ASSESSMENT OF PRODUCTION SYSTEM, MORPHOLOGICAL TRAIT AND EGG QUALITY PARAMETERS OF INDIGENOUS CHICKEN IN WEST ARSI ZONE, OROMIA REGION, ETHIOPIA

M.Sc. THESIS

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HAWASSA UNVERSITY

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This is to certify that the thesis entitled "Assessment of production system, morphological trait and egg quality parameters of indigenous chicken in west Arsi zone, Oromia region, Ethiopia "submitted in partial fulfillment of the requirements for the degree of Master's with specialization in Animal Production, The Graduate Program of the School of Animal and Range Science, and has been carried out by Desta Gutema Shure, under our supervision. Therefore, we recommend that the student has fulfilled the requirements and hence here by can submit the thesis to the school.

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STATEMENT OF AUTHOR

I declare that this thesis is my own work and all sources of material that are used for this thesis have been properly documented. I have followed all ethical and technical principles of grant in the preparation, data collection, data analysis and completion of this thesis. Any scholar matter that is included in the thesis has been given recognition through citation. This thesis is submitted in partial fulfillment of the requirement for Master Science degree at Hawassa University and is deposited at the university's library to be made available to borrowers under the rules of library. I solemnly declare that this thesis is not submitted to any other institution anywhere for the award of any academic degree, diploma or certificate.

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ABBREVIATION

ANOVA	Analysis of variance
FAO	Food and Agriculture Organization of the United Nations
CACC	Central agricultural census commission
EARO	Ethiopian agricultural research organization
SPSS	Statistical package social software
HH	Household
FM	Feather morphology
FD	Feather distribution
PP	Plumage pattern
PC	Plumage colour
SC	Skin colour
SK	Shank colour
ELC,	Ear-lobe colour
CT	Comb type
DA	Development agent
DAGRIS	Domestic animal genetic resources information system
MM	Millimeter
KG	Kilogram
CM	Centimeter
SNNPRS	SNNPRS South Nation Nationality people regional state

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ASSESSMENT OF PRODUCTION SYSTEM, MORPHOLOGICAL TRAIT AND EGG QUALITY PARAMETERS OF INDIGENOUS CHICKEN IN WEST ARSI ZONE, OROMIA REGION, ETHIOPIA

By Desta Gutema

Major advisor: Prof. Tegene Negesse (PhD)

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ABSTRACT

A study was *conducted in two selected woredas (Heban Arsi and Negelle Arsi) of West Arsi zone of Oromia Regional State, Ethiopia. Production system, some morphometric traits and egg quality parameters of indigenous chickens were assessed. Using purposive multistage sampling a total of 120 households possessing 5 or more matured chickens were selected for the study. A total of 360 indigenous chickens were used for determination of morphological traits. Egg quality parameters were evaluated on 240 eggs collected. Extensive management system was practiced in the study area. About 23.3% of households used purposively made chicken houses. Overall mean age at sexual maturity of hens was 6 months and cockerels 5.86 months. Disease, predators and feed shortages were the three major chicken production constraints. Majority of body feather colour of indigenous chickens were red and Red brownish /Kokima followed by White, black with white tips/Teterma, Black, Grayish/Gebsima and Multicolor/Ambasma. All of the chickens possessed normal feathers with the dominant white and red ear lobe colors, yellow shank colors, pea and single comb and plain as well as flat head shape. Overall mean body weight of chickens was 1.3kg. The wingspan length, shank length, shank circumference, comb length, wattle length, body length, back length and keel length measurements were 32.58, 7.74, 3.82, 3.35, 1.44, 30.79, 18.72 and 9.19cm respectively. The average egg weight, shell thickness, egg width, egg length was 39.88, 0.291, 37.80 and 50.64mm respectively with average shape index of 74.72%. The subsequent average albumen height, yolk height, yolk width and yolk color was 4.02 mm, 13.75 mm, 37.04 mm, and 6.77 colour fan of 1-15 respectively with the corresponding Hough unit score of 69.37%. To sum up, both study woredas and sex of chickens looks to approve the traits of indigenous chickens and egg quality traits under traditional managements system. Detailed Molecular characterizations is recommended to assess morphological traits of indigenous Chickens of the study woredas.*

Key word*:* *Indigenous chicken, Heban Arsi, Negelle Arsi, qualitative traits, liner body measurements, egg quality parameter.*

1. INTRODUCTION

Agriculture is the backbone of many developing countries and Ethiopia being of no exception (Diriba, 2018). Agriculture and allied activities also account for the largest intangible source of income for the urban residents of the country (Rahel, 2003). Family poultry production has been widely perceived as a fast way to ensure food security, generate employment income, and promote women's empowerment at a relatively low investment (FAO, 2014).This may be because the chickens require comparatively less investment, have a shorter life span and can reproduce in a short span of time (Padhi, 2016). The poultry products are highly nutritious and can be affordable to almost all sections of the society (Alders and Pym, 2009).

As the investment in terms of feed and water are less chicken rearing is easy even by old, infirm and elders, egg production also provides the chicken rearers a steady source of income all the year round (FAO, 2003). However, poultry farming also comes with a cost, as the chickens are prone to many diseases and infections (Gocsik *et al.* 2014). These chickens are raised on very basic inputs which in most of the times inadequate and sometimes even adverse, thus these are impediments to the development of the poultry sector in country (Pieter, 2013).

Studies have indicated that most of the chickens raised under the prevailing traditional production systems are low producers and mature quite late (Fisseha *et al.* 2010). These are further coupled with fewer numbers of eggs and also that the average egg weight too is sub optimum (Fisseha *et al.* 2010). The growths of these chicks are also slow and rarely mature early (Siyaya and Masuku, 2013). The egg production is also correlated with the availability of feed which is rarely adequate the year round (Butler, 2016). The quantity and quality of feed also vary across locations and also between seasons within a location (Mammo, 2012).

There have also been reports were the entire flocks were wiped out due to vaccine preventable diseases and also due to predators (Chah *et al*. 2014). The chickens are rarely housed comfortably which leads to loss of production and the reproduction ability besides some of the eggs may be lost due to breakage and also due to poor hatchability (Fisseha *et al*. 2010). Moreover, in order to understand the keeping quality of the eggs and minimizing the handling losses it's imperative to understand the egg quality parameters (Ahmedin and Mangistu, 2016). Hence egg quality parameters are important for the fact that weak shelled and cracked eggs hatch poorly besides these traits also are linked with the table qualities and hatching qualities of the eggs (Ahmedin and Mangistu, 2016).

One of the stumbling blocks of improving the poultry sector understands the genetic potential of the chicken itself (Padhi, 2016). The goals for which the chickens are reared have to be understood before any developmental work can begin (Nigussie *et al*. 2010).

The morphological studies also assist in understanding the extent to which a particular genotype can be improved and for which type of traits, this is because most of the production traits are lowly to moderately heritable (Ngeno, 2015). Hence, chickens are classified into both qualitative and quantitative traits, the former being influenced by a very few pairs of genes and are least influenced by the environment, these traits include the feather colors, color of the skin, shank and allied structures (Ngeno *et al*. 2014). The qualitative traits have aesthetic properties and to a certain extent influence the adaptation of the chickens too (FAO, 2010). On the other hand the quantitative traits are those which are influenced by many pairs of genes and are also influenced greatly by environment (Hill, 2010). These traits are those which have economic importance and are therefore important when it comes to their improvement (Hill, 2010). So far, only little research has been done on characterization of indigenous chicken genetic resources of West Arsi zone. Therefore, this study was initiated to undertaken comprehensive characterization of indigenous chicken, including production practice as well as egg quality traits and started with the following objectives.

Objectives

General objectives

- To access production system, morphological trait and egg quality traits of indigenous chicken in the area

Specific objectives

- To asses indigenous chicken husbandry practices in the study area
- To asses morphological characteristics of local chicken population.
- To evaluate egg quality traits of local chicken population.

2. LITERATURE REVIEW

2.1. Socio-economic importance of village chicken production

Chickens in developing countries have more diverse use and benefits to households. Ethiopia has about 56.53 million poultry of which is 94.3% is indigenous chicken (CSA, 2017). In spite of having a large population of chicken, the overall productivity of the chicken in the country are dismally low which can be due to several intrinsic and non-intrinsic factors (Fisseha *et al*. 2010). The economic contribution of the sector is still not proportional to the huge chicken numbers, attributed to the presence of many production, reproduction and infrastructural constraints (Fisseha *et al*. 2010). The use of native chicken in tropics varies from region to region and from community to community within a region and they are part of balanced farming system having a vital roles in the rural households as a source of high quality animal protein and emergency cash income and play a significant role in the sociocultural life of the rural community (Padhi, 2016). One of the most important positive characters of native chickens is their hardiness, which enable them to tolerate the harsh environmental condition and poor husbandry practices (climate, handling, watering, and feeding) without much loss in production (Padhi, 2016).

2.2. Chicken production systems in Ethiopia

Family chicken production is an appropriate system that makes the best use of locally available resources (Tadelle *et al*. 2003a). Under the backyard chickens production system the numbers of chickens being raised per household are very few with an average of 7–10 adult chickens which usually comprise of, 2–4 hens, a rooster or two and a number of growers of various ages (Tadelle and Ogle, 2001). Chicken can be reared under different management and production systems, Based on the genotypes, feed input and expected output, mortality rate, purpose of rearing the chickens, length of broodiness, growth rate and overall numbers of chicken being reared (Padhi, 2016). In Ethiopia there are three types of chicken production systems viz. free-range production system, semi-intensive production system and intensive production system.

2.2.1. Free range system/Extensive system

Chickens are reared extensively for meat and egg provision for household consumption, occasional source of income and various socio-cultural obligations (Njenga, 2005). The system is prevalent in low human population density rural areas and is based entirely on low input-low output management. The birds leave their night shelters in the morning and are left to source any available feed resources around the homestead and take care of themselves. Free-range feed resources utilized include grass, insects, earthworms and various seeds (Birech, 2002). During cropping seasons, birds are sometimes confined and supplemented with maize, kitchen leftovers and any other available feed resource. Night shelters include rudimentary coops, kitchens, stores and human habitats. Due to low inputs, production is also low but cost per unit egg or meat is nearly negligible (Birech *et al*. 2002).

2.2.2. Semi-intensive system

In this system, chickens are kept in small flocks of between from 10–50 chickens mainly for consumption and sale (Wondmeneh 2004). Levels of inputs range from low to medium depending on the commercial value attached to the flock. The birds are left to free range around the homestead or in fenced runs feeding on grass, insects, kitchen wastes, and any other available feed resource (King'ori *et al*. 2010). They are provided with some form of housing ranging from simple shelters to proper chicken houses. Healthcare depends on the commercial value attached to the enterprise. However, water and supplementary feeds are provided. Because input levels are low, production is lower than in intensive system. The system is common in high human population density rural and peri-urban areas.

2.2.3. Intensive system

The size of flock ranges from 50 to 500 adult birds, depending on the objectives (Wondmeneh 2004). birds are fully confined in constructed shelters or runs and provided with commercial or home-made feed rations, may occasionally get greens (kales, cabbage, spinach, young grass and some weeds) (Kingori *et al*. 2010) and get health care. Deep litter and slatted floors system is characterized by more eggs production, high growth rates with lower mortalities (Okeno *et al.* 2012).

