	North Bench (n = 90)	Overall mean
Family size	7.2±2.6[a]	6.56±2.2[ab]	6.4±2.2[b]	6.7±2.4
Cattle	2.4±1.8	2.2±1.41	2.3±1.7	2.3±1.6
Sheep	1.6±1.9[a]	1±1.5[b]	1.7±1.7[a]	1.4±1.8
Goats	0.2±0.9[b]	0.9±1.5[a]	0.63±1.23[a]	0.6±1.3
Horses	0.02±0.15	0.11±0.44	0.04±0.21	0.06±0.3
Asses	0.00	0.03±0.18	0.13±1.06	0.06±0.6

[ab] Row means with different subscript letters are significantly different at $p<0.05$; N = number of respondents; SD = standard deviation.

From the whole family member, women were the main responsible to manage chickens in every aspects including feeding, house cleaning, health care, breeding and marketing chicken products while men involve in house construction (Table 4).

Table 4. Family labour allocation in chicken management (%) in the study area (N = 270)

Variables	Responsible family member				
	Wife	Husband	Daughter	Son	husband and wife
Feeding	76.7	7.8	7.4	8.1	-
Sanitation	75.2	6.3	11.5	4.4	2.2
House construction	13	75.9	-	11.1	-
Health care	51.8	43.3	0.4	3.7	0.7
Breeding Management	87.8	8.9	0.4	3	0.4
Marketing	87.8	5.6	3	3.7	0.4
Overall responsibility	87.8	6.7	5.6	-	-

N = number of respondents

4.2 Village Chicken Management

4.2.1 Flock characteristics

As presented in Table 5, the average chicken flock size per household was 3.6 hens, 1.2 cocks, 1.8 pullets, 1 cockerel and 2.5 young chicks with the overall flock size of 10.4. The average cock to hen ratio in the current study was 1:2.9. The flock size and flock structure was influenced by district except cock number. South Bench and North Bench had significantly higher total flock size and number of pullets than Sheko while North Bench district had significantly lower hen number. In number of chicks and cockerel South Bench was higher than South Bench however there was no significant difference between Sheko and the other two districts (Table 5)

Table 5. Structure and composition of flocks in the study districts (Mean±SD)

Number of chicken	South Bench (N = 90)	Sheko (N=90)	North Bench (N = 90)	Over all mean (N = 270)
Hen	3.9±1.6[a]	3.8±1.4[a]	3.3±1.2[b]	3.6±1.4
Cock	1.1±0.8	1.3±0.9	1.2±1.0	1.2±0.9
Pullet	2.1±1.5[a]	1.4±1.3[b]	2.0±1.5[a]	1.8±1.4
Cockerel	1.2±1.3[a]	0.8±1.0[b]	1.1±1.4[ab]	1.0±1.3
Chicks	3.1±3.4[a]	1.8±2.7[b]	2.7±2.9[ab]	2.5±3.0
Hen : cock	3±1.7	2.8±1.5	2.7±1.2	2.9±1.5
Total	11.5±5.1[a]	9.2±3.5[b]	10.4±4[a]	10.4±4.3

[ab] Row means with different subscript letters are significantly different at $p<0.05$

N = number of respondents, SD= standard deviation

As presented in Table 6, the major source of replacement stock was newly hatched chicks followed by purchasing from local market and both hatching and purchasing. From the total interviewed households, 71.8% responded that newly hatched chicks were the primary sources of chicken replacement while 10.7% purchase from local market for replacement of lost chickens due to different reasons.

Table 6. Source of replacement stocks in the three districts of the study zone (%)

Variables	South Bench (N = 90)	Sheko (N = 90)	North Bench (N = 90)	Overall mean	X^2
Hatching	66.7	68.9	80		
Purchasing	20	21.1	5.6	15.6	10.75*
Both	13.3	10	14.4	12.6	0.98

X^2 = chi-square value; *significant at $p < 0.05$; N = number of respondents

4.2.2 Feeding management

As shown in Table 7, the major feeding system (80.7%) in the study area was scavenging with random supplementation. About 78.9% of the interviewed farmers in South Bench, 81.1% in Sheko and 82.2% in North Bench districts occasionally supplemented their chicken with different feed resources. About 18.7% households in South Bench and 16.7% in Sheko and North Bench provide regular supplementation to their chickens. From those respondent farmers who provide supplementary feeds, 86.7% in South Bench, 91% in Sheko and 90% in North Bench provide supplementation throughout the whole year as shown in Tables 7 and 8.

Table 7. Feeding system and season of supplementation

Variables	South Bench (N = 90)	Sheko (N = 90)	North Bench (N = 90)	Overall mean	X^2
Feeding practices (%)					
Scavenging only	4.4	1.1	-	1.9	5.38
Random supplementation	78.9	82.2	81.1	80.7	4.62
Regular supplementation	16.7	16.7	18.9	17.4	0.38
Season of supplementation (%)					
Dry season	8.9	5.6	6.7	7.1	0.88
Rainy season	4.4	3.4	3.3	3.7	0.26
Year round	86.7	91	90	89.2	9.6*

X^2 = chi-square value; *significant at $p < 0.05$; N=number of respondents

As shown in Table 8, 46.7% of the respondent farmers provide supplementary feed randomly without a fixed frequency per day while 3.7% never provide totally. The rest 28.1% and 21.5% provide once a day and twice a day, respectively. As shown in Table 9 maize was the most frequently provided (91.1%) supplementary feed followed by sorghum (4.8%), taro (3.2%) and Kocho (0.9%). The types of supplementary feeds offered among the three studied districts were significantly different. Sorghum was not common in North Bench district while taro and Kocho were not common in Sheko district.

Table 8. Frequency of supplementary feeding (%) in the three districts

Variables	Districts				
	South Bench (N = 90)	Sheko (N = 90)	North Bench (N = 90)	Overall mean	X^2
No supplementation (%)	4.4	3.3	3.3	3.7	0.26
Once a day	23.3	34.4	26.7	28.1	3.36
Twice a day	18.9	19	26.7	21.5	2.3
Randomly	53.3	43.3	43.3	46.7	3.45

X^2 = chi-square value; N = number of respondents

Table 9. Types of supplementary feeds offered (%)

Districts	N	Maize	Sorghum	Taro	Kocho
South Bench	90	90	2.2	6.1	1.7
Sheko	90	87.6	12.7	-	-
North Bench	90	95.6	-	3.5	0.9
Grand total	270	91.1	4.8	3.2	0.9
X^2		13.72**	8.58*	4.54**	-

X^2 = chi-square value; *significant at p <0.05; **significant at p <0.01; N=number of respondents

As shown in Table 10, most of the interviewed farmers (95.6%) provided the available feedstuff by throwing on the ground without any feeder. Only 4.4% respondents use different feeders of wood made, plastic made or broken spot feeding equipments (Table 10). In the current study majority of chickens holders (94.4%) provided their chickens with grain supplementary feeds without any treatment however, 5.6% of the respondents experienced to grind grain feeds prior to offering to their chicken (Table 10). Particularly in Sheko feed treatment prior to offering to chicken was totally not adopted. The tuber feedstuff mainly taro was cooked and broken by hand before provision while Kocho was provided from the one ready for household consumption as respondents confirmed in focal group discussion.

The current study also revealed that the major source of supplementary feed was home grown crops (83 %). Only 1.1% of chicken holders based on local market purchased supplementary feeds and the rest 15.9% of the respondents used both as indicated in Table 10.

Table 10. Ways of feed provision and sources of supplementary feed

Variables	Districts				
	South Bench (N = 90)	Sheko (N = 90)	North Bench (N = 90)	Overall mean	X^2
Methods of feeding (%)					
Using feeder	7.8	3.3	2.2	4.4	3.66
Without feeder	92.2	96.7	97.8	95.6	3.66
Feed treatment (%)					
Grinding	5.6	-	11.1	5.6	-
No treatment	94.4	100	88.9	94.4	10.6*
Sources of supplementary feeds (%)					
Home grown	86.7	88.9	73.3	83	11.67
By purchasing	2.2	-	1.1	1.1	-
Both	11.1	11.1	25.7	15.9	6.96

X^2 = chi-square value; *significant at $p < 0.05$; N=no of respondents

4.2.3 Housing management

From the total interviewed households, only 24.1 % of them constructed separate house for chickens. About 30% of households in South Bench, 15.6% in Sheko and 12.1% in North Bench reported to provide a separate house for their chickens. On the other hand, 75.9% the respondents do not construct separate house for their chickens. They rather keep their chickens in the kitchen, in the animal house or perch inside the house during the night time (Table 11).

With regard to the frequency of chicken house cleaning, about 54.8% of the interviewed farmers reported that they clean in a week while the rest 18.9%, 16.7% and 9.6% of the respondents cleaned in the frequency of more than a week, every day and every two days, respectively (Table 11). The major reasons for not construct a separate house were poor attention to chickens (40%) followed by risk of predator, theft and disease particularly external parasite (30.7%). Lack of awareness (17.1%) and lack of resources for house construction (12.2%) were also the other reasons not to construct separate house (Table 12).