2.3. Chicken management practice

2.3.1. Feed resource, Feeding and watering Chicken

In Ethiopia, village chicken production systems is usually kept under free range system and the major proportion of the feed is obtained through scavenging (Aberra, 2014). The major feed sources of rural chicken were insect worms; seed, plant materials and house hold west any edible found in environments (Aberra, 2014). Common types of Supplementary feed are home grown cereal grain such as maize, wheat, sorghum barley and finger millet which is available during crop harvesting time (Fisseha *et al*. 2014 and Meseret, 2010). According to Addisu *et al*. (2013), all of the chickens owner were found to keep their chicken in free range/scavenging type of production system with occasional supplementary feeds (89.87%) like wheat (36.27%), sorghum (36.27%) and maize (23.53%). Fisseha et al. (2010) finding report also revealed that all village chicken owners provided water to their birds and hence 85.4% producers were fetch their chicken only during the dry season whereas14.3% of them fetches throughout the year in Bure district.

2.3.2. Housing of chicken

The study report of Solomon (2007) indicated that chickens live in family dwelling together with humans in traditional free range production system. Meseret (2010) and Fisseha et al. (2010) also reported that about 94.4% of the rural household has no separate poultry house in Gomma district and 77.9% of the village chicken owners provide only night shelter whereas 22.1% provided separate poultry house in Bure district.

2.3.3. Diseases and Predators.

The finding report of Aberra (2011) revealed that scavenging system is characterized by high chick mortality in the first two weeks of life, caused mainly by predators and Newcastle disease. Bushra (2012) also mentioned that major causes of death for village poultry were disease mainly Newcastle Diseases locally known as “Sombe/Fengil, followed by predation. According to the study result of Duguma (2009) mortality of village chicken due to disease outbreak is higher during the short rainy season, mainly in April (66.8%) and May (31.4%).

2.4. Production and reproductive potential of indigenous chickens

2.4.1. Production performance of indigenous chickens

According to the report of FAO (2004) the average egg laying of local scavenging hen were about 36-40 eggs/year in Ethiopia. As indicated in Table 1, the finding reports of different scholars were also revealed low egg production per clutch of local hen under extensive chicken management system.

Table 1.Average Egg laid /clutch's per year of local chicken

No	Location	Average Egg laid /clutch's	Reference
1	Sudan	3 - 12 eggs per year	Khalafalla *et al*. (2001)
2	Amhara, Ethiopia	9-19 eggs/clutch	Halima (2007)
3	Burkina Faso	12 eggs	Kondombo (2005)

As shown in Table 2, different researchers indicated low annual egg production potential of hen from indigenous chicken's production system. According to the finding result of Aberra and Tegene (2011) the production level of scavenging hens is generally low, with only 40-60 small sized eggs produced per bird per year under smallholder management conditions. Amsalu (2003) also reported that local hen lays about 36 eggs per year in 3 clutches of 12 to 13 eggs in about 16 days. By contrast, Tadiose *et al*. (2017) reported that numbers of eggs from native chickens vary across agro ecologies, genotypes and also the way chickens are managed besides diseases and parasites prevailing in areas.

Table 2:-Average annual egg production level of indigenous chicken.

SNo	Location	average annual egg laid		Reference
1	Western zone of Tigray	lowland,	48.98,	Markos *et al*. (2015)
		highland	54.20	
		Midland	54.87	
2	Gomma wereda of Jimma zone		43.8	Meseret (2010),
3	North West Ethiopia		18-57	Halima (2007)
4	North Wollo zone of Amhara		49.51	Addisu *et al*. (2013)
	Bure district of Amhara		60	Fisseha *et al*. (2010)

2.4.2. Sexual maturity of indigenous chicken

According to the study result of Tadiose *et al*. (2017) the overall profitability of farms are influenced by how early the chickens mature and the numbers of eggs they lays in a year. The study result of Duguma (2009) also shown that several non-genetic factors influenced sexual maturity of chicken besides of their genetics. As indicated in Table 3, different scholars were reported average age of sexual maturity of local chicken.

Table 3:- Average age of sexual maturity of indigenous chicken in Ethiopia.

SNo	Location	Average age of sexual maturity of local chicken	Reference
1	Ethiopia	7 months.	Sonaiya and Swan (2004)
2	North West Ethiopia	5 to 6 month	Halima (2007)
3	West Amhara region	6.49 month	Zemene *et al*. (2011)
4	western zone of Tigray	5.71 month	Markos *et al*. (2015)
5	Bure districts	5.9-7.1 month	Fisseha *et al.* (2010)
6	SNNPR	7.7 months	Mekonnen (2007)
7	North Wollo zone of Amhara region	6.6 months.	Addisu *et al*. (2013)

2.4.3. Clutch size and hatchability of indigenous chicken.

According to the finding result of Paneru *et al*. (2016) indigenous chickens are ideal mothers, good setters, hatching their own eggs, excellent foragers, vigor, aggressive, hardy and possess some degree of natural immunity against some diseases. As indicated in Table 4, different researchers have shown percentage hatchability of local hens in scavenging nature.

Table 4: average hatchability percentage of local hens recorded by different researcher.

SNo	Location	Av. hatchability % of local hens	Reference
1	Western zone of Tigray	74.3	Markos *et al*. (2015).
2	North Western of Ethiopia	60.7	Halima (2007)
3	Nole Kabba wereda of Western Wollega	82.1	Habte *et al*. (2013)
4	Central highlands of Ethiopia	82.74	Tadelle and Ogle (2001)
5	Metekel Zone of North West Ethiopia	84.74	Solomon *et al*. (2013)
6	Halaba wereda of southern Ethiopia	83.72	Nebiyu *et al*. (2014)
7	West Amhara region of Ethiopia	79.1	Zemene *et al*. (2011)
8	Gomma districts of Oromia region	22	Meseret(2010)

2.4.4. Incubation practice

According to the finding result of Shishay *et al*. (2014) Broody hens were the sole means of egg incubation and brooding young chicks. Hence, the study result of Tadelle *et al*. (2003a) also revealed that culture of selecting broody hens for egg incubation purposes were through looking hen's past egg incubation performance (73.9%), presence of big body size (7.9%), presence of thick feather (2.1%) and size of eggs laid (2.5%), respectively. The finding result of Fisseha (2009) also indicated egg incubation materials namely: Clay pots, bamboo baskets, cartons or even simply a shallow depression in the ground are common materials and locations used for egg setting. The finding report of Tadelle *et al*. (2003a) also revealed bedding materials namely: Crop residues, usually teff, and wheat and barley straws.

2.5. Constraints of village chicken production system

The finding report of Duguma (2009) indicated the most important in village chicken production systems is high mortality rate which could reach as high as 80–90% within the first few weeks after hatching and Newcastle disease (NCD) as highly infectious and causes more losses than any other diseases in the tropics. Nwanta *et al*. (2008) also approved rapid spreading of disease through flock and mortality could reach up to 100%. According to (Tadelle *et al*. 2001) high mortality of chicks were occurred due to diseases, parasites, predation, lack of feed, poor housing and insufficient water supply in the central highlands of Ethiopia.

2.6. Opportunities in Village Chicken Production Systems

According to the Okeno *et al*. (2012) indigenous chicken are means of investment to the welfare of women and children in traditional, low-input farming systems in the tropics. Indigenous chicken are alternative source of animal protein due to the fact that they can be slaughtered and consumed as a single meal hence do not require storage facilities.

2.7. Qualitative traits

As shown in the Table 5, different researcher's revealed morphological variation of indigenous chicken like color difference (pure black, white, silver white, gray, red and various combinations of several colors), comb type, head shape, shank color and other even within ecotype.

Table 5: Morphological variations of indigenous chicken ecotypes.

Location	morphological Trait	% of trait	References
Ethiopia	Single, Rose and Pea	55,28.5 and 15.2	Aberra and Tegene (2011)
Central Tigray	Red, Grey, Ambasma	52.3, 20.9 and14.1	Alem *et al*. (2013)
Metekel Zone	Red,white, gray and black body colour	25.2,4.8,19,11.5	Tesfahun (2018)

2.9. Egg quality

Weight, percentage of eggshell; thickness and strength of eggshell and shape were the observed differences in egg quality trait and are important egg aspects that influence grading, packaging, price, acceptability by consumers and hatchability (King'ori, 2012). Egg width is indicated to be a good estimator of shape index and thus can be used as a criterion for determining stiffness of eggs (Bobbo *et al*. 2013). According to the study of Duman *et al.* (2016) eggs were classified with respect to shape index (SI), namely as a sharp egg (SI < 72), a normal (standard) egg (SI = 72–76) or a round egg (SI > 76). The Indigenous Chicken eggs in the study fell in the normal standard category (74.1). Round eggs and unusually long eggs have poor appearances and do not fit well in egg crates; therefore, they are much more likely to be broken during the transport than the eggs of normal shape (Duman *et al*. 2016).

Table 6. External egg qualities of Indigenous Chicken in Luanda, Kenya (Means ± SEM)

SNo	Trait	Location	Mean±SD/SE	References
1	Egg weight (g) Egg length (mm) Egg width (mm)	Kenya	46.5± 0.68 5.47±0.03 4.05±0.03	Bobbo *et al*. (2013)
2	egg weight(g) shell thickness(mm)	Gorogutu District, Eastern Hararghe	45.45 0.29	Ahmedin and Mangistu (2016)

Table: 7: Internal egg qualities (Means ± SEM)

No	Trait	Location (woreda)	Mean ± SD	Reference
1	Yolk height (mm) Albumen height (mm) Hough unit (HU)	Bure, Ethiopia	15.1±1.3 4.1±1.9 66.5 ±7.2	Fisseha *et al.* (2010)
2	Albumen height (mm)	Gomma district, Ethiopia	2.87	Meseret (2010)

3. MATERIALS AND METHODS

3.1. Description of the study areas

The study was conducted in two adjacent Woredas namely Arsi Negelle and Heban Arsi Woreda of west Arsi zone, Oromia Regional State of Ethiopia.