Table 11. Types of shelter used by households in the three districts

Variables	South Bench (N = 90)	Sheko (N = 90)	North Bench (N = 90)	Overall mean	X^2
Types of Night shelter (%)					
Separate house	30	15.6	26.7	24.1	5.93
Inside the house	40	32.2	33.3	35.2	2.02
In the kitchen	21.1	41.1	32.2	31.5	8.9*
In animal house	8.9	11.1	7.8	9.3	2.89
House Sanitation (%)					
Every day	17.8	14.4	17.7	16.7	0.66
Every two days	8.9	12.2	7.8	9.6	1.26
Once a week	54.4	61.1	48.9	54.8	4.24
More than a week	18.9	12.2	25.6	18.9	5.31

X^2 = chi-square value; *significant at $p < 0.05$; N = number of respondents

Table 12. Reasons for not constructing a separate poultry house (%)

Variables	South Bench (N=63)	Sheko (N=76)	North Bench (N=66)	Overall mean	X^2
Poor attention to chickens	22.2	50	45.5		
Risk of predator and theft	30.2	27.6	33.3	30.5	0.4
Lack of construction material	17.3	10.5	9.1	12.2	1.84
Lack of awareness	28.6	11.8	12.1	17.1	6.25

X^2 = chi-square value; *significant at $p < 0.05$; N = number of respondents

4.2.4 Disease and predators

From the total 270 interviewed households, 95.6% responded the presence of disease in the study area. The occurrence of disease in Sheko was 90% while in South Bench and North Bench it was 98.9% and 97.8, respectively. The current study also revealed as the mode of disease occurrence was very much seasonal in dry and rainy season. About 88.8 % in South Bench, 93.8% in Sheko and 63.6% in South Bench reported disease occurrence in rainy season. The rest 10.1% in south Bench, 6.2% in Sheko and 32.9% in south Bench reported year round disease problem. High problem of disease was reported in rainy season (81.8%) as shown in Table 13 particularly in the early and late rainy season as respondents explain during the key informant group discussions.

About 63.2% of the respondent farmers didn’t taken any measure when chickens get diseased while 21.3% treat with traditional medicine and 15.5% got veterinary service as presented in

Table 13. Relatively better veterinary access (25%) was in North Bench as the respondents' information while in South Bench and North Bench it was about 7.4%.

Table 13. Season of disease occurrence and actions taken by the households (%)

Variables	South Bench (N = 89)	Sheko (N = 81)	North Bench (N = 88)	Overall mean	X^2
Rainy season	88.8	93.8	63.6		
Dry season	1.1	-	3.4	1.5	3.53
Year round	10.1	6.2	32.9	16.7	27.27**
Measures taken					
No measure	67.9	67.9	57.9	63.2	2.62
Traditional medicine	22.5	24.7	17.1	21.3	1.5
Veterinary service	7.4	7.4	25	15.5	11.47**

X^2 = chi-square value; **significant at p <0.01; N = number of respondents

As shown in Table 14, Wild bird was the most challenging predator (70.5%) followed by mongoose, locally called *Shelmetmat (*18.4%), serval cat, locally called *Anur* (7.7%) and wild cat (3.5%) in order of their importance. As farmers indicate in the group discussion; chasing and killing, keeping chicken in and around the house by providing feed and by restraining, trapping with special equipment and poisoning with toxic chemicals by meat or dead chicken were the common techniques to protect predators while some respondents didn't taken any action in the studied districts.

Table 14. Challenging predators (%) in the three districts of the study area

Districts	N	Wilde birds	Shelmetmat	Anur	Wild cat
South Bench	86	72.1	19.8	2.3	5.8
Sheko	88	67.1	12.5	19.3	1.1
North Bench	87	72.4	22.3	1.2	3.5
Grand total	261	70.5	18.4	7.7	3.5
X^2		2.52	3.32	26.39**	2.81

X^2 = chi-square value; **significant at $p < 0.01$; N=no of respondents

4.2.5 Breeding and reproductive management

As shown in Table 15, from the total 270 interviewed households 81.2% of the respondents reported to have their own breeding cock while the rest 18.8% reported to use from their neighbors. Incubation time was found to be seasonal in the current study that 72.2% of the interviewed farmers were incubating in dry season, while 15.9% incubate at any time of the year regardless of season and the rest 11.9% incubate in rainy season (Table 15).

In the current study 36.3% of the total 270 interviewed farmers experienced egg selection prior to incubation while the rest 63.7% don’t practiced it. From the total 98 (36.3% of the total 270) respondents who practice egg selection 40.8% select primarily based on egg age while 53.1% and 6.1% was based on breakage and egg size, respectively (Table 15). Feeding and exercise frequency of local broody hen in the current study was 37.4% once a day, 43% twice a day, 13.3 % every other day and 6.3% every three days as shown in Table 15.

Table 15. Source of breeding cock and incubation management in the studied districts

Variables	Districts			Overall mean	X^2
	South Bench	Sheko	North Bench		
Source of breeding cock (%)					
Own	74 (82.2%)	72 (80%)	75 (83.3%)	221 (81.8%)	4.78
From neighbors	16 (17.8%)	18 (20%)	15 (16.7%)	49 (18.2%)	0.57
Season of incubation (%)					
Dry season	69 (76.7%)	64 (71.1%)	62 (68.9%)	195 (72.2%)	4.0
Rainy season	12 (13.3%)	11 (12.2%)	9 (10%)	32 (11.8%)	1.08
Year round	9 (10%)	15 (16.7%)	19 (21.1%)	43 (15.9%)	4.41
Egg selection (%)					
No	49 (54.4%)	60 (67.8%)	63 (70%)	172 (63.7%)	6.68
Yes	41 (45.6%)	30 (32.2%)	27 (30%)	98 (36.3%)	5.8
Primary criteria of Egg selection (%)					
Egg age	12 (29%)	12(40%)	17 (63%)	41 (41.8%)	-
Breakage	29 (71%)	16 (53.3%)	6 (22.2%)	48 (49%)	19.57**
Egg size	-	2 (6.7%)	4 (14.8%)	6 (6.1%)	-
Broody hen feeding and exercise frequency (%)					
Once a day	30	36.7	45.6	37.4	4.41
Twice a day	46.7	37.8	44.4	43	2.23
Every two days	11.1	18.9	10	13.3	3.91
Every three days	12.2	6.7	-	6.3	11.65**

X^2 = chi-square value; **significant at $p < 0.01$; N=number of respondents

About 97.8 % of the interviewed farmers practiced different techniques to minimize broodiness of hen when the egg is used for other purpose other than incubation as shown in Table 16. The techniques practiced were hanging the bird upside down (43.7%), disturbing the nest (38.2%), moving the hen to the neighbors' house (10%), feather peaking (4.1%) and depriving the bird from feed and water (1.8%).

Table 16. Traditional methods used to reduce the occurrence of broodiness (%)

Variables	South Bench (N=90)	Sheko (N=90)	North Bench (N=90)	Overall mean	X^2
No action	1.1	1.1	4.4		
Hanging upside down	40	48.9	42.2	43.7	2.42
Depriving feed & water	3.3	2.2	-	1.8	2.91
Disturbing in the nest	44.4	26.7	43.3	38.2	8.09*
Feather picking	-	7.8	4.4	4.1	-
Moving to neighbors	11.1	13.3	5.5	10	3.42

X^2 = chi-square value; *significant at $p < 0.05$; N = number of respondents

As presented in Table 17, the types of incubation materials in the studied area were wood made (53.3%), mud made on the dark corner of the house (26.3%), on the ground (16.3%), basket (locally known as *Canta*) (2.2%) and clay pot (1.8%). Wood made incubation Material was widely used in the studied districts. Grass (57.4%), cereal straw particularly Teff (31.1%), coffee seed coat (6.7%) and worn out cloths (4.8%) were also the major types of bedding materials in the study area (Table 17).

Table 17. Types of incubating and bedding materials

Variables	South Bench (N = 90)	Sheko (N = 90)	North Bench (N = 90)	Overall mean	X^2
Incubation materials (%)					
On the ground	16.7	12.2	20	16.3	1.68
Basket	2.2	-	4.4	2.2	4.08
Wood made	61.1	42.2	56.7	53.3	9.04*
Mud made	18.9	41.1	18.9	26.3	15.96**
Clay pot	1.1	4.4	-	1.8	3.13
Bedding material (%)					
Grass	68.	52.2	51.1	57.4	9.59*
Coffee seed coat	6.7	10	3.3	6.7	3.33
Teff straw	20	32.2	41.1	31.1	8.81*
Cloth	4.4	5.6	4.5	4.8	0.22

X^2 = chi-square value; *significant at $p < 0.05$ and **significant at $p < 0.01$ N=number of respondents.

4.3 Production Performance of Village Chicken

As presented in Table 18, the average age of cockerels at first mating and pullet at first egg laying was 5.9 and 6.4 months, respectively. Both cockerels and pullets from North Bench were fast grower (5.6 months) than in South Bench (5.9 months) and Sheko (6.1 months) districts. The average number of eggs per clutch of local chickens was 14.8 eggs. In district wise South Bench was significantly higher than North Bench but there was no difference between Sheko and the rest two districts. The average numbers of clutches per year was 3.7 while the average annual egg production was 54.6 eggs. The average annual egg production I Sheko was higher than the value in North Bench as shown in Table 18.