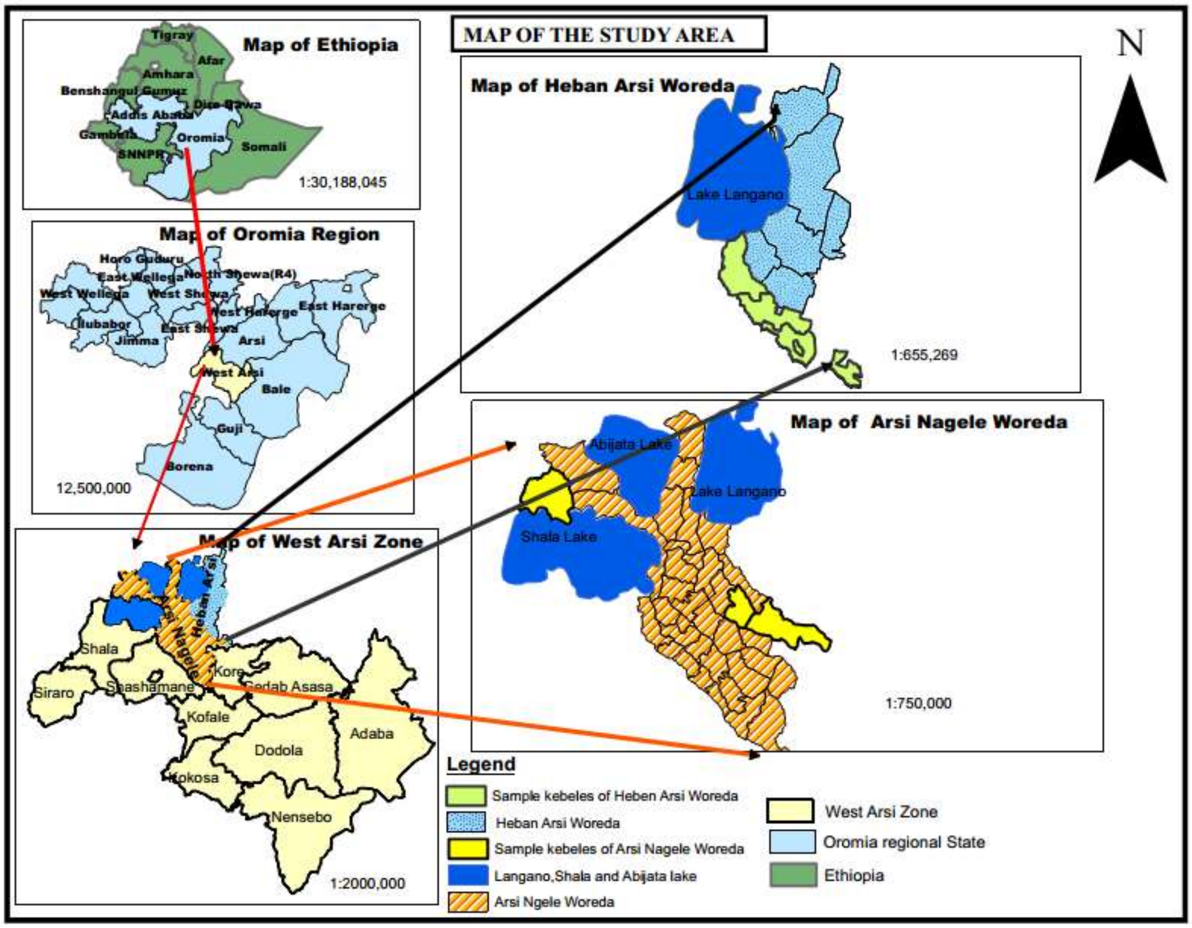

Figure 1: Map of the study area

Negelle Arsi woreda is found at the northern part of west Arsi Zone and has a location which lies between 38^0 0’0” E--38^0 55’0’’E longitudinally and $07^0$0’0”N-$07^0$40’0”N latitudinal and has a total surface area of 238,1.463 km^2 (238,146.3 he) with elevation ranging from 1500m-2500m. Heban Arsi woreda is also found in West Arsi Zone and 226 km far to south east of Addis Ababa and has nine rural kebele and three urban kebeles with 35,613.6 hectare of land

and has 75,831(male=41,103 and female= 34728) population. The woreda has altitude of 1850m meters above sea level and lies between 38.2726^0N and 38.87126^0N latitude and 7.2776^0E and 7.2776^0E longitude and has temperature of 10^0c, 17.5^0c and 25^0c lower, middle and higher temperature respectively. The woreda has average rainfall of 825 mm.

3.2. Sample size determination

The total households included, chicken population and egg collected in the study were determined according to the formula given by Arsham (2002). $N=0.25/SE^2$, Where, N= Sample size, SE= Standard error. Thus, using the standard error of 0.0456 with 95% confidence level, 120 households were included in the study.

3.3. Procedures of data collection and analysis

3.3.1. Sampling design

This study involved survey part, morphological valuation and egg quality parameter of indigenous chicken. The study was conducted in two woredas specifically Heban Arsi and Negelle Arsi, which were purposively selected based on their potential for indigenous chicken production and ease of use for data collection. Rapid field observation was done with extension agents and some farmers to gather information related to potentiality of indigenous chicken rearing and other facilities within the woredas. Then, a total of six kebeles (three kebele from each woreda) namely Shoba Bultum, Argeda Shaldo, Buku Woldaya, Besaku, Chiri Lalu and Alge were purposively selected based on agro-ecological coverage of woredas. From those selected kebeles, a total of 120 households (20 households from each kebele) who have at least 5 indigenous adult chickens and have at least 3 years' experience in rearing chickens were purposively selected for the study. Questionnaire was pre-tested with 5

Households from each kebeles and basic modifications were made prior to the actual data collection based on the pre-test.

3.3.2. Sampling and data collection

For assessment of production system, selected households were interviewed using semi-structured or modified questionnaire for data collection on parameters such as socio-economic characteristics of household, flock composition, flock size, chicken husbandry practices like chicken housing, feeding, health management and constraints for chicken production. Moreover, clutch size, number of eggs per clutch, number of eggs per set, hatchability; percent to be weaned and culling practice were assessed. Errors in data collection were minimized through the use of carefully training as well as follow up of enumerators (research technical assistants) during field data collection.

For valuation of qualitative parameter, three chickens per household (two hens and one rooster) , a total of 360(3x20x6) chicken from six kebeles were selected and used for primary data collection. After selection, important qualitative parameters such as comb type, feather characteristics (FC), shank colour (SC), ear-lobe colour (ELC), spur presence(SP),earlobe presence(ELP),ear lobe colour (ELC),ear mark presence(EMP),shank feather(SHF),and head shape(HS) were held by visual appraisal as FAOs guide line for chicken genetic resources (FAO, 2012).

For measuring of quantitative parameter, some chickens (360 chickens) with one and more years of age were selected by considering the slow growth of indigenous chickens to reach their fully-grown age and used for linear measurements and body weight. Ages of chickens' were determined by "recalling method" of interviewed farmers. Farmers were told to keep their chicken at their house during morning for eases and precision of body weighing and other measurement. Each selected chicken were identified by its sex and sampling site and then, carefully weighed using a hanging balance (kg) and linear measurements (cm) were measured using a tailor's tape and caliper. These linear measurements were included body length (BL), and wing span (WS), shank length (SL), shank circumference (SHC), keel length (KL), body weight (BW), wattle length (WL), comb length (CL) and back length (BKL) as in table 8.

Table 6:- Body weight and linear measurement of local chicken in the study woredas.

Trait	Coverage	Units
BKL	Length from insertion of the neck into the body to the saddle	Cm
KL	Measurement from sternum to bottom of keel	Cm
CL	Distance from insertion of comb in beak to end of combs lobe.	Cm
WL	Length from insertion of right wattle in to beak	Cm
BL	From the tip of the beak to the tip of the tail without feathers.	Cm
SHL	Taken as the distance between the foot pad and top of hock joint	Cm
WSL	Length between tips of right and left wings after fully stretch	Cm
BW	Taken on spring balance using to the nearest 100g for birds	Kg
SHC	Measurement around midway of shank	Cm

Back length, Keel length, Comb length, Wattles length, Body length, Shank length, Wingspan length, Body weight, Shank circumference.

Source: FAO (2012)

For the evaluation of external and internal egg quality parameter, 240 fresh eggs (2 eggs from each household) were collected, identified by its sampling site and transported to Hawassa University for quality parameters analysis using suitable portable fridge to avoid loss of quality during collection and transportation. Each egg was individually weighed (EW) in gm using digital weighing balance. Egg width (EW) and egg length (EL) in mm were taken whereas Egg shape index in % were calculated via egg width/egg length)*100), equation.

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. Albumen height, yolk width and yolk height (mm) were measured by using digital caliper. Yolk colour was measured using 1–15 leveled colour fans. Hough Unit (HU) was calculated by using albumen height and egg weight calculated using the formula: $HU = 100 * \log (AH - 1.7(EW)^{0.37} + 7.6)$ (Haugh, 1937).

Where; HU = Hough unit,

AH = Albumen height and

EW = Egg weight

3.3.3. Statistical Analyses

The qualitative and quantitative data sets were analyzed using appropriate statistical analysis procedures. Statistical Package for Social Sciences (SPSS, 2007) version 20.0 and computer based statistical software were used. Analyses of Variance (ANOVA) were carried out on some of the quantitative parameters (functional traits). Correlation analysis was conducted to identify the relationship between quantitative morphological traits and body weight. Binomial variables from records on qualitative characters were reported as percentages, mean, standard deviation and standard error. Chi Square Test was also used to compare the results of quantitative traits and to estimate the qualitative variables.

Model for quantitative data sets was:

$$Y_{ijk} = \mu + A_i + A_{ij} + E_{ijk}$$

Where, Y_{ijk} = measured parameters in the dependent variables

μ = overall mean

A_i = effect of i^{th} woreda (i = 2)

A_{ij} = effect of j^{th} sex of chicken in i^{th} woreda (j=1, 2)

E_{ijk} = error components associated with the above

Model used for study of egg quality was:

$$Y_{ik} = \mu + A_i + E_{iK}$$

Where: Y_{ik} = the measured quantitative traits of eggs in the i^{th} woreda

μ = overall mean

A_i= the effect of i^{th} (i=1, 2) woreda on egg quality.

E_{iK}= random residual error.

4. RESULTS AND DISCUSSION

4.1. Production system of indigenous chicken in the study woredas

4.1.1. Socio-economic characteristics of the households.

Majority of interviewed respondents were males whereas the remaining few were females (Table 9). Sizes of male households in Heban Arsi were higher than male respondents in Negelle Arsi woredas. But, sex of respondents has no statistical significance ($p>0.05$) between the study woredas. This implies that culture in the woredas forced males as household head. In agreement to this study, Mekonnen (2007) report indicated 86.2% of interviewed farmers were male and 13.8% were female in dale, Wonsho and loka abaya woredas of Southern Ethiopia. Solomon *et al*. (2013) and Matiwos *et al*. (2015) also reported that about 69% and 31% respondents participating in poultry production were males and female respectively in Metekel zone, Northwest Ethiopia and 70.2% of interviewed household were males and 29.8% were female respondents in Amaro district, SNNPRS of Ethiopia. Conversely, Tadesse *et al*. (2013) report indicated that proportions of females (70%, 74.16% and 65.6% and 70%) were higher than male (30%, 25.84%, and 34.4%and 30%) headed households, respectively in Ada'a and Lume districts of East Shewa.

Overall, about one third of interviewed respondents were illiterate whereas the remaining respondents had Read and write, 1 - 4 grades, 5 - 8 grades and 9 – 12 grades education respectively (Table 9). The degrees of the educational status of the respondents were significantly varied in the study woredas.

In close agreement with the current finding result, Fisseha (2009) reported education level of respondents; 39.3% were illiterate, 31.1% had basic education (Reading and writing), 21.4% had primary education and 8.2% had secondary education and above.

This finding also revealed that majority of respondents in the study woredas were Muslim while the remaining few households were Orthodox and protestant Christian followers. Religious distribution were significantly ($p<0.05$) different between the study woredas. Hence, slightly higher numbers of Muslim followers were observed in Heban Arsi) than in Negelle Arsi woreda whereas Orthodox followers in Heban Arsi woreda were lower than in Negelle Arsi woreda and protestant followers took the remaining proportion of interviewed households in the study woredas (Table 9). In agreement to the current finding, Meseret (2010) reported that 86.1% and 12.8% of the respondents were followers of Muslim and Orthodox Christian, respectively in Gomma district of Jimma zone.

Considerably all interviewed households were farmers whereas the remaining few respondents were traders in the study woredas. No significantly different ($p>0.05$) occupations of respondents' between study woredas. However, substantial numbers of interviewed households were involved in agriculture. This finding result agreed with the study report of Meseret (2010) from Gomma district of Jimma zone.

Table: 7.Socio-economic characteristics of households (Frequency and Chi-square values)

Parameter %	**Heban Arsi woreda (60hh)**	**Negelle Arsi woreda 60hh)**	**Overall (120hh)**	**X^2**
Sex of household (%)				1.563
Male	88.3	80	84.2	
Female	11.7	20	15.8	
Education level of household (%)				1.00
Illiterate	38.3	31.7	35	
Read and write/basic education	21.7	20	20.8	
1- 4 grade	18.3	20	19.2	
5 – 8 grade	11.7	15	13.3	
9 -12 grade	10	13.3	11.7	
Religion of household (%)				8.005^{ab}
Muslim	81.7	75	78.3	
Orthodox Christian	8.3	23.3	15.8	
Protestant Christian	10	1.7	5.8	
Major occupation of household (%)				2.03
Farmer	96.67	100	98.33	
Trader	3.33	--	1.67	
Employer	--	--	--	
Other	--	--	--	

HH = interviewed households; X^2 = chi square; ^{ab} = significant at $p<0.05$

The major ages of interviewed respondents participate in chicken production lies between age of 29 to 60 interval while small number of them were from old (>60years) and it might be due to productive force and age after sequestration from major agricultural activities respectively (Table 10). Age of interviewed households had no statistical significance ($p<0.05$) between study woredas. This study result is relatively similar to the report of Mekonnen

(2007) who reported the overall mean age of respondents was 51.4 years in dale, Wonsho and loka abaya woredas of Southern Ethiopia. But, much higher than report of Solomon *et al*. (2013) and Moges *et al*. (2013) who indicated the average age of respondents participating in poultry production was 41.02 and 40.86 year in Metekel zone and Bure district of North Western Amhara region of Ethiopia.

No significant ($p>0.05$) differed per head land holding of household's between the study woredas (Table 10). But, slightly lower average lands holding per head of interviewed respondents were observed in Heban Arsi than those from Negelle Arsi woredas. This study result was somewhat higher than the report of Mekonnen (2007) who indicated average farmland holdings of 0.86 ha ranged from 0.13 to 3 hectares per household heads'. And much lower than the finding report of Deneke (2014) who identified the average farmland holding of interviewed respondent were 1.66 ha per heads' in Arsi zone.

The higher mean family size per head of households were found in age category of between 15 to 60 years whereas lower mean family size per head were reported in age category of below 14years and above 60 years in study woredas (Table10). This result shown that the productive labor force (age class of 15 to 60years') were not significantly ($p> 0.05$) different between the study woredas. but, mean family size of male with age class between 15 to 60years' were found higher in Heban Arsi than from Negelle Arsi woredas whereas mean family size of females with age between 15 to 60 in Heban Arsi was lower than from Negelle Arsi woredas . Higher number of chicken handling labors were allocated from age class of below 15years'and between 15 to 30 years' while lower number of labor were from old (above 60 years') (Table 10). This might be due to age before marriage or under main family member and after sequestration from major agricultural activities. Labour allocation has no statistical significance ($p>0.05$) between study woredas.

The current study result is slightly higher than the findings of Aseffa (2007) who reported 7 persons per household for Awassa Zuria woreda in the SNNPR and much higher than report of Deneke (2013) who indicated 6.40 for Arsi Zone in Oromia region, higher than finding of Melaku *et.al*. (2016) who reported that average family size of respondents were (5.41 ± 0.18) in borena, wogdi and legambo woredas in south wollo of Amhara region. It is also higher than finding of Aman *et al*. (2015) who reported (6.8) average family size in Kambata Tambaro and Wolaita Zones, SNNPR, Ethiopia.

The average number of cattle and small ruminant owned in Heban Arsi woreda were slightly higher than cattle and small ruminant headed in Negelle Arsi woreda whereas equine and chicken owned per head were comparably similar in both woredas (Table 10). The average number of cattle and small ruminant owned were significant ($p<0.05$) differed between study woredas whereas chicken and equine holding per household were not statistically significant.
The current study result is similar with finding of Fisseha (2009) who reported cattle (4.16) and chicken (13.1) population in Bure district and comparable with the result of Azage *et al*. (2010) who reported a mean flock size of 13, 12 and 9 chickens per household for Bure, Fogera and Dale woreda in Ethiopia, respectively.

Table: 8. Age of households, landholding, family size and Animals ownerships of households in study woredas (Mean±SD).

Parameters		Heban Arsi woreda(60HH)	Negelle Arsi woreda(60HH)	Total (120HH)
Age of household(year)		50.48±10.14	47.65 ±10.83	49.07±10.54
land holding of households(ha)		0.95±0.52	0.99±0.70	0.97 ±0.61
Average Family size per households				
up to 14 years of age	Male	1.33±0.47	1.42±0.55	1.37±0.51
	Female	1.79±0.74	1.56±0.59	1.69±0.68
between 15-60 age	Male	1.85±0.99	1.6± 0.76	1.72±0.88
	Female	1.72±0.17	1.85±0.93	1.79±1.05
above 60 years of age	Male	1.00±0.00	1.00± 0.00	1.00±0.00
	Female	1.00±0.00	1.00± 0.00	1.00±0.00
Labor allocation				
Male up to 14 years age		1.07 ±0.26	1.09 ±0.29	1.08±0.27
Female up to 15 years age		1.21 ±0.41	1.24 ±0.056	1.22±0.47
Male between 15--30 age		1.20 ±0.41	1.13 ±0.34	1.16±0.37
Female between 15--30 age		1.00±0.00	1.00±0.00	1.00±0.00
Male of between 31--60 age		1.00±0.00	1.00±0.00	1.00±0.00
Female between 31--60 age		1.00	1.00	1.00
Male of above 60 age		1.00	1.00	1.00
Animals owned per household				
Cattle		5.11 ± 3.21^{a}	5.069 ± 2.79^{b}	5.09 ±2.99
Small ruminant		6.43 ± 3.03^{a}	6.37 ± 2.23^{b}	6.40 ±2.65
Equine		1.29±0.62	1.4±0.61	1.35±0.61
Chicken		12.45±1.95	12.78±2.40	12.62 ±2.19

hh= household; a, b=different at $p < 0.05$;

4.1.2. Flock Structure and size.

The dominant age groups of flock structure owned by interviewed households were chicks followed by Pullets and Cockerels while Cocks were lower in the study woredas (Table 11). This variation might be due to less allowing of hens to incubate during summer because of high disease prevalence, feed shortage as well as suitability of season for predators attack when crop garden grown and low survival rate of chicks produced under traditional management. Similarly, Aseffa (2007) report indicated that chicks (3.8) and hens (2.5) are the dominant age groups found in Awassa Zuria district.

Table: 9. Flock structure and size in the study area (Mean ± SEM)

Parameter	Heban Arsi woreda(60hh)	Negelle Arsi woreda(60hh)	Total (120hh)	P-value
Flock composition				
Cockerels	3.35 ± 0.23	3.00 ± 0.20	3.18 ± 0.15	.255
Pullets	3.57 ± 0.23^{a}	4.33 ± 0.21^{b}	3.95 ± 0.16	0.015
Hens	2.55 ± 0.12	2.72 ± 0.09	2.63 ± 0.07	.261
Cocks	1.34 ± 0.86^{a}	1.06 ± 0.03^{b}	1.19 ± 0.05	0.001
Chicks	3.91 ± 0.16^{a}	5.07 ± 0.18^{b}	4.52 ± 0.12	.000

hh= interviewed household; a,b=different at $p < 0.05$;

4.1.3. Source of initial and replacement Foundation Stock

Half of interviewed household’s get initial foundation stock from purchase whereas the remaining producers get through gift and both gift and purchase respectively with the relevant replacement stocks of Hatched and purchased in study woredas (Table 12). Source of initial foundation and replacement stock is similar (p>0.05) between study woredas. This may happen due to adjacent study woredas. In agreement to the current finding Bogale (2008) reported that most of the respondents get first chicken through purchase (43.7%) whereas the remaining proportion were from gifts (5.6%), homebred (31%) and hatched (9.7%) and Mekonnen (2007) reported that majority of replacement stock (75.5%) were from chicken hatched in houses and 22.2 % of replacement stock were from purchase in Awassa Zuria.

Majority of interviewed household's money expenditure were for purchase of chicken whereas the few respondents spend their money on purchase of feed, chicken as well as medication and medication alone in the study woredas (Table 12). Household's money expense in chicken farming were not significantly ($p>0.05$) different between the study woredas. This may be due to share of similar source of initial and replacement stock across study woredas. by contrast, Mekonnen (2007) reported that expense in poultry production were for purchase of foundation stock (12.5%), purchase of feed 23%, purchase of both birds and feeds 33% and for medication 31.5%.

Crop sale (70.8%) is major source of money whereas sale of chicken (7.5%), egg (10%), livestock (2.5%), money lender (0.8%), Friends (2.5%), cooperatives (1.7%) and off farm work returns (4.2%) cover the other (Table 12). The source of finance in chicken farming were significantly ($p<0.05$) different between study woredas. This is because of better credit assess in Heban Arsi whereas still limited in Negelle Arsi woreda. Similarly, Mekonnen (2007) report shown source of money for all expense in chicken production was personal income.

Table: 10. Initial and foundation of replacement stock, purpose for spending money and source of money to finance chicken farming in study woredas.

Parameters (%)	Heban Arsi woreda(60HH)	Negelle Arsi woreda(60HH)	Total	X^2
Source of initial foundation stock				5.351
Gift	13.3	11.7	12.5	
Purchase	45	65	55	
Gift and Purchase	41.7	23.3	32.5	
Foundation of replacement stock				0.144
Purchased	38.3	35	36.7	
Hatched	61.7	65	63.3	
Purpose of spending money				6.862
Purchase of hen	91.7	86.7	89.2	
Purchase of feed	3.3	11.7	7.5	
Purchase of veterinary product	--	1.7	0.8	
Purchase of hen and vet. Product	5	--	2.5	
Source of money to finance chicken production				14.49^{ab}
Chicken sale	8.3	6.7	7.5	
Egg sale	15	5	10	
Crop sale	65	76.7	70.8	
Livestock sale	--	5	2.5	
Money lender	1.7	--	0.8	
Friend	5	--	2.5	
Cooperatives	3.3	--	1.7	
Off farm work	1.7	6.7	4.2	

hh= interviewed household ;x^2= chi square; ab=different at $p < 0.05$;

Almost all of interviewed households were undertaken extensive chicken production while remaining few producers followed semi-intensive system (Table 13). Chicken production system were not significantly ($p>0.05$) different between study woredas. This indicates that production systems in both woredas were still nearly extensive and helps local chicken production to cop up with feed deficiency via scavenging by their own. Similarly, Halima (2007) reported that nearly all (99.27 %) the chickens are managed under extensive chicken management system in Northwest Ethiopia. But, current finding result were higher than the study result of Emebet (2015) who reported that 71.55% of respondents were follow extensive management system, while 28.45%, of the respondents were follow semi-extensive chicken management system. Majority of interviewed households were handles their chicken every day whereas as few respondents were take care of their chicken every 4, 5 and 6 day per week separately in the study woredas(Table 13). Chicken handling frequency were not significantly ($p>0.05$) different between the study woredas. All the interviewed households were shown interest of improving chicken production in the study woredas. Thus, higher numbers of interviewed respondents were anticipated to expand chicken production up to 10 layers in Heban Arsi than in Negelle Arsi woredas whereas the remaining was more or less comparable in the study area (Table 13). Intension of producers to expand chicken production were not significantly ($p>0.05$) different between the study woredas. In contrast to the current finding, Deneke (2014) report indicated that about 33.8%, 3.3%, 15%, 0.8%, 17.5%, 17.5% of interviewed households were intended to expand chicken production up to 10, 15, 20, 25, 30 and From 40 to 100 layer hens respectively in Arsi zone, Oromia region. No religious as well as social taboos associated with chicken and egg production, consumption and marketing were obtained in study woredas. By contrast, Tadelle and Ogle (2001) report indicated that color, sex, comb type, age of birds used for sacrifices were important as was the commitment of an individual to a particular spiritual being or cosmic force in central highland of Ethiopia.