Table 18. Production performance of local chicken in three districts of BML (Mean±SD)

Parameters	South Bench (N = 90)	Sheko (N = 90)	North Bench (N = 90)	Overall mean
Age of cockerels (months)	5.9±0.9[a]	6.1±0.9[a]	5.6±0.9[b]	5.9±0.9
Age of pullets (months)	6.6±1.1[a]	6.6±1.1[a]	6.0±1.0[b]	6.4±1.1
No. of eggs/clutch	15.7±3.9[a]	14.9±3.5[ab]	13.9±2.7[b]	14.8±3.5
Clutch length (days)	46.9±16.5	44.3±16.8	47.8±14.9	46.3±16.1
No of clutches/year	3.6±0.7	3.9±2.2	3.5±0.5	3.7±1.3
No of eggs per year	56.4±18.6[ab]	58.5±46.6[a]	48.8±11.9[b]	54.6±30.0

[ab] Row means with different subscript letters are significantly different at $p<0.05$; SD = standard deviation; N =number of respondents

The average number of eggs incubated by local hen was about 11.8 of which 9.5 chicks were hatched with 82.2% hatchability (Table 19). The mean survival rate of chicks was 48.8% with a significant difference among the two districts. It was significantly higher in Sheko district (51.2%) than in North Bench (46.8%) but there was no significant difference between South Bench and the other two districts. The time at which chicks are allowed to scavenge out of home in the current study was 11.2 days while the mean brooding length of village chicken in the study area in this study was 2.9 months.

Table 19. Reproductive performance of local chickens in the study area (Mean±SD)

Performance parameters	South Bench (N=90)	Sheko (N=90)	North Bench (N=90)	Overall mean
No. eggs incubated	11.8±2.6	11.3±2.2	11.7±2.1	11.8±2.6
No. of chicks hatched	9.6±2.2	9.3±2.2	9.7±1.8	9.5±2.1
Hatchability (%)	81.3±10.1	82.1±8.3	83.0±8.4	82.2±8.9
No of chicks survived	4.5±1.5	4.7±1.4	4.5±1.5	4.6±1.5
Survival rate (%)	47.8±12.6^{ab}	51.2±10.9^{a}	46.8±19.3^{b}	48.8±12.6
Time allowed to scavenge (days)	9.7±6.1^{b}	10.5±6.4^{b}	13.3±7.8^{a}	11.2±7.0
Brooding length (months)	2.8±0.8	3.0±1.3	2.8±0.7	2.9±1.0

^{ab} Row means with different subscript letters are significantly different at $p<0.05$; SD = standard deviation; N = number of respondents

4.4 Constraints of Village Chicken

As indicated in Table 20, the most serious constraint was disease (70.7%) followed by predator (25.2), shortage of feed (2.2%), lack of shelter (0.7%) and theft (1.1%).

Table 20. Major constraints of chicken production (%) in the study areas

Districts	N	Disease	Predators	Shortage of feed	Lack of shelter	Theft
South Bench	90	76.7	20	2.2	1.1	-
Sheko	90	76.7	23.3	-	-	-
North Bench	90	58.9	32.2	4.4	1.1	3.3
Grand total	270	70.7	25.2	2.2	0.7	1.1
X^2		12.54**	3.97	4.08	1.01	-

X^2 = chi-square value; **significant at p <0.01; N=no of respondents

4.5 Pattern of Using Chicken Products

In the current study there was no any traditional or religious taboo related to the consumption of chicken products. However, some of the respondents select plumage color (31.1%) and comb type (25.6%) of the chicken for home consumption. As presented in Table 21, the primary purpose of chicken for majority of the respondents (76.7%) was selling for cash income. Egg selling for cash income (46.7%), hatching (30.4%) and home consumption (23%) were the three major purpose of egg in the study area (Table 21).

Table 21. Purpose of chicken production and usage of products

Districts	N	Purpose of chicken (%)		Purpose of egg (%)		
		Consumption	Sell	Consumption	Sell	Hatching
South Bench	90	18.9	81.1	14.4	60	25.6
Sheko	90	30	70	28.9	38.9	32.2
North Bench	90	21.1	78.9	25.6	41.1	33.3
Grand total	270	23.3	76.7	23	46.7	30.4
X^2		3.87	6.73	6.1	10.93*	1.87

X^2 = chi-square value; *significant at $p < 0.05$; N=no of respondents

As presented in Table 22, only 3.4 chickens on average were slaughtered per year in the interviewed farmers of the study area.

Table 22. Number of chickens slaughtered once and in a year (Mean±SD)

Variables	South Bench (N=90)	Sheko (N=90)	North Bench (N=90)	Over all mean
No. of chickens slaughtered/year	3.2±0.9	3.7±1	3.3±1.01	3.4
No. of chickens slaughtered once	1±0.18	1.1±0.29	1±0.1	1

SD = standard deviations; N = number of respondents

As shown in Table 23, about 91.5% of the interviewed farmers slaughtered chicken primarily during holidays while the rest 4.4%, 3%, and 1.1% slaughtered every time when available, when being sick and to entertain gusts, respectively. The primary time of egg consumption in the current study was every time when available and needed (69.3%), in holydays (18.7%), when being sick (9.4%) and in gust reception (2.6%).

Table 23. Time of chicken meat consumption in three districts of the study areas

Variables	South Bench (N = 90)	Sheko (N = 90)	North Bench (N = 90)	Overall mean	X^2
Chicken meat consumption (%)					
Holidays	94.4	86.7	93.3	91.5	15.18*
When being sick/birth	1.1	4.4	3.3	3	1.84
Every time	4.5	6.7	2.2	4.4	2.19
Reception of relatives	-	2.2	1.1	1.1	-
Egg consumption (%)					
Holidays	21.1	23.6	11.4	18.7	5.48
When being sick/birth	16.7	2.2	9.1	9.4	11.4**
Every time	61.1	67.4	79.5	69.3	9.64*
Reception of relatives	1.1	6.7	-	2.6	9.22*

X^2 = chi-square value; *significant at $p < 0.05$; **significant at $p < 0.01$; N=no of respondents

4.6 Evaluation of Egg Quality Parameters

The external and internal egg quality parameters of local chicken in the study area are presented in Table 24. The mean egg weight of chicken was 43.9 g while the mean egg width and egg length was 52.1 mm and 37.8 mm, respectively with an average shape index value of 72.7%. The mean albumen weight and yolk weight was 23.1 g and 15.1 g, respectively. In the current study the mean albumen height was 3.4 mm with the average HU score of 61.2. The mean yolk height was about 14 mm while the mean yolk color was 10.9. The mean shell thickness of local chicken egg in the study area was found to be 0.35 mm at the narrow end, 0.32 mm at the center, 0.31 mm at the broad end with an overall mean value of 0.33 mm.

There was no significant variation among the three studied districts in egg weight, albumen weight and yolk height. Eggs from Sheko district were significantly higher in egg length, egg width and yolk height but were lower in shell thickness than the other two districts. The shell weight and shell thickness of eggs from South Bench were higher than other districts. Eggs from North Bench were better in albumin height and HU while they were lower in yolk weight, shell weight and yolk color.

Table 24. Egg quality parameters of eggs from three districts of Bench Maji zone (Mean±SD)

Egg quality parameters	South Bench (N=90)	Sheko (N=90)	North Bench (N=90)	Overall mean
Egg weight (g)	44.0±3.8	44.3±5.3	43.4±4.7	43.9±4.7
Egg length (mm)	$51.7±3.8^{b}$	$53.6±3.6^{a}$	$50.9±3.6^{b}$	52.1±3.8
Egg width (mm)	$36.9±3^{b}$	$39.3±3.0^{a}$	$37.2±2.2^{b}$	37.8±2.9
Shape index (%)	$71.5±4.9^{b}$	$73.3±4.1^{a}$	$73.3±3.4^{a}$	72.7±4.3
Albumen weight (g)	23.1±2.8	23.1±3.4	23.0±3.3	23.1±3.2
Yolk weight(g)	$15.1±1.7^{ab}$	$15.3±2^{a}$	$14.8±1.8^{b}$	15.1±1.8
Albumen height(g)	$3.3±0.7^{b}$	$3.4±0.8^{b}$	$3.6±0.7^{a}$	3.4±0.7
Hough unit (HU)	$59.5±6.8^{b}$	$60.7±7.2^{b}$	$63.4±6.8^{a}$	61.2±7.1
Yolk height(mm)	14.1±1.7	14.1±1.7	13.9±1.7	14.0±1.7
Yolk color	$11.2±1.8^{a}$	$11.1±1.6^{a}$	$10.3±1.8^{b}$	10.9±1.7
Shell thickness (mm)				
Narrow end	$0.37±0.03^{a}$	$0.34±0.04^{b}$	$0.34±0.03^{b}$	0.35±0.04
Center	$0.34±0.04^{a}$	$0.30±0.04^{c}$	$0.32±0.04^{b}$	0.32±0.04
Broad end	$0.32±0.04^{a}$	$0.29±0.04^{c}$	$0.31±0.03^{b}$	0.31±0.04
Average	$0.34±0.03^{a}$	$0.31±0.04^{c}$	$0.33±0.03^{b}$	0.33±0.03

^{ab} Row means with different subscript letters are significantly different at $p<0.05$; N =number of observation

4.7 Carcass Characteristics of Local Chickens

The carcass traits of local chickens in the studied districts are presented in Table 25. The mean live weight of male chickens in the current study was about 1449 g. The average weights of breast, thigh, drumstick, back, wing, neck and skin were 246g, 188g, 149g, 114g, 98g, 50g and 71g, respectively. The edible carcass weight of the current study including the weights of neck, giblets and skin was about 966 g with 66.7 dressing percentage. In most carcass traits, chickens from Sheko district were superior as compared with those chickens from the South Bench and North Bench districts. The weights of liver and gizzard were numerically high in Sheko though it was not significant statistically.