Table: 11. Time allocated to handle flock and need to expand chicken rearing in the study area.

Parameters (%)	Heban Arsi woreda(60HH)	Negelle Arsi woreda(60HH)	total (120hh)	X^2
Chicken production system				2.034
Extensive	96.7	100	98.3	
Semi-intensive	3.3	--	1.7	
Time allocated to handle flock				3.010
4 day	--	3.3	1.7	
5 day	10	5.0	7.5	
6 day	3.3	3.3	3.3	
7 day	86.7	88.3	87.5	
Improve chicken rearing				
Yes	100	100	100	
Flock size expansion				0.756
Up to 7 layers	25	25	25	
Up to 8 Layers	25	31.7	28.3	
Up to 10 layers	50	43.3	46.7	
Taboos in raising chicken				
No	100	100	100	

Hh=interviewed household; X^2 *= chi-square; ab = different at* $p<0.05$

4.1.4. Chicken husbandry practices

4.1.4.1.Feeds and feeding practices

In this finding result, all interviewed households allowed their chicken for scavenging with restricted supplementation in study woreda. In agreement with this finding, Yakubu (2010) reported revealed that chickens scavenge under trees, field crops, family leftover feeds and also pilfering of family food when put outside for sun drying.

Almost all of household provided supplementary feed whereas the remaining few producers do not supply additional feed (Table 14). Feed supplementary is not significantly ($p>0.05$) different between study woredas. The reason why they did not provide supplement feed to their chicken was not specified by interviewed household. comparable to the current survey, Desalew (2012) report indicated that about 97.8% of respondents were using scavenging with additional supplements and only 2.2% were used only scavenging with no additional feed supplements for chicken.

Majority of producers' used feed resources of both grain and Kitchen wastes whereas few households use grain: Maize, wheat, barley and sorghum alone in the study woredas (Table 14). Source of feed resource is significantly ($p<0.05$) different between study woredas. Lower number of interviewed households were used both grain and kitchen wastes in Heban Arsi than in Negelle Arsi woreda. This may occurred due to low attention of producers in consider of chicken farming as first tasks rather raising as additional work.

Similarly, Mahoro *et al*. (2017) reported that, Small quantities of grain (maize, cereals), kitchen and households' leftovers were occasionally offered to the chickens.

Overall, substantial number of interviewed respondents feed their chicken in the form of whole grain for mature chicken, ground grain and kitchen wastes for chicks while the next frequently reported were whole grain for mature chicken and ground grain for chicks in the study woredas (Table 14). Significant forms of feedstuff consumption were offered to different age group of chicken. No significantly ($p>0.05$) different form of feed consumption between the study woredas. Hence, the most common form of feedstuff supplement were whole grain for mature chicken, ground grain and kitchen wastes for chicks and higher in negelle Arsi than those reported from Heban Arsi woredas. This study result was in line with survey result of Samson and Endalew (2010).

Current survey results also indicated that substantial number of interviewed households provided feed to their flock at Evening whereas the rest of producers supply during Morning, Noon, Morning as well as Noon and morning, Noon and Evening in the study woredas. Frequency of feeding chicken were not significantly ($p>0.05$) different between the study woredas (Table 14). In contrast to this finding, Alem *et al*.(2013) report stated that 48.7% of the respondents of midland and lowland of central Tigray provide supplement 2 times a day, 41.9% of the respondents provide feed once a day and 9.4% of the respondents provide three times a day to their chickens.

Table 12. Feed resources and feeding of chicken in the study woredas

Parameters %	Heban Arsi woreda (60hh)	Negelle Arsi woreda (60hh)	Total (120hh)	X^2
Do your chickens scavenge? (%)				
Yes	100	100	100	
Feed Supplementation (%)				
Yes	98.3	100	99.2	1.008
No	1.7	--	0.8	
Types of feed resource (%)				
Grain	37.3	3.3	20.2	21.302[ab]
Grain and kitchen waste	62.7	96.7	79.8	
Specific name of feed (%)				
Maize, wheat, barley and sorghum grain	39	16.7	27.7	10.481[ab]
Kitchen wastes	6.8	1.7	4.2	
Maize,wheat,sorghum , barley grain and kitchen wastes	54.2	81.7	68.1	
Form of feed consumption for different age level (%)				
Whole grain for mature chicken and ground grain for chicks	37.3	15	26.1	
Kitchen waste for chicks and whole grain for mature chicken	10.2	--	5	16.322[ab]
Whole grain for mature chicken, ground grain and kitchen wastes for chicks	52.5	85	68.9	

Table 14 Feeds resources and feeding of chicken in the study woredas (continued)

Frequency of feed supplementation				2.085
Morning	23.7	20	21.8	
Noon	6.8	11.7	9.2	
Evening	47.5	48.3	47.9	
Morning and Noon	11.9	6.7	9.2	
Morning ,Noon and Evening	10.2	13.3	11.8	

hh = interviewed households; X^2 *= chi square;* ^{ab} *= significant different at* $p< 0.05$

Almost all of interviewed households' practiced spreading mode of feeding chicken whereas the remaining few households put feed in container in study woredas (Table 15). Feeding method are not significantly ($p>0.05$) different between the study woredas. In agreement to the current survey result Mearg (2016) also revealed that almost all (93.4%) farmers in study woredas use pouring grain on the ground and the rest (6.6%) farmer's uses feeder materials to feed their chickens in central zone of Tigray.

All interviewed household were provided water to their chicken in adlib form during dry season and get from backdrops during rainy season (Table 15). In line with this finding, Halima (2007) and Desalew (2012) also reported that about 99.45% of the farmers in Amhara region provided water for their chickens in north western Ethiopia and about 96% of respondents provide water with free access in Ada'a and Lume districts of East Shoa zone of Oromia region.

Overall, major source of water namely river, rain water, tap water, borehole and wells water were identified to fetches chicken in the study woredas(Table 15). Above half of interviewed respondents uses tape water to fetch their chicken. Source of water supply are significantly ($p<0.05$) different between study woredas. Hence, higher numbers of households fetches from tap or pipe water in Heban Arsi than in Negelle Arsi woredas. This may occur due to better assess of pipe in Heban Arsi than in Negelle Arsi woredas. comparably Mearg (2015) also reported that major sources of household water supply in dry season in midland agro ecology of central zone of Tigray are rivers(4.1%), pond(2.5%), springs(1.2%), water well (12.5%) and hand operated pipe water(26%), while in highland the water sources are rivers (6.6%), ponds (2.1%), spring(12.8%), water well(5.8%) and hand pump(9.9%) in the central zone of Tigray in Northern Ethiopia. Majority of interviewed households' uses plastic drinker whereas, the remaining households uses various watering material namely clay made, metallic material and other (wooden and cracked stone) in study woreda (Table 15). Drinker utilization was not significant (p>0.05) different between study woredas. In agreement to the current study results Mearg (2015) also indicated in midland, plastic made troughs (29.8%), wooden trough (25%), earthen pot (24.2%), stone made(9.7%) and metal made(11.3%) are the most widely used watering troughs in the central zone of Tigray in Northern Ethiopia.

Table: 13. Way of feed supplementation and watering of chicken

Parameters %	Heban Arsi woreda(hh60)	Negelle Arsi woreda(60hh)	Total (120hh)	X^2
Feeding practice				1.137
Thrown on ground	89.8	95	92.4	
Put feed in container	10.2	5	7.6	
Providing water to chicken				
Yes	100	100	100	
Source of water				19.227^{ab}
River water	6.7	36.7	21.7	
Rain water	8.3	3.3	5.8	
Tap water	68.3	51.7	60	
Borehole water	10	8.3	9.2	
Well water	6.7	--	3.3	
Type of waterer				1.243
Clay material	10	16.7	13.3	
Plastic made material	65	61.7	63.3	
Metallic material	6.7	5	5.8	
Other(wooden and cracked stone)	18.3	16.7	17.5	

hh =interviewed households; X2= chi-square; ab = significant at p <0.05.

4.1.4.2.Housing of chicken

As shown in Table 16, all the interviewed households provided shelter to their chicken at night.in agree to this finding result, Emebet (2015), also reported that all producers (100%) provide shelter to their bird during night .Most of households shares family dwelling namely; kitchen, room inside house, perch in main house, hand woven basket, in bamboo cage while the remaining households were using purposively made houses. Majority of interviewed respondents used perch inside the house for night shelter in both woredas. Chicken housing system were not significant ($p>0.05$) different between study woreda. this implies that still higher number of producer uses common house with family which may affect healthy of both human and chicken in study woredas. Similarly, Fisseha *et al*.(2010) reported that only 62 farmers (22.1%) prepared separate overnight houses for village birds and majority (77.9%) of village chicken owners kept birds on various night shelter including; perches inside the house (45.7%), on the floor covered by bamboo made materials (27.1%), on ceilings of the house (3.6%) and under locally constructed sitting place (1.4%).

Regarding to cleaning of purposively made chicken coop, cage and hand woven basket, three forth of interviewed households were cleaned every day while the remaining interviewed respondents cleaned every 3 day, every 2 days and once per week in study woredas (Table 16). Chicken houses cleaning frequency were not significant ($p>0.05$) different between study woredas. comparable to this finding results, Emebet (2015) report indicated that about 27% of the households cleaned their chickens house every day, while 31.8%, 30.1% and 11.1 % of the owners cleaned once per week, month and year, respectively in southwest showa and gurage zones of Ethiopia.

Table; 14. System of housing and frequency of chicken houses cleaning in the study woredas (frequency and chi-square)

Parameter %	Heban Arsi Woreda(60HH)	Negelle Arsi woreda(60HH)	Total (120HH)	X^2
Housing or rest at night in				5.388
In the kitchen	11.7	10	10.8	
Room inside house	--	6.7	3.3	
Perch on tree	50	51.7	50.8	
In hand woven basket	11.7	6.7	9.2	
In bamboo cage	1.7	3.3	2.5	
In house purposively made	25	21.7	23.3	
Chicken house cleaning/ week				1.786
Every day	83.3	76.7	80	
3 day per week	8.3	15	11.7	
Twice per week	5	6.7	5.8	
Once per week	3.3	1.7	2.5	

hh = interviewed households; X^2 *= chi square;* ^{ab} *= significant at* $p< 0.05$

4.1.4.3. Diseases and health of chicken

According to surveyed households, higher number of producers confirmed the prevalence of chicken disease outbreak namely: Newcastle disease, Respiratory disease, Choriza and unspecified in the study woredas (Table 17). Comparably, Emebet (2013) also reported that the major cause of death in local chicken in South Part of Ethiopia (89.5%) is seasonal outbreak of diseases, specifically Newcastle Disease. About half of interviewed households reported Diarrhea, standing, shrinked feather and paralysis combined symptom of disease while the remaining households reported Diarrhea, sneezing and blindness in the woredas. Hence, Fengile/Newcastle, Respiratory disease, Choriza and other unknown disease were found common diseases outbreak (Table 17). The prevalence of diseases outbreak and symptoms of disease were not significantly (p>0.05) different between study woredas. This result is Agree with the result of Fisseha *et al*. (2010) in North West Ethiopia Bure district (98.2%) and Addisu (2014) who reported the major cause of death in local chicken is seasonal outbreak of diseases, specifically Newcastle disease. The highest season for outbreak of disease was during summer followed by autumn in both woredas. This implies that rainy season is the most favourable season for infectious diseases of chickens. Season for disease outbreak were not significant (p>0.05) different between study woredas. Comparably report of Samson and Endalew (2010) indicated that highest chicken death rate was observed during rainy season (June, July and August) in Mid Rift Valley of Oromia.

More than half of interviewed households reported that all chickens age group were susceptible to disease whereas the highest death occurred on chicks and layers/brooder hen in the study woredas (Table 17). This study result also indicated that about half of interviewed producer handle sickness via mechanism namely; treating them, calling vet.doctor, killing them soon, consuming them soon, and selling them soon whereas the remaining household do not interfere in any reaction against sickness. This may happened because of low attention of farmers to handle chicken and believe as irregular or extra work in the households (Table 17). The reaction against sickness is not significant (p >0.05) different between study woredas. This finding also indicated that about half of interviewed producers treat their sick by feeding combination of traditional medicine namely: Tenadam, peper, lemon and garlic juice with injera or bread firfir and cut inside wing, whereas the rest households treat through Feeding tenadam with injera firfir, peper with injera firfir, garlic and lemon juice with injera firfir, Cutting inside wing to allow bleeding separately. Traditional medication of sickness was not significant (p>0.05) different between the study woredas. Still higher number of producers uses local medicine and agree with suggestion of Deneke (2014) who specified that no proper dosage and difficult to apply for all age group. Comparably Fisseha *et al*. (2010) indicated the use of traditional medicine to treat sickness.

Table: 15. Diseases and health management of chicken in the study woredas

Parameter %	Heban Arsi Woreda(60hh)	Negelle Arsi woreda(60hh)	Total (120hh)	X^2
Is there Serious disease of chicken?				0.342
Yes	96.7	98.3	97.5	
No	3.3	1.7	2.5	
Producer action to flock sickness				7.704
Treat them myself	21.7	28.3	25	
Call vet.doctor	--	1.7	0.8	
Kill them immediately	1.7	1.7	1.7	
Consume them immediately	15	8.3	11.7	
Sale them immediately	8.3	21.7	15	
No action	53.3	38.3	45.8	
Symptom of disease				2.262
Diarrhea	30	29.3	29.7	
Sneezing	11.7	15.5	13.6	
Blindness	10	3.4	6.8	
Diarrhea ,standing, shrinked feather and paralysis	48.3	51.7	50	
Name of disease				2.744
Fengile (Newcastle disease)	28.3	39.7	33.9	
Respiratory disease	16.7	17.2	16.9	
Choriza	10	12.1	11	
Other(unknown)	45	31	38.1	

Table: 16. Diseases and health management of chicken in the study woredas (continued).

Susceptible age				5.223
Chicks	16.7	31	23.7	
Pullets	--	1.7	0.8	
Layers	13.3	6.9	10.2	
All chicken age group	70	60.3	65.3	
Season of disease outbreak				9.771
During winter	11.7	5	8.3	
During summer	53.3	66.7	60	
During spring	6.7	3.3	5	
During autumn(belg)	18.3	25	21.7	
During summer and winter	8.3	--	4.2	
No answer	1.7	--	0.8	
Severity death age				4.392
Chicks	31.7	31	31.4	
Layer/brooder hen	13.3	6.9	10.2	
Chicks and layers(brooders)	35	34.5	34.7	
All chicken	20	22.4	21.2	
No serious disease	--	5.2	2.5	
Disease prevention method				
Separate newly purchased chicken for some day	13.3	6.9	10.2	8.550^{ab}
Avoid buying chicken at season of disease outbreak	38.3	50	44.1	
Traditional treatment(smoking resting site)	23.3	6.9	15.3	
Isolating sick chicken	25	36.2	30.5	
Local/traditional/ treatment				2.459
Feeding tenadam with injera firfir	--	5.9	3.2	

Table: 17. Diseases and health management of chicken in the study woredas (continued)			
Cut inside wing to allow bleeding	21.4	23.5	22.6
Feed peper with injera firfir	7.1	17.6	12.9
Feed garlic and lemon juice with injera firfir	7.1	11.8	9.7
All listed above are in use for treating sickness	64.3	41.2	51.6

hh = interviewed households; X^2 = chi square; ab = significant at $p < 0.05$

4.1.4.4. Production and reproduction performance of indigenous chicken.

Ages at sexual maturity of male and age at first egg of female are not statistically significant ($p>0.05$) different between study woredas. But, slightly higher age at sexual maturity of male and age at first egg of female were found on chicken from Negelle Arsi than in Heban Arsi woredas (Table 18). This variation may occur due to different management system (housing, feeding, watering and health care) of handling producers. The current finding result is close agreement with finding result of Melkamu and Wube (2013) who reported that village chicken attain age at sexual maturity and age at first egg laying at an average age of 6 months in Debsan TiKara Keble at Gonder Zuria Woreda, North Gonder and also closely agreed with finding of Mearg (2015) who indicated the overall mean age at first mating of male chickens and the age at first egg of female chickens were 5.29 and 5.96 months in central zone of Tigray. But higher than the finding report of Endale (2010) who reported the mean age at first mating of cockerel (5.06 months) and age of hen at first laying (5.8 months) in Mezhenger, Sheka and Benchi -Maji zones and but, lower than the finding report of Eskinder (2013) who reported 6.51 and 6.99 months of age at first mating in Horro and Jarso districts.

The overall average numbers of eggs per clutch, average numbers of days per clutches, Average numbers of eggs per set, Number of chicken hatched per batches and hatchability percentage were not significant ($p>0.05$) different between study woredas (Table 18). This finding result is comparable with the finding of Agide (2015) in which the average number of clutches per hen per year of village chicken were 2.93, 2.83 and 2.98 in Kowet, Menze Gera Mider and Moretina Jiru districts. Melkamu and Wube (2013) Also reported that hen lays about 13 eggs /hen/ clutch and the size is three times per year with 72% of hatchability on the average 10 number of egg settled per clutch. But, lower than report of Fisseha *et al*. (2010) who reported average number of eggs/hen/clutch and the total number of clutches/hen/year were 15.7 and 3.8, respectively in Bure district as well as the average number of eggs incubated once/hen was 13 eggs (ranged 7 - 22 eggs) and high (11chicks) (range 0 - 19) numbers of chicks were hatched with average hatchability percentage of local hens was 82.6%. According to Alem (2014) the average number of clutches per year per hen was 3.2 ranged from 2 to 5 with an average clutch length of 21.6 days ranged from 15 to 28 days and Average numbers of eggs set for incubation per broody hen were 10.2 eggs with hatchability of 85.8% for local eggs in Central Tigray. These variations may occur because of different management system in chicken farming. Mearg (2016) also reported that the overall mean survival rates of chicks were 6.72 (72.02%) in the central zone of Tigray in Northern Ethiopia and Alemayehu et al.(2013) reported that, chicken stayed alive up to 8 weeks during wet season was range from 5.6 to 6.8 in Benishangul Gumuz.

Table: 17. Production and reproductive performance of indigenous chicken in the study woredas (Mean ±SD)

Parameter	Heban Arsi woreda(60hh)	Negelle Arsi woreda(60hh)	Total(120hh)
Age at sexual maturity of hen(month)	5.97 ± 0.69	6.03 ± 0.69	6.00 ± 0.69
Age at sexual maturity of cockerel(month)	5.82 ± 0.6	5.9 ± 0.73	5.86 ± 0.66
Number of times the hen hatches in the year or clutch/year	3.02 ± 0. 65	2.90 ± 0.66	2.96 ± 0.65
Average number of eggs per clutches	13.37 ± 1.72	13.0 ± 1.09	13.18 ± 1.45
Average number of days per clutches	22.35 ± 2.34	22.62 ± 1.95	22.48 ± 2.15
Average number of eggs per set	11.20 ± 1.58	11.32 ± 1.65	11.26 ± 1.61
Number of chicken hatched per batches	8.67 ± 1.54	8.73 ± 1.52	8.7 ± 1.52
Hatchability	77.73 ± 10.78	77.36 ± 9.02	77.54 ± 9.90
Number of chicks surviving to adulthood	66.55 ± 1.01	65.06 ±1.05	5.73 ±1.03
Clutch period after hen is supposed to set egg for hatching	2.1 ± 0.51	2.18 ± 0.5	2.14 ± 0.51

hh and number in bracket = interviewed households; ^{a,b} = significant at $p< 0.05$

The current study result indicated that nearly half of interviewed households in Heban Arsi woreda and lower number of producers in Negelle Arsi woreda used clay incubator while the rest entire incubator in use were mud container, cracked ground and grass made incubators respectively. The respondents showed that hatchability is usually poor with such types of egg incubation (Table 19). Comparably Deneke *et al*.(2014) reported that common types of incubating materials used in the study area are made of cattle dung made, mud made, other materials like plastics, carton and metal sheets, clay and wood.

Overall interviewed households use bedding material namely Straw, Old cloths and Hay in study woredas (Table 19). The widely used bedding materials are straw. Bedding materials are not statistically significant ($p>0.05$) different between study area. This survey result is not in line with the finding result of Deneke (2014) who reported that all the chicken owners use bedding materials from crop residues such as '*teff'* straw, barley straw and wheat straw.

Table: 18. Incubation materials and bedding materials of indigenous chicken (frequency and Chi-square values)

Parameter %	Heban Arsi Woreda(60hh)	Negelle Arsi woreda(60hh)	Total(120hh)	X^2
Materials used for egg incubation				10.761^{ab}
Mud container	23.3	33.3	28.3	
Clay pot	46.7	21.7	34.2	
Wooden container	18.3	16.7	17.5	
On ground and grass made container	11.7	28.3	20	
Kind of bedding material used for incubation				4.198
Straw	63.3	55	59.2	
Hay	28.3	23.3	25.8	
Old cloths	8.3	21.7	15	

hh = interviewed households; X^2 *= chi square;* ^{ab} *= significant at* $p< 0.05$

4.1.4.5.Chicken culling practices in the study woredas

Less than half of interviewed households cull their chicken purposively while the entire of them cull their chicken when need of money (Table 20). Purposive culling of chicken are not significantly (p>0.05) different between study area. Purpose of culling chicken are for consumption, sale, sacrifices and combination of consumption, sale and sacrifices respectively not significantly (p>0.05) different between study woredas. Sickness found the major reason for culling chicken in Heban Arsi while poor productivity is the major in Negelle Arsi woreda and has no statistical significant (p>0.05) different between study woredas. Comparably Moges *et al*.(2010) reported that major type of birds culled from the flock were; old aged birds (51.4%), lower producers (23.6%), sick birds (16.8) and chicken more than need, mainly cockerels (8.2%) in Bure district, North West Ethiopia. Similarly Ermias (2015) also reported low egg production was the 1st ranked (P<0.001) in highland and disease problem (P<0.001) was the 1st ranked and followed by low egg production in lowland agro-ecology of central Oromia Region, Ethiopia.