Table 25. Carcass yield (g) of local chickens in three districts of Bench Maji zone (Mean±SD)

Carcass components	South Bench (N=15)	Sheko (N=15)	North Bench (N=15)	Overall mean
Live weight	1358±108^{b}	1545±133^{a}	1445±137^{b}	1449±146
Breast	224±31.5^{b}	276±32.1^{a}	238±24.4^{b}	246±36.5
Drumstick	138±11.7^{b}	165±19.3^{a}	144±16.7^{b}	149±19.6
Thigh	174±17.4^{b}	203±22.2^{a}	187±20.8^{b}	188±23.1
Back	107±8.8^{b}	125±11.3^{a}	111±10.6^{b}	114±13.0
Wings	91.8±6.7^{b}	106±10.1^{a}	96.7±7.2^{b}	98.1±9.9
Neck	48.2±3.0^{b}	51.2±4.0a	50.8±4.4^{ab}	50.1±4.0
Skin	65.5±7.1^{b}	76.5±12.7^{a}	71.0±6.9^{ab}	71.0±10.2
Gizzard	21.5±3.2	23.5±4.3	21.9±2.4	22.3±3.4
Liver	20.6±3.0	21.5±3.0	20.0±3.2	20.7±3.1
Heart	5.8±1.3^{b}	7.8±1.5^{a}	6.8±1.2a^{b}	6.8±1.5
Carcass weight	897±76.5^{b}	1056±103^{a}	947±78^{b}	966±108
Dressing %	66.1±1.9^{b}	68.3±2.5^{a}	65.6±2.8^{b}	66.7±2.7

^{ab} Row means with different subscript letters are significantly different at $p<0.05$; N = number of observation, SD = standard deviations

The proportions of the major carcass components were 25.4% breast, 19.5% thigh, 15.4% drumstick, 11.8% back and 10.2% wing (Table 26). There was also significant difference among the three districts in some of the carcass parts. Accordingly, chickens reared in Sheko district had higher breast percentage than those kept in other districts.

Table 26. Proportions of carcass yield (%) of local chickens in BMZ (Mean±SD)

Carcass components	South Bench (N=15)	Sheko (N=15)	North Bench (N=15)	Overall mean
Breast	24.9 ± 1.6^{b}	26.1 ± 1.3^{a}	25.1 ± 1^{b}	25.4±1.4
Thigh	19.4±1.2	19.2±0.8	19.8±1	19.5±1
Drumstick	15.4±0.4	15.6±0.8	15.1±0.7	15.4±0.7
Back	11.9±0.4	11.9±0.7	11.7±0.8	11.8±0.6
Wings	10.3±0.7	10±0.6	10.2±0.7	10.2±0.7
Neck	5.4 ± 0.4^{a}	4.9 ± 0.3^{b}	5.4 ± 0.4^{a}	5.2±0.4
Skin	7.3±0.7	7.2±0.8	7.5±0.6	7.3±0.7
Gizzard	2.4±0.3	2.2±0.3	2.3±0.3	2.3±0.3
Liver	2.3 ± 0.2^{a}	2 ± 0.2^{b}	2.1 ± 0.3^{ab}	2.1±0.3
Heart	0.6±0.1	0.7±0.1	0.7±0.1	0.7±0.1

^{ab} Row means with different subscript letters are significantly different at $p<0.05$; N =number of observation

5 DISCUSSION

5.1 Socio Economic Characteristics

The average family size of the household in the current study was about 6.7 which is similar with Moreda *et al.* (2013) who reported an average family size of 6.4 in southwest and south parts of Ethiopia. However, this value is higher than the average national (4.7) and regional (4.9) family size per household reported by CSA (2007). The sex, marital status and level of education in the current study were comparable with those reported by Fisseha (2009) in northwestern Amhara region, Ethiopia. In line with the findings of Meseret (2010), women were the main responsible to manage chickens in every aspect such as feeding, house cleaning, health care, breeding management and marketing chicken products while men involve better only in house construction. The average livestock holding per household in the study area was lower than the reported value by Worku *et al.* (2012) in northwest Ethiopia. The majority of the respondents in the current study were between 25 and 55 years old group and the respondents' level of education was in good agreement with the findings of Meseret (2010) in southwestern Ethiopia.

5.2 Management of Local Chickens

5.2.1 Flock size and composition

The average chicken flock size per household in the current study was in agreement with those reported by Aberra and Tegene (2011) in southern Ethiopia and by Deneke *et al.* (2014) in southeastern Oromia region of Ethiopia. However, it was higher than Moreda *et al.* (2013) result who reported 4.85 average flock size in southwest and southern parts of the country.

Meseret (2010) also reported a flock size of 6.23 in Gomma Woreda, southwestern Ethiopia, which was lower than the current result. On the other hand, the flock size in the present study is lower than Fisseha *et al.* (2014) who reported flock size of 13.7 in Amhara region, Ethiopia. According to Aberra (2014), the flock size of African scavenging chicken varied from 6 to 34 which is in line with the current result.

There was also a significant variation in flock size among the studied districts. Accordingly, the flock size observed in Sheko district was lower than the flock size in the rest two districts. The variation in flock size in different districts might be attributed to the difference in chicken management and off take rate (Addis, 2014; Fisseha *et al.*, 2010). Kondombo (2005) also stated that nutritional deficiencies might be the reasons for low flock sizes in scavenging chicken production systems which might result in flock size variations in different areas.

In agreement with Meseret (2010) and Moreda *et al.* (2013), hen followed by young chicks while the number of cocks and cockerels were relatively low dominated the flock composition in the study area. The result was somewhat different from the national flock composition, which is dominated by chicks followed by hens (CSA, 2014). This might be due to low culling rate of aged hens and high occurrence of disease and predators in the area as chicks are at high risk than the other age groups. In addition to this, large proportion of hens in the flock might justify the need of households to increase egg production by increasing the number of hens in the flock for sell and/or household consumption (Moreda *et al.*, 2013).

The average cock to hen ratio in the current study was 1:2.9, which 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). Yakubu (2010) in Nigeria also reported a much lower cock to hen ratio of 1 to 3.4. The flock size and flock structure was influenced by district except the cock number. The major source of replacement stock was hatched chicks which might possibly result inbreeding in indigenous chicken population which was in agreement with the findings of Nebiyu *et al*., (2013). This might be due to the low economic level of the farmers to replace by purchasing. Contrary to the current study, Melese and Melkamu (2014) reported in northwestern Ethiopia that about 66% of interviewed households indicated that the main sources of replacement of chicken stocks was purchasing from local markets.

5.2.2 Feeding system

In the current study, scavenging with occasional supplementation was the major feeding system (80.7%). Comparably, Fisseha *et al.* (2010) in northwestern Ethiopia and Kondombo (2005) in Burkina Faso indicated a traditional chicken production system based on scavenging with seasonal supplementations. In line with the findings of many scholars, in the current study there is no planned feeding for village chickens rather only scavenging with random supplementation was employed to maintain the flock with low level of production (Addis, 2014; Solomon, 2008; Aberra, 2014). Yusuf (2014) also reported that the scavenging system of production which bases on bulk scavenge feed resources is the major type of feeding management. However, 17.4% of the respondents practiced regular supplementation indicates the desire of farmers to enhance chicken productivity with improved nutrition.

Most of the respondents provide home grown supplementary feeds throughout the year unlike the study by Fisseha *et al*. (2010) and Halima (2007) who reported a seasonal supplementation. This was because farmers in southwestern Ethiopia in general and in Bench

Maji zone in particular, experienced to grow mainly maize and sorghum two or more times per year. The other reason might be that in the study area taro and *Kocho* were the two common non-grain feeds, which are available throughout the year. Except maize, the types of supplementary feeds in this study were different from feeds used in other parts of the country. Worku et *al*. (2012) for example, reported maize, wheat, and barley as major grain supplements while Fisseha *et al*. (2010) and Halima (2007) reported wheat, maize and millet as the three common supplementary feeds in northwestern parts of Ethiopia. The feed type variation in different areas is due to the differences in types of crops grown in different agro ecologies of the country. Household scratches and worms including coffee worms as well as different fruits were also valuable types of scavengeable feedstuffs to village chicken. In line with this, Aberra (2014) stated green plants, fruits, worms, household leftovers and gleanings from cultivated land as a basic feeds for scavenging feeding system in most African countries.

Throwing on the ground feeding system in most respondents and the types of feeders used by some farmers in the current study were in agreement with the findings of Halima (2007) who reported that only 3.4 % of the respondents provided feed with different local feeders. In another study conducted by Worku *et al*. (2012), about 16 % of the interviewed households provided feed using different feeders in west Amhara region, which was relatively better feeding exercise than observed in the current study. Poor practice of using feeder might explain this scenario due to lack of awareness among livestock keepers which show in area of extension intervention to encourage farmers to utilize locally available equipments.

5.2.3 Poultry housing and management

Poultry housing in scavenging system of chicken production in many African countries was absent or not well planned (Aberra, 2014). Kondombo (2005) also stated that poor housing is the main cause for chicken loses due to attack by predators. Construction of chicken house was less adopted in the study area i.e. only 24.1 % of the interviewed farmers in the current study constructed separate house, which indicates that farmers in the area do not give too much emphasis to chicken housing. In line with the current result, Worku *et al.* (2012) and Nebiyu *et al*. (2013) reported that only 11.7 % and 12.1% of the interviewed farmers have constructed a separate house, respectively. Most of the respondents (76%) in the current study do not construct separate houses rather they housed their chicken only at night on a perch inside the house, in the kitchen, and/or in the animal house, which is in good agreement with reports of Meseret (2010). Thus, one can conclude that the biosecurity of village chicken in the study area is extremely poor which can be a potential source of disease for both farm animals and humans. Biosecurity of chicken is highly dependent on the level of chicken house sanitation (Solomon, 2008).

5.2.4 Disease and predators

From the total 270 interviewed farmers, 95.6% experienced serious flocks devastating disease in the study area. In good agreement with the current findings, Fisseha *et al.* (2010) reported that 97.5% of the respondents in northwestern part of Ethiopia experienced chicken disease. This high prevalence of disease in the current result attributed to chickens' vulnerability to disease when different flocks scavenge together in the backyard that increases the chance of disease transmission (Aberra, 2014; Solomon, 2008). From the three study districts, the occurrence of disease in Sheko seems relatively lower (90%) while in South Bench and North Bench it was comparatively higher (98.9% and 97.8, respectively). The current study also revealed that the mode of disease occurrence in the study area was very much seasonal in dry and rainy season. High problem of disease (88.8%) was reported during the rainy season particularly in the early and late rainy season, which is consistent with the findings of Tadelle *et al.* (2013), Fisseha *et al*. (2014) and Nebiyu *et al*. (2013).

In the current study, only 15.5% of the households do have access to veterinary services which seems much better than those of Fisseha *et al*. (2010) and Halima (2007) who reported that only 8.9% and 6.66% of the respondents had access to veterinary services. In the current study, 63.2% of the respondents do not attempt to treat their chickens when they are sick while 21.3% treat using traditional medicines. These results are in good agreement with those of Moreda *et al.* (2013). However, the effectiveness of the traditional medicines used by the poultry keepers have to be further researched.

According to Nigussie *et al*. (2010), predation is one of the challenging factors to hinder the production of village chicken in most parts of Ethiopia. In the present study, wild birds, mongoose (*Shelmetmat)*, serval cat (*Anur)* and wildcat in the order of their importance were the most challenging types of predators reported by the households. Melese and Melkamu (2014) also reported wild birds and *Shelmetmat* as the major challenging predators. According to Aberra (2014), chicken lose due to predators have to be avoided by using different measures such as construction of well designed house, clearing grass and shrub covers around the homestead and avoid keeping white birds. The study area is dominated by a dense vegetation cover up to the homestead area, which makes the protection of scavenging chickens from predation very difficult. In agreement with the present findings, Fesseha *et al*. (2014)

stated the methods of predator protection in northwestern Ethiopia such as keeping birds in house (47.9%) and killing predators in different ways (33.9%) were the major ones.

5.2.5 Breeding and reproductive management

Majority of the respondents (81.2%) have their own breeding cock while the rest used from their neighbors. Relatively to the current result, high proportion of the interviewed farmers (47.8%) in Gomma Woreda, southwestern Ethiopia reported that they do not have breeding cock (Meseret, 2010). In the current study, almost all the respondents leave their chicken in the backyard to scavenge freely resulting in random mating which could possibly reduce the problem of inbreeding in the population. However, it is the worst if exotic chicken breeds are introduced unintentionally or deliberately to cause genetic dilution that deteriorate the unique traits of local chicken to withstand environmental and managemental stresses (Aberra, 2014; Kefyalew, 2013; Nigussie *et al*., 2010; Yakubu, 2010).

Incubation in the study area was found to be seasonal and most of the interviewed households preferred incubating during the dry season, which is in line with the findings of Aberra *et al*. (2013a) who reported a seasonal incubation of 95% in dry season. Matiwos *et al*. (2013) also reported a seasonal incubation of 80.7% in dry season and the rest during the rainy season. The possible explanation for incubating of eggs during the dry season might be low hatchability due to the effect of cold environment during the rainy season. Hatching of eggs during the rainy season can also expose them to disease and predator resulting in high chick mortality. The majority of the respondents (63.7%) in the current study reported that they select eggs prior to incubation based on breakage egg size and storage time which is in good agreement with the findings of Fisseha (2009).

Most types of incubation materials in the studied area were similar with those reported by Aberra *et al*. (2013a) and Fisseha (2009). However, 53.3% of households used wood made incubation materials, which was somehow unique to the area and appreciated by the respondents to secure the incubated eggs from the attack of rat and ant. Grass, cereal straw particularly teff, coffee seed coat and worn out cloths were the most common bedding materials used in the order of their importance. On the other hand, Aberra *et al*. (2013a) reported in northwestern Ethiopia that 97% of the bedding materials used was crop residue. This might be explained by the availability of cereal crop residues in that particular study area which is not the case in the current study area.

Broodiness is a necessary phenomena in village chicken production system to hatch and rear chicks as well as to accumulate body reserve to the next clutch time. However, local chickens are characterized by showing a prolonged broodiness, which is uneconomical since it affects the egg production potential of the hen by reducing the frequency of clutch size per year (Aberra, 2014). The majority of the interviewed households (97.8 %) reduce the expression of broodiness when the egg is used for other purposes other than incubation. Nigussie *et al*. (2010) and Matiwos *et al*. (2013) reported different methods practiced by farmers to avoid broodiness behavior of the hen such as hanging the bird upside down, disturbing the nest, moving the hen to the neighbors' house, feather peaking and depriving the bird from feed and water, which were in agreement with the current result. Most of the traditional techniques mentioned here are aimed to stress the bird to discourage the activity of broodiness. However, such practices might be stressful to the hens which possible could lead to reduced productivity.

5.3 Production Performances of Village Chicken

The average age of cockerels at first mating and that of pullets at first egg laying in the current study was in agreement with Alem (2014) who reported 6.1 and 6.3 months for cockerels and pullets of local ecotypes, respectively. Consistent with the current result, Aberra *et al*. (2013b) and Nebiyu *et al*. (2013) also reported the age of pullets at firs egg laying 6.6 and 6.5 months, respectively. On the other hand, Melkamu and Andargie (2013) reported a longer pullet age (7 months) at first egg and a shorter age of cockerels at first mating (4.7 months). This variation might be due to the availability of better scavengeable feed resources, prevalence of diseases and genetic variation of the local chickens.

Significant variations were also observed in the number of eggs per clutch of local chickens among the studied districts. The average number of eggs per clutch (14.8), number of clutches per year (3.7) and the mean annual egg production of village chicken (54.6) in the current study was comparable with those reported by Fisseha (2009) and Yakubu (2010) hoever it were slightly higher than those reported by Alem (2014) in Tigray region. In contrary, Melkamu and Andargie (2013) reported higher values on those stated parameters than observed in the current study. These variations in different parts of the country might be attributed to the variations in management systems, availability of adequate feed resources in terms of quantity and quality, variations in disease prevalence and veterinary services. Moreover, factors related to the genetic potentials of different ecotypes reared in various regions of the country might be responsible for the observed differences. It is thus worthwhile to note that the existence of such genetic variations in key performance traits will give better opportunities to breeders to improve the genetic potentials of local chickens through selection and systemic breeding.

Average number of eggs incubated, chicks hatched and hatchability percentage in the current study were in good agreement with the results by Aberra *et al*. (2013b) and Nebiyu *et al*. (2013). In contrary, very low hatchability (22%) value was reported in Gomma Woreda, southwestern Ethiopia (Meseret, 2010). On the other hand, Matiwos *et al*. (2015) reported higher hatchability (98.6%) than current result. These variations might be due to differences in culling practice, nutritional management and incubation management in different locations. The mean survival rate of chicks to marketable age (48.8%) in the current study was higher than the value reported by Meseret (2010) but lower than those reported by Fisseha (2009) and Melese and Melkamu (2014) in other parts of Ethiopia. There was also significant variation in chick survivability among the studied districts that Sheko district was better than North Bench however there was no difference between South Bench and the other two districts. This might be due the relative low disease occurrence in Sheko district relative to the rest two districts as revealed in the current study. Low survivality of chicken in the current study suggests high chick mortality due to disease and predation.

5.4 Constraints of Local Chicken Rearing

The production potential of village chicken in Ethiopia has been affected by different constraints (Addis, 2014; Hunduma *et al.*, 2010; Tadelle *et al*., 2013). Disease, predator, shortage of feed, lack of shelter and theft were the major constraints in the current study in their order of importance which was in agreement with the works of different scholars in different parts of the country (Fisseha *et al*., 2014; Halima, 2007; Hunduma *et al.*, 2010; Melese and Melkamu, 2014; Yakubu, 2010). In contrast with the current study, Worku *et al*. (2012) and Nebiyu *et al*. (2013) reported predation as a major constraint of poultry production in the rural communities of Ethiopia. Poor feeding system was one of the constraints in the current study, which is in agreement with Aberra (2014) who reported that, not only the amount of supplementary feed is insufficient but also the quality of the feed provided is poor. Lack of proper housing system in the current study was the potential reason resulting in high chicken mortality due to disease and predation, which is in line with the report by Tarekegn *et al.* (2015) in Eastern Ethiopia.