Table: 19. Indigenous chicken culling practices in the study woredas

Parameter (%)	Heban Arsi Woreda (60hh)	Negelle Arsi woreda(60hh)	Total (120hh)	X^2
Do you cull chicken?				0.539
Yes	41.7	48.3	45	
No	58.3	51.7	55	
Purpose of rearing chicken				0.728
For consumption	20	25	22.5	
For sale	35	30	32.5	
For sacrifices	6.7	5	5.8	
Consuption,sale and sacrifices	38.3	40	39.2	

Reason for culling chicken				2.334
Poor productivity	13.3	10	11.7	
Old age	5	3.3	4.2	
Sickness	8.3	16.7	12.5	
Poor yield, old age and illness	20	16.7	18.3	
Other(when need of money)	53.3	53.3	53.3	

hh = interviewed households; X^2 = chi square; ^{ab} = significant at p< 0.05.

4.2. Major constraints of chicken production and marketing in the study woredas

As indicated in Table 21, disease and predators were the major constraints of chicken production while the second and the least were feed shortage as well as diseases followed by predators in the study woredas. Constraint of chicken production were not significantly (p>0.05) different between study woredas. This may occurred due to presence of backyard crop grown and longer trees which helps severe occurrence of wild birds in all seasons of the year and poor housing, poor veterinary service and feed shortage in study woredas. Comparably Eskinder (2013) reported that disease and predator were the major constraints for chicken production system. Halima (2007) also reported that predation was one of the major Village chicken production constraints in North West Ethiopia.

The current study result indicated that major problem in chicken marketing is demand seasonality (Poor sale) while instable bad price, lack of market place, substitute availability and poor infrastructure are minor issues and significant (p<0.05) different between the study woredas (Table 21). Instable bad price, Poor sale (demand seasonality) and Substitute availability have shown slightly higher impact on chicken marketing in Heban Arsi than in Negelle Arsi woreda. This may occur due to weak linkage between market and producers as well as high impact of local traders in the woredas. Similarly, the study result of Abera and

Geta (2014) revealed that there is no formal poultry and poultry product marketing channel and informal marketing of live birds and eggs involving open markets are common in Haramaya woreda.

Table: 20.Major constraints of chicken production and marketing (Frequency and Chi- square)

Parameter (%)	Heban Arsi Woreda(60hh)	Negelle Arsi woreda(60hh)	Total (120hh)	X2
Chicken production Problem				1.353
Disease	10.0	16.7	13.3	
Predators	11.7	13.3	12.5	
Feed shortage	26.7	23.3	25.0	
Disease and predators	51.7	46.7	49.2	
Chicken marketing Problem				13.736^{ab}
Instable bad price	25.0	13.3	19.2	
Poor sale (demand seasonality)	58.3	50.0	54.2	
Lack of market place	1.7	16.7	9.2	
Substitute availability	13.3	10.0	11.7	
Poor infrastructure	1.7	10.0	5.8	

hh=interviewed households; X2=chi square; ab=significant at p<0.05

The results from Appendix Table 21 indicated the average distance travelled by the respondents for marketing the chicken and eggs. Thus, producer from Heban Arsi have good market access than respondents from Negelle Arsi woreda. This study result also indicated significant seasonal variation in the price of Chicken and egg marketing across the studied woredas. Hence, higher price of both chicken and eggs were occurred during year round festivals whereas the least prices were seen during marketing for scarification (Appendix Table 22). The price of chicken and egg sale were significant ($p<0.05$) different between the study woredas. This may due to weak market linkage and demand seasonality in the study woredas. In the current finding, the price of chicken were higher than price report of Hana (2016) who shown price of cock (108±0.80) and hen (100±0.6 Birr), north Gondar zone, Ethiopia.

4.3. Extension services and source of information on improved chicken production

More than two third of interviewed households contact development agents while the rest of them do not get advice (Table 22). Meeting site was the most common contact site while the least contact site was farmers' house in the study woredas (Table 22). The site at which producers get development agents is significant ($p<0.05$) different between study woredas. Hence, most of producers in Heban Arsi woreda contact development agents at agent office whereas a significant number of respondents in Negelle Arsi get them at meeting site. Inline to the current study result Bogale (2008) reported that most common meeting place (40.3%) was reported to be extension agent's office, second common place (23.6%) reported to be at the farmers' homes; another but less common reported place of meeting place (18.1%) was meeting at crop demonstration site in fogera woreda, Amhara region.

This study result has shown that higher number of interviewed producers get extension agents' once per 6 month while the least meeting frequency was once per month. Frequency of meeting with extension agents were no significantly ($p>0.05$) different between study woreda. Overall, nearly half of interviewed households those do not met development agents were due to lack of important development agents at kebele while the other reason were because of lack of information about extension, difficulties in reaching development agents /less in number and busy as well as low attentiveness of farmers(Table 22) and similar across the study woreda. This implies steal weak linkage between producer and extension workers. Similarly, Demeke (2014) also reported that frequency of producer to contact development agents were no response obtained, once in a month, once in two months, once in three months, once in four months, once in six months and once in twelve months in Arsi zone Oromia region.

As indicated in the Table 22, all the interviewed households get information related to improved chicken production and development agents was the major source of information whereas the remaining source of information were friends, neighbors' and other in both woredas (Table 22). No significant ($p>0.05$) different source of information between study woredas. This survey result also shown that entire of interviewed producer have hope of expanding chicken production. Hence, majority of interviewed households were advocated access to credit service while the remaining need were access to improved breed, training or extension and veterinary service in both woredas. Comparable to the current study result Mengesha *et al*. (2011) also reported that majority of respondents 43.3% in Ada'a and 41.1% in Lume districts suggested access to day-old chicks, annual vaccination and training on modern poultry rearing should supplied by government in Jamma district of South Wollo, Ethiopia.

Table: 23. Extension service and information source for chicken production in the study woredas (Frequency and Chi- square)

Parameter %	Heban Arsi Woreda(60hh)	Negelle Arsi woreda(60hh)	Total(120hh)	X^2
Have you discuss about chicken with development agent?				1.195
Yes	81.7	73.3	77.5	
No	18.3	26.7	22.5	
Where do you contact DA?				
At agent office	46.9	14	31.5	13.738[ab]
At farmer house	--	2.3	1.1	
At meeting	24.5	51.2	37	
At cooperatives meeting	10.2	9.3	9.8	
At demonstration site	18.4	23.3	20.7	
How frequently do you contact DA per month(day)				3.546
1 day per month	4.1	7	5.4	
1 day per 3 month	18.4	25.6	21.7	
1 day per 6 month	44.9	51.2	47.8	
1 day per12 month	32.7	16.3	25	
Reason for not contacting DA				1.901
Have not heard about extension in chicken	--	6.2	3.7	
Cannot easily reach DA (less in number and busy)	18.2	31.2	25.9	
No need to contact agents (no important DA at kebele)	45.5	43.8	44.4	

Table: 24. Extension service and information source for chicken production (Frequency and Chi- square) (continued)

Other(lack of attentiveness)	36.4	18.8	25.9	
Information of improved chicken production practice				
Yes	100	100	100	
No	--	--	--	
Major source of information on improved chicken raising				0.344
Friends	13.6	11.7	12.6	
Development agent	55.9	55	55.5	
Neighbor	20.3	20	20.2	
Other	10.2	13.3	11.8	
Do you intend to expand chicken production				
Yes	100	100	100	
Role of government to improve chicken keeping				1.053
Provide improved breed	26.7	31.7	29.2	
Training on chicken management and extension	6.7	10	8.3	
Access to credit service	40	33.3	36.7	
Access to veterinary service	26.7	25	25.8	

Number in bracket = number of interviewed households.hh = interviewed households; X^2 = chi square; ^{ab} = significant at $p< 0.05$

4.4. Morphological Characteristic of indigenous chicken in the study woredas

4.4.1. Some qualitative trait of indigenous chicken in the study woredas

As indicated in table 23, majority of observed chicken were females while the remaining were males in the study woredas. About two third of indigenous chicken possessed spurs whereas the rest few had no spur. Spur presence is not significant between the study woredas. In relation to sex of chicken, all males and more than half of observed female possessed spurs (Table 23). Here, Spur presence was significantly ($p<0.05$) different between sex of chicken. Comparably Bogale (2008) report indicated that almost all of the male chickens had spur while only half of the female chicken had spur.

Pea comb constitutes the maximum proportion of comb type followed by single comb and Rose comb while Strawberry founds the least observed comb type and not significant ($p>0.05$) different between the study woredas. Alongside of sexes, majority of male chicken possessed Rose comb followed by pea comb type whereas most of observed female owned pea comb followed by single comb. Hence, proportion of comb type found significantly ($p<0.05$) different between sex of chicken. In agreement to the current study Halima (2007) and Niguse *et al*. (2010b) reported that 50.72% and 53% of chicken had pea comb type in North West Ethiopia and different parts of Ethiopia, respectively. But, Agide (2015) reported that average proportion of rose, single and pea combs were 65.33%, 29.13% and 5.33% in Kowet, Menze Gera Mider and Moretina Jiru districts, respectively.

In this finding result plain was the major observed head shapes of indigenous chicken followed by flat while Crest was the least observed head shape in the study woredas. Head shapes of observed chicken were not significant ($p>0.05$) different between study woredas. As compared to sex of chicken, plain and flat were predominant head shape followed by least observed crest head shape on male chicken whereas plain was prominently observed head shape followed by flat while the least observed was crest head shape on female chicken (Table 23). Hence, Significant ($p<0.05$) different head shape found between sex of chicken. Similarly, Addis (2014) also reported that plain head shape (70.4%) was dominant in North Gonder. Eskinder (2013) also reported that about 71.17 and 95.11% of the chicken population was characterized by having plain head shape in Horro and Jarso, respectively.

All chicken in study woredas as well as both sexes had ear lobes. A few observed male indigenous chickens owned shank feather while female chicken had no. Chicken possessing shank feather were significantly ($p<0.05$) different between sex of chicken. In contrast to the current finding Bogale (2008) reported no shank feather was observed both in male and female chicken population. Generally the morphological variation between male and female chicken may be because of action of hormonal difference between sexes and poor selection of breeding chicken.

About two third of observed indigenous chicken owned yellow shank color followed by black while white was the least observed shank color. Almost similar proportion of shank color was observed in both study woredas (Table 25).In relation to sex of chicken, majority of observed male and female chicken owned yellow shank color whereas others color in male and black in female was the second predominant shank color. Shank color were observed significantly ($p<0.05$) different between sexes of chicken. The current survey result is agree with the study suggestion of Deneke (2014) who reported that the shank colour is mainly affected by the level of nutrition mainly feed sources containing carotene. Comparably Melaku (2016) report indicated Yellow shank colour (41.17 %) was dominant over white (19.83 %) and black (15.5 %) shank colours in south wollo.