5.5 Pattern of Using Chicken Products

In the current study, there was no any traditional or religious taboo related to chicken production and chicken product consumption which was consistent with Alem *et al.* (2014) and Fisseha (2009). However, some of the respondents select plumage color (31.1%) and comb type (25.6%) of the chicken for home consumption, which is in line with the reports of Nigussie *et al*. (2010) and Tadelle *et al*., (2013). Scavenging poultry production plays economical, nutritional, social and cultural roles to the rural households in many developing countries (Aberra, 2014; Aklilu, 2007; FAO, 2010). The primary purpose of chicken rearing in the study area was selling for cash income followed by home consumption, which was in good agreement with those of Fisseha *et al*. (2010) and Nigussie *et al*. (2010). On the contrary, Alem *et al*. (2014) reported that home consumption is the primary purpose of chicken production in central Tigray zone, Ethiopia. Produced eggs were also used primarily for sell, followed by hatching, and home consumption which is in line with the observations of Matiwos *et al*. (2015) in Amaro district of Southern Ethiopia. The current study also showed that most people in the study area consume relatively more eggs than chicken meat as the former is easily affordable than the latter.

In good agreement with Aklilu *et al*. (2007) and Alem *et al*. (2014), the practice of chicken product consumption in the current study was highly associated with celebrating holydays.

Only 3.4 chickens were slaughtered annually in the household, which was lower the than reported value by Alem *et al*., (2014) in central Tigray zone of Ethiopia. The current study in general indicated poor habit of chicken product consumption due to low level of income and poor trend to focus on ASF such as egg and meat. It is apparent that egg and meat plays higher role to satisfy the protein requirement of the family members of any household (Aberra, 2014) and thus egg consumption in the rural community shall be encouraged.

5.6 Evaluation of Egg Quality Parameters

The mean egg weight in the current study (43.9 g) was in good agreement with the findings of Fisseha (2009) and Meseret (2010) who reported an average egg weight of 43 g and 41.7 g, respectively. Getachew *et al*. (2016) also reported comparable egg weight value of 41.1 g from indigenous chicken in western Shewa zone of Oromia region, Ethiopia. On the contrary, Halima (2007) reported much lower egg weight values (34.1 g to 41.7 g) for different chicken ecotypes in northwestern part of the country. Aberra *et al*. (2010) reported 44.7 g for eggs collected from Ethiopian Naked neck chicken, which was reared under intensive management. Consistent with the reports of Aberra *et al*. (2013b), the egg width, egg length and shape index in the current study were 52.1 mm 37.8 mm and 72.7%, respectively. Fisseha (2009) also reported comparable values for the same parameters.

The shell thickness in the present study was comparable with that of Desalew *et al*. (2015), who reported 0.31 average shell thicknesses in East Shewa, Ethiopia. Aberra *et al*. (2013b) also reported about 0.30 mm shell thickness, which is comparable with the current finding. On the other hand, Fisseha (2009) reported lower value of shell thickness (0.26 mm) in northwestern Ethiopia. However, Aberra *et al*. (2010) reported a relatively higher shell thickness value (0.37mm) in Ethiopian Naked neck chickens reared under improved production system. These variations in shell thickness among local chicken ecotypes reared in various parts of the country might be due to the availability of mineral calcium in the scavenging feed material as well as the type of agro-ecology in which chickens are reared. According to King'ori (2012), shell thickness is influenced by calcium availability in layer nutrition and ability of the hen to absorb calcium by the shell gland. Higher value of shell thickness in the present study might be due to better calcium content of the available scavenging feed resources in the study area like taro, which has been reported to be rich in calcium containing about 11% (USDA, 2016). Hence, it would be worthwhile to recommend further feed analysis of the scavenging feed resources available in the study area.

The albumen, yolk and shell weights in the current result were in agreement with Meseret (2010), Aberra *et al*. (2010) and Ahmedin (2014). The mean albumen height (3.4 mm) in the current study was lower than the average albumen height of 4.51 mm reported by Aberra *et al*. (2013a) in northwestern Amhara region, Ethiopia but higher than observed by Meseret (2010) who reported 2.87 mm and 2.1 mm albumen height for fresh eggs collected from household and purchased from local market , respectively. The average HU value (61.2) was in line with Halima (2007) who reported values ranging from 55 to 65 for different local chicken ecotypes. Getachew *et al*. (2016), Aberra *et al*. (2010, 2013c) and Fisseha (2009) reported relatively higher HU value in different parts of Ethiopia. Veena *et al*. (2015) also reported about 74.4% and 74.1% HU in winter and summer seasons, respectively in India. The low albumin height and the resulting HU in the current study might be attributed to low culling practice i.e. maintaining old hens and/or poor egg handling technique in the studied area (King'ori, 2012). Moreover, low albumen height and HU might be due to some sort of quality deterioration during transportation since the experiment was done at JUCAVM which is far from the study area. It might be also due to longer rainy season prevailed in the study area, which result high water uptake with succulent feed items available in the area (Veena *et al*., 2015).

The investigated yolk height was about 14 mm in the current study, which was in agreement with the findings of Aberra *et al*. (2013c), Ahmedin (2014) and Halima (2007) in different parts of the country. However, Aberra *et al*. (2010) reported 16.9 mm yolk height in eggs of naked neck local chicken, which is higher than found in the current study. In contrary, Meseret (2010) reported 11 mm for fresh eggs and 9.1 for market purchased eggs, which are lower than the current result. These differences might be due to the duration and the temperature in which eggs were transported and stored as well as the age of the hens when eggs were collected. The genetic potentials of individual chicken ecotypes may also contribute to the observed variations.

The mean yolk color in the current study was 10.9, which is comparable with the findings of Aberra *et al*. (2010), Meseret (2010) and Getachew *et al.* (2016). However, it was very much higher than that of Halima, (2007) who reported a yolk color ranging from 3.0 to 4.0 for different local birds in northwestern Ethiopia. Etalem *et al*. (2009) and Samson *et al.* (2013) also reported yolk color value of 4.5 for Rhode Island Red and 5.9 for Fayoumi chicken under backyard production system. High value of yolk color in the current study and elsewhere in the country might be attributed to the quality and availability of greenish scavenge feed materials in the free-range production system (Zaman *et al*., 2000)**.** It is generally assumed that since local chickens get their feed merely by scavenging and foraging their eggs contain appreciable amounts of xanthophylls which is responsible for deep yellow color of the yolk. It would also worthwhile to note that some of the works with low yolk color might have been conducted under intensive management system to test specific locally available feed resources by using various feed ingredients which might be deficient in xanthophylls.

There were significant variations in most egg quality parameters among the three studied districts. Eggs from Sheko district were significantly higher in egg length, egg width and yolk height but lower in shell thickness. Eggs from South Bench were higher in shell thickness while low in shape index. Eggs from North Bench were better in albumen height and HU but lower in yolk weight and yolk color. These differences might arise from variations in nutrient composition of the available scavenging feed resources, culling practice, egg handling and storage techniques in the three districts (Etalem *et al*., 2009; Halima, 2007; King'ori, 2012; Isidahomen *et al*., 2013).

5.7 Carcass Characteristics

The slaughter weight of matured male chicken in the current study was in good agreement with the body weight reported by Aberra and Tegene (2011) in southern Ethiopia. Halima (2007) also reported 1517 g body for Guangua chicken ecotypes in northwestern part of Ethiopia, which was comparable with the current result. Raphulu *et al*. (2015) reported 1531 g body weight for mature Venda scavenging chickens in South Africa which is slightly higher than observed in the present study. These variations might be explained by a difference both in quality of the available scavenging feed resource and genetic potentials of the birds reared in different countries. Halima (2007) reported slaughter weights ranging from 1045 g to 1292 g for different local male chicken ecotypes in northwestern Amhara of Ethiopia, which is lower than observed in the current result. The existence of differences in matured body weight of local scavenging chickens by different scholars might be attributed to chicken genetic makeup, age of the bird, management system, and season of the year when body weight measurements were taken.

Dressing percentage of 66.7 was observed in the current study which is consistent with the finding by Halima (2007) who reported 64 %, 65.3% and 66.8% for Melo Hamusit, Mecha and Gelila local ecotypes, respectively. In good agreement with the current result, Taddele also reported 65.5% of dressing and Ogle (2000) in hens reared in central highlands of Ethiopia. Magala *et al*. (2012) reported much higher dressing of 71.8% for local Ugandan chicken under different management systems. The dressing percentage of indigenous chicken reported by various scholars was somehow comparable with that of exotic chicken breeds reared under the hot tropical climate. For instance, Asrat *et al*. (2009) and Melkamu (2013) reported 67% and 64.3 % dressing percentage values, respectively for RIR chickens reared under intensive management system. Aberra *et al*. (2013c) reported dressing percentage of Koekoek chickens ranging from 59-63.3%, which is slightly lower than the findings observed in the present study. On the other hand, Kefyalew et al. (2015) reported a relatively higher dressing percentage of 71.1% for commercial broilers at Haremaya University.

The relatively high dressing percentage observed in the current study and in other similar findings reported by different authors in different locations might be attributed to the parts of carcass included or excluded while computing the percentage. It can also be further affected by the scavenging nature of chicken production and types of cereals/grains supplemented to the local chickens. It has been reported that chickens under free range production system have higher dressing percentage than chickens under confined management (Wang *et al*., 2009). Physical exercise of birds in free range birds in search of their feed would facilitate the protein synthesis rather than lipogenesis which results low amount of abdominal fat accumulation that reduce the dressing percentage (Dal Bosco *et al*., 2010; Dou *et al*., 2008; Castellini *et al.*, 2002). On the other hand, Halima (2007) reported lower dressing value of 53.3% for Tilili male chicken ecotype. Similarly, mean dressing percentage 53.8% was also reported in Sudan for three indigenous foul ecotypes (Yousif *et al*., 2014). Such low dressing percentage might be due to the differences in production system and the genetic potential of chickens.

The mean weight of carcass yield and most of the carcass cuts i.e. drumstick, thigh, breast back and wing in the current study are in line with the findings of Aberra *et al.* (2013c) and Raphulu *et al*. (2015). The mean weights of the giblets were somewhat lower than the values reported by Aberra *et al*. (2013c). In most carcass traits, chickens reared in Sheko district had significantly higher weights of carcass components than chickens kept in the other two districts. This might be attributed to dissimilarities of chicken ecotypes in the study area that show the possibility to improve meat production by selection. The proportions of breast, thigh and drumstick are the most valuable meat parts that determine the chicken meat quality (Holcman *et al*., 2003). The proportion of such valuable meat parts in the current study were in good agreement with the reports of (Aberra *et al*., 2013c) but higher than those of Magala *et al.* (2012). Chickens from Sheko district had the highest breast yield indicating their genetic potential for meat production over those chickens reared in the other districts.

6. CONCLUSION AND RECOMMENDATION

Scavenging with random supplementation was the sole system of chicken production in the studied area in which the production potentials of village chicken was hindered by poor feeding management, unconventional housing system and high prevalence of disease and predation. Maize, sorghum, taro and Kocho were the most common supplementary feeds in their order of importance. Not only the feed availability but also the feeding system was poor in the current study, as farmers do not adopt feed treatment and using feeder to their chicken. There was no adoption to construct separate chicken house and as a result chickens are sheltered at night in an inappropriate shelters. Disease was highly challenging factor for village chicken production by causing seasonal devastation of the flock. Veterinary access was poor and most farmers do not take any measure when chicken get sick. Predation was also serious cause to lose chickens particularly young chicks.

Indiscriminate mating was the major breeding system in the studied districts since chicken flocks of the neighbors scavenge together. This potentially can reduce the problem of inbreeding however, it can also result genetic dilution if exotic blood is introduced to the area that can deteriorate the noble genetic potential of indigenous chicken to help rural residents under poor management. Incubation time was seasonal in the current study that most farmers tend to incubate in dry season for better hatchability and chick survivability. Local chicken ecotypes in the study area were relatively late maturing under farm management condition. Longer brooding time and small numbers of clutch per year also lower attributed the egg production potential of indigenous chicken. The hatchability percentage in the current study was high however; there was a low survivability rate due to disease and predator challenges.

Under the existing management system village chickens exhibited relatively good quality eggs in egg weight, shape index and shell thickness. The quality of the egg was also expressed by a high value of yolk height and yolk color. However, the HU score of indigenous chicken in the study area was relatively lower that might be due to poor egg handling technique and holding aged hen for egg production. Most of the respondent farmers do not practice collecting and storing eggs in cooler area rather they leave on the laying nest until incubation or used for consumption and/or market. The carcass traits of village chicken were also relatively good with a high dressing percentage and high proportions of the valuable carcass portions.

Local chickens exhibited significant variations in their performance that chickens from Sheko displayed a significant high egg production performance and carcass yield traits over the other two districts. Chickens from North Bench were fast maturing however, they were lowest egg producers. The eggs from North Bench were significantly high in albumen height and Hough unit score. There were also significant variations observed among the three studied districts in egg length, egg width, yolk height, shell weight, shell thickness, albumin height, HU and yolk color indicating the genetic variation among indigenous chickens in the study area that have to be exploited by improved management and genetic improvement through systematic breeding programs.

Based on the results revealed, the current study suggests the following recommendations.

- Interventions to improve the management activities particularly feeding, housing and health care management are crucial to enhance the existing low level of chicken production.
- As disease is the most challenging factor in the studied districts veterinary services have to be accessed the rural households and the curability of traditional medicines have to be further investigated.
- It is imperative to conserve the indigenous chicken ecotypes as uncontrolled breeding system is believed to cause genetic erosion through genetic dilution if exotic breeds are introduced to the area unintentionally.
- Improvement of indigenous chickens' genetic potential through selection and improved management should receive a fundamental attention as they are exhibiting good quality egg and meat production potential under the farm level management.

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APPENDIX I: ANOVA TABLES:

Table 1. Average flock size

Sources of variations	DF	Sum squares	Mean square	F value	P value	CV
District	2	245.363	122.681	6.83	0.0013	40.9
Error	267	4795.911	17.962			
Total	269	5041.274				

Table 2. Average numbers of hens in the flock

Sources of variations	DF	Sum squares	Mean square	F value	P value	CV
District	2	19.563	9.781	4.91	0.0080	38.6
Error	267	531.711	1.991			
Total	269	551.274	741			

Table 3. Average numbers of cocks in the flock

Sources of variations	DF	Sum squares	Mean square	F value	P value	CV
District	2	1.03	0.515	0.64	0.529	73.6
Error	267	215.078	0.805			
Total	269	216.107				

Table 4. Average numbers of pullets in the flock

Sources of variations	DF	Sum squares	Mean square	F value	P value	CV
District	2	28.363	14.181	7.02	0.0011	76.77
Error	267	539.711	2.021			
Total	269	568.074				

Table 5. Average numbers of cockerels in the flock

Sources of variations	DF	Sum squares	Mean square	F value	P value	CV
District	2	10. 141	5.07	3.12	0.046	122.9
Error	267	433.489	1.623			
Total	269	443.63				

Table 6. Average numbers of chicks in the flock

Sources of variations	DF	Sum squares	Mean square	F value	P value	CV
District	2	70.489	35.244	3.88	0.022	118.9
Error	267	2424.711	9.081			
Total	269	2495.2				

Table 7. Average cockerel age at first mating (months)

Sources of variations	DF	Sum squares	Mean square	F value	P value	CV
District	2	13.592	6.796	7.83	0.0005	15.9
Error	267	231.7645556	0.868			
Total	269	245.3570741				

Table 8. Average pullet age at first egg laying (months)

Sources of variations	DF	Sum squares	Mean square	F value	P value	CV
District	2	23.091	11.545	10.15	<.0001	16.71
Error	267	303.850	1.138			
Total	269	326.9407407				

Table 9. Average number of eggs per clutch

Sources of variations	DF	Sum squares	Mean square	F value	P value	CV
District	2	148.141	74.07	6.33	0.0021	23.1
Error	267	3122.6	11.695			
Total	269	3270.741				

Table 10. Average clutch number per year

Sources of variations	DF	Sum squares	Mean square	F value	P value	CV
District	2	5.4800185	2.7400093	1.50	0.2249	36.96
Error	267	487.5892778	1.8261771			
Total	269	493.0692963				

Table 11. Average number of eggs per year

Sources of variations	DF	Sum squares	Mean square	F value	P value	CV
District	2	4640.2381	2320.1191	2.62	0.0750	54.58
Error	267	236857.6011	887.1071			
Total	269	241497.8393				

Table 12. Average number of eggs incubated per hen

Sources of variations	DF	Sum squares	Mean square	F value	P value	CV
District	2	16.03	8.015	1.50	0.226	19.96
Error	267	1430.967	5.359			
Total	269	1446.996				

Table 13. Average number of eggs incubated per hen

Sources of variations	DF	Sum squares	Mean square	F value	P value	CV
District	2	8.289	4.144	0.97	0.3812	21.75
Error	267	1143.178	4.282			
Total	269	1151.467				

Table 14. Average hatchability percentage

Sources of variations	DF	Sum squares	Mean square	F value	P value	CV
District	2	138.48	69.24	0.86	0.423	10.89
Error	267	21393.631	80.126			
Total	269	21532.11				

Table 15. Average number of chicks hatched per hen

Sources of variations	DF	Sum squares	Mean square	F value	P value	CV
District	2	1.785	0.893	0.41	0.6631	32.12
Error	267	579.255	2.169			
Total	269	581.041				

Table 16. Average survivality percentage

Sources of variations	DF	Sum squares	Mean square	F value	P value	CV
District	2	2.341	1.17	2.43	0.09	3.24
Error	267	128.844	0.483			
Total	269	131.185				

Table 17. Time to allow chicken for scavenging (days)

Sources of variations	DF	Sum squares	Mean square	F value	P value	CV
District	2	660.2	330.1	7.07	0.001	61.25
Error	267	12465.267	46.686			
Total	269	13125.467				

Table 18. Average brooding length (months)

Sources of variations	DF	Sum squares	Mean square	F value	P value	CV
District	2	2.9685	1.484	1.60	0.2033	33.48
Error	267	247.25	0.926			
Total	269	250.218				

Table 19. Average Egg length (mm)

Sources of variations	DF	Sum squares	Mean square	F value	P value	CV
District	2	558.971	279.485	20.54	<.0001	7.08
Error	447	6083.325	13.609			
Total	449	6642.296				

Table 20. Average Egg width (mm)

Sources of variations	DF	Sum squares	Mean square	F value	P value	CV
District	2	487.595	243.798	32.05	<.0001	7.29
Error	447	3400.1	7.606			
Total	449	3887.696				

Table 21. Average Shape index (%)

Sources of variations	DF	Sum squares	Mean square	F value	P value	CV
District	2	332.825	166.413	9.47	<.0001	5.77
Error	447	7856.655	17.576			
Total	449	8189.48				

Table 22. Average egg weight (g)

Sources of variations	DF	Sum squares	Mean square	F value	P value	CV
District	2	59.613	29.807	1.37	0.2561	10.64
Error	447	9749.989	21.812			
Total	449	9809.603				

Table 23. Average albumin weight (g)

Sources of variations	DF	Sum squares	Mean square	F value	P value	CV
District	2	0.637	0.318	0.03	0.969	13.73
Error	447	4494.384	10.054			
Total	449	4495.02				

Table 24. Average yolk weight (g)

Sources of variations	DF	Sum squares	Mean square	F value	P value	CV
District	2	16.684	8.342	2.49	0.084	12.15
Error	447	1500.43	3.357			
Total	449	1517.114				

Table 25. Average albumin height (mm)

Sources of variations	DF	Sum squares	Mean square	F value	P value	CV
District	2	7.769	3.885	7.01	0.001	21.6
Error	447	247.691	0.554			
Total	449	255.46				

Table 26. Average Hough unit value (%)

Sources of variations	DF	Sum squares	Mean square	F value	P value	CV
District	2	1181.406	590.703	12.29	<.0001	11.33
Error	447	21487.033	48.069			
Total	449	22668.439				

Table 27. Average shell weight (g)

Sources of variations	DF	Sum squares	Mean square	F value	P value	CV
District	2	1.6907111	0.8453556	2.34	0.0979	12.4
Error	447	161.7899333	0.3619462			
Total	449	163.4806444				

Table 28. Average yolk color value

Sources of variations	DF	Sum squares	Mean square	F value	P value	CV
District	2	74.096	37.048	12.75	<.0001	15.66
Error	447	1299.281	2.907			
Total	449	1373.378				

Table 29. Average shell thickness (mm)

Sources of variations	DF	Sum squares	Mean square	F value	P value	CV
District	2	0.078	0.039	35.9	<.0001	10.08
Error	447	0.487	0.001			
Total	449	0.565				

Table 30. Average slaughter weight (g)

Sources of variations	DF	Sum squares	Mean square	F value	P value	CV
District	2	264764.133	132382.067	8.23	0.001	8.75
Error	42	675387.867	16080.663			
Total	44	940152				

Table 31.Average carcass weight (g)

Sources of variations	DF	Sum squares	Mean square	F value	P value	CV
District	2	198345.173	99172.586	13.19	<.0001	8.97
Error	42	315789.164	7518.79			
Total	44	514134.337				

Table 32. Dressing percentage (%)

Sources of variations	DF	Sum squares	Mean square	F value	P value	CV
District	2	59.774	29.887	4.96	0.012	3.68
Error	42	253.273	6.03			
Total	44	313.047				

Table 33. Average weight of drumstick (g)

Sources of variations	DF	Sum squares	Mean square	F value	P value	CV
District	2	5846.165	2923.083	11.09	0.0001	10.9
Error	42	11070.127	263.574			
Total	44	16916.292				

Table 34. Average weight of thigh (g)

Sources of variations	DF	Sum squares	Mean square	F value	P value	CV
District	2	6274.088	3137.044	7.65	0.0015	10.78
Error	42	17218.396	409.962			
Total	44	23492.484				

Table 35. Average weight of breast (g)

Sources of variations	DF	Sum squares	Mean square	F value	P value	CV
District	2	21866.926	10933.463	12.51	<.0001	12.02
Error	42	36720.079	874.288			
Total	44	58587				

Table 36. Average weight of back (g)

Sources of variations	DF	Sum squares	Mean square	F value	P value	CV
District	2	2945.442	1472.721	13.87	<.0001	9.02
Error	42	4459.624	106.181			
Total	44	7405.066				

Table 37. Average weight of wings (g)

Sources of variations	DF	Sum squares	Mean square	F value	P value	CV
District	2	1491.539	745.769	11.24	0.0001	8.3
Error	42	2786.293	66.34			
Total	44	4277.832				

Table 38. Average weight of neck (g)

Sources of variations	DF	Sum squares	Mean square	F value	P value	CV
District	2	82.021	41.011	2.75	0.0755	7.71
Error	42	626.439	14.915			
Total	44	708.46				

Table 39.Average weight of skin (g)

Sources of variations	DF	Sum squares	Mean square	F value	P value	CV
District	2	913.008	456.504	5.28	0.009	13.1
Error	42	3633.791	86.519			
Total	44	4546.799				

Table 40. Average weight of gizzard (g)

Sources of variations	DF	Sum squares	Mean square	F value	P value	CV
District	2	33.794	16.897	1.47	0.24	15.21
Error	42	483.932	11.522			
Total	44	517.726				

Table 41. Average weight of liver (g)

Sources of variations	DF	Sum squares	Mean square	F value	P value	CV
District	2	16.616	8.308	0.87	0.425	14.89
Error	42	399.241	9.506			
Total	44	415.858				

Table 42. Average weight of heart (g)

Sources of variations	DF	Sum squares	Mean square	F value	P value	CV
District	2	28.227	14.114	7.65	0.0015	19.94
Error	42	77.477	1.845			
Total	44	105.704				

APPENDIX III: DIFFERENT PHOTOS

Figure 1 Types of separate chicken house

Figure 2 Chickens scavenging at the field

Figure 3 Chickens feeding on coffee worm

Figure 4 Types of incubating materials

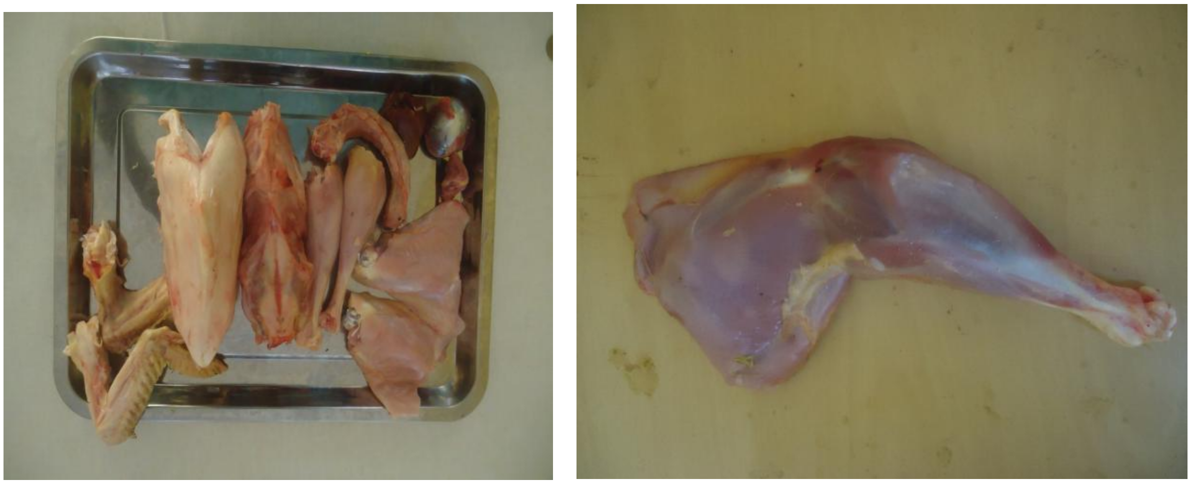

Figure 5 Different meet cuts (left) and the whole leg (right)

Figure 6 Drumstick (left) and Thigh (right)

Figure 7 Brest (left) and Neck (right)

BIOGRAPHY OF THE AUTHOR

The author, Welelaw Edmew Worku, was born in Dera Woreda of South Gondar Zone, Amhara Regional State, Ethiopia in 1987. He completed his elementary education at Anbesamie Primary School in the year 2004 and he continued his secondary education at Ghion Secondary and preparatory School in Bahir Dar. In this school, Welelaw completed his secondary education in 2006 and preparatory education in 2008. Then after he joined Debre Markos University in 2009 and graduated with B.Sc. degree in Animal Science in 2011.

After his graduation, Welelaw joined Mizan Agricultural Technical and Vocational Education and Training (ATVET) College, one of the five Federal Agricultural colleges under the Ministry of Agriculture where he is working since 2012 till now being a senior instructor in the department of Animal Science. He has also served as a head of Animal Science department in the College. In the year 2014, he joined Hawassa University, College of Agriculture for his Msc. degree study.