Majority of observed chicken possessed Red earlobe color followed by white with red whereas the least found earlobe color was black and white. Earlobe color owned chicken were significantly ($p<0.05$) different between study woredas but not significant ($p>0.05$) between sex of chicken. Comparable Mearg (2016) reported white with red (35.7%), black (33.7%), and red (28.9%) as major observed earlobe color in central zone of Tigray.

Table: 26. Some qualitative traits and Shape of indigenous chicken in the study woredas

Variables (%)	Study area		X^2	Sex of chicken		Overall (360)	X^2
	Heban Arsi (180)	Negelle Arsi (180)		Rooster (120)	Hen (240)		
Sex of chicken			360^{ab}				
Male	33.3	33.3				33.3	
Female	66.7	66.7				66.7	
Spur presence			0.755				55.636^{ab}
Present	74.4	78.3		100	64.6	76.4	
Absent	25.6	21.7		--	35.4	23.6	
Comb type			1.158				50.490^{ab}
Rose	22.2	19.4		41.7	10.4	20.8	
Pea	37.8	42.2		35	42.5	40	
Strawberry	6.1	7.2		5	7.5	6.7	
Single	33.9	31.1		18.3	39.6	32.5	
Head shape			0.773				12.60^{ab}
Plain	50	46.1		47.5	48.3	48.1	
Crest/Gutya	14.4	13.9		5.8	18.3	14.2	
Flat	35.6	40		46.7	33.3	37.8	

Table: 27. Some qualitative traits and Shape of indigenous chicken (continued)

Shank feather			4.045[ab]				8.090[ab]
Present	2.2	--		3.3	--	1.1	
Absent	97.8	100		96.7	100	98.9	
Shank colour				8.3	21.2	16.9	
Black	16.7	17.2		0.8	6.7	4.7	
White	3.3	6.1	2.011	73.3	58.8	63.6	17.260[ab]
Yellow	66.1	61.1		17.5	13.3	14.7	
Other	13.9	15.6					
Earlobe colour				50	49.6	49.7	
Red	52.8	46.7	8.139[ab]	0.8	1.7	1.4	2.397
Black	2.8	--		20.8	15.4	17.2	
White	13.9	20.6		28.3	33.3	31.7	
white and red	30.6	32.8		8.3	21.2	16.9	

Number inside bracket = chicken observed; X^2 *= chi square;* [ab] *= significant at* $p<0.05$*;*

4.4.2. Feather characteristic and Color traits.

Qualitative traits namely body feather, breast, neck, back feather colours, comb colour, shank colour and earlobe colour of indigenous chickens were observed. Hence, the results indicated that major body feather colours of indigenous chickens were Red followed by Kokima and White in the study woredas (Table 24). Body feather color of chicken are not significantly ($p>0.05$) different between the study woredas. In relation to sexes of chicken, Red followed by white were the dominant body feather color of male chicken whereas Kokima followed by red were the most common body feather color of female chickens. Body feather color of chicken were observed significantly ($p<0.05$) different between sex of chickens. The dominantly observed breast feather color of indigenous chicken were Red brownish or Kokima followed by Black color (Table 24). Proportion of breast color is not significantly ($p>0.05$) different between study woredas. Concerning sex related feather characteristics, major male chicken owned black followed by Kokima/red brown breast feather color whereas majority of observed female chicken possessed red brown/Kokima followed by black breast feather color (Table 28). Hence, the observed breast feather color of chicken were significantly ($p<0.05$) different between sex of chicken. Red color followed by Gray/Gebsima color, white and multicolor, Teterma and black were the predominantly observed neck color of indigenous chicken (Table 29). Significantly ($p<0.05$) differed neck color of indigenous chicken were found between study Woredas. Within sexes of chicken, major observed neck colors of male chicken were red followed by multicolor whereas most of observed female chicken possessed Grayish or Gebsima followed by Red. Neck color of indigenous chicken were significant ($p<0.05$) different between sex of chickens.

Overall, observed back feather color of indigenous chicken were red, Black, White, Grayish/Gebsima, Black with white tips/Teterma, Red brownish/Kokima and Multicolor respectively in the study woredas (Table 24). Back feather color of chicken were not significant ($p>0.05$) different between study woredas. Relating to sex of chicken, the major observed back feather color of male chicken were red followed by black with white tips whereas prominent back feather color of female were red brownish or Kokima followed by red. Back coloration of chicken were found significantly ($p<0.05$) different between sexes of chicken (Table 24). The large variation in plumage color may occurred due to lack of selection of breeders chicken and agree with the suggestion report of Bhuiyan *et al*. (2005) who stated that the presence of large variations in plumage colours of indigenous chicken revealed much genetic dilution. Comparably, Bogale (2008) also reported that out of the 50 cocks observed, 48% were Key, 18% were Netch, 8% were Seran, 4% were Gebsima, 3% were Tikur, 8% were Teterma, and 4% were Kokima plumage color in fogera woreda, Amhara regional state.

Table: 30. Feather characteristics and color trait of indigenous chicken

Variables (%)	study woredas		X^2	Sex of chicken		overall	X^2
	Heban Arsi	Negele Arsi		Rooster (N=120)	Hen (N=240)		
Body colour			10.988				49.402^{ab}
Red	24.4	27.2		40.8	18.3	25.8	
Black	16.1	6.1		8.3	12.5	11.1	
White	12.8	13.9		12.5	13.8	13.3	
Grey	7.2	8.3		10	6.7	7.8	
Black with white tip	8.9	14.4		15	10	11.7	
Red brown	23.3	22.8		7.5	30.8	23.1	
Multicolor	7.2	7.2		5.8	7.9	7.2	
Breast colour							
Red	3.9	10.6		15	3.3	7.2	
Black	26.7	30	8.506	35.8	24.6	28.3	26.215^{ab}
White	12.8	13.9		12.5	13.8	13.3	
Multicolor	7.2	7.2		5.8	7.9	7.2	
Red brown	49.4	38.3		30.8	50.4	43.9	
Neck colour							
Red	23.9	27.2	14.154^{ab}	40.8	17.9	25.6	41.402^{ab}
Black	16.7	6.1		8.3	12.9	11.4	
White	12.8	13.9		12.5	13.8	13.3	
Grey	26.7	22.2		7.5	32.9	24.4	
Black with white tip	8.9	15		15	10.4	11.9	
Multicolor	11.1	15.6		15.8	12.1	13.3	

Table: 31. Feather characteristics and color trait of indigenous chicken (continued)

Back colour							
Red	23.9	27.2		40.8	17.9	25.6	
Black	16.7	6.1		8.3	12.9	11.4	40.239^{ab}
White	12.8	13.9		12.5	13.8	13.3	
Grey	7.2	8.3	11.815	10	6.7	7.8	
Black with white tip	8.9	14.4		15	10	11.7	
Red brown	23.3	22.8		7.5	30.8	23.1	
Multicolor	7.2	7.2		5.8	7.9	7.2	

X^2 = chi square; $^{a,\,b}$ = significant at $p < 0.05$ for both male and female.

4.4.3. Some quantitative trait of indigenous chicken in the study woredas

The average body weight of male was measured higher than that of female and it may be due to the effect of different hormone in male and female chicken. This finding is in accordance with suggestion of Yakubu *et al*. (2010) who recognized Male chickens were heavier than females which may due to differential effects of androgens and estrogen on growth performances of chickens. Comparably Deneke (2014) reported 1.39kg and 1.23kg average live body weight of male and female chicken respectively in Arsi Zone, Oromia region.

The overall wingspan length of measured indigenous chicken was almost similar between study woredas (Table 25). But, wingspan was found Significant ($p<0.05$) differed between sexes of chicken. Hence, Male chicken had longer wingspan measurement than female).This may be because of differential effect of hormone on muscular growth of male and female. In close agreement to the current study result, Mearg (2016) also reported that the overall mean wingspan of 36.27cm and 32.17cm for male and female across agro ecologies in the central zone of Tigray in Northern Ethiopia.

The average shank length, shank circumference, comb and wattle length measurements of indigenous chicken were not significant ($p>0.05$) different between study woredas (Table 25). However, shank length, shank circumference, comb and wattle measurement were significantly ($p<0.05$) different between sexes of chickens (Table 25). Therefore, Roosters possessed longer and wider shank as well as longer comb and wattle than hen in both study woredas. This difference may be due to better possession of postures on male than on female chicken as well as effect of Sexual dimorphism and help them harbour of heavy body and agree with suggestion of Aberra and Tegene (2011) who reported Shank length is regarded as a good indicator of skeletal development, which is related to the amount of meat a chicken can carry. This finding result is higher than the report of Deneke (2014) who indicated the average shank length and comb length of indigenous chicken of male and female were (7.41±0.52cm and 4.82±1.70cm) and (6.54±0.34 cm and 2.48±0.73cm) respectively in Arsi Zone, Oromia region.

The mean body and back length measurements of indigenous chicken were significantly ($p<0.05$) different between sexes of chickens though, it is similar between the study woredas. Hence, male chickens have longer body and back length with higher body weights than in females (Table 25). This may also due to better conforming nature of male owning large bone and meat than on female chicken and agree with the study suggestion of Dumonant *et al*. (2010), who reported that chicken with higher body length are expected to have a higher body weight as the skeletal dimension of such birds are expected to be larger. The current finding is higher than report of Emebet *et al*. (2014) and Addisu *et al*. (2013) for chicken reared in North Gonder and South west and south part of Ethiopia, respectively.

The average keel bone length measurement of indigenous chicken were not significant ($p>0.05$) different between study woredas. By contrast, mean keel bone length were Significant ($p<0.05$) different between sexes of chicken. Moreover, males had longer average keel bone length than female. This may also due to the effect of hormone. The current finding is close agreement with finding of Deneke (2014) who reported average keel bone length of males and females were 9.70±0.80cm) and (9.02±0.05cm) separately in Arsi Zone, Oromia.

Table: 32. The average body weight (kg) and linear body measurements (cm) of indigenous chicken in the study woredas (M±SD)

Variables	study area		sex of chicken		Total (N=360)
	Heban Arsi (180)	Negelle Arsi(180)	Rooster (N=120)	Hen (N=240)	
Body weight	1.31 ± 0.56	1.30 ± 0.16	1.37 ± 0.18[c]	1.27 ± 0.13[d]	1.32 ± 0.16
Wingspan length	32.48 ± 3.51	32.68 ± 3.61	35.78 ± 2.79[c]	30.98 ± 2.72[d]	32.58 ± 3.56
Shank length	7.64 ± 1.127	7.85 ± 1.126	8.88 ± 0.80[c]	7.17 ± 0.79[d]	7.74 ±1.13
Shank circumference	3.79 ± 0.70	3.85 ± 0.57	4.403 ± 0.56[c]	3.53 ± 0.44[d]	3.82 ± 0.64
Comb length	3.35 ± 1.41	3.34 ± 1.44	5.25 ± 0.52[c]	2.39 ± 0.39[d]	3.35 ± 1.42
Wattle length	1.46 ± 1.34	1.44 ± 1.37	3.29 ± 0.31[c]	0.51 ± 0.31[d]	1.44 ± 1.35
Body length	30.93 ± 3.46	30.65 ± 3.47	33.89 ± 2.68[c]	29.24 ± 2.69[d]	30.79 ± 3.46
Back length	18.73 ± 1.36	18.7 ± 1.34	19.98 ±1.36[c]	18.09 ± 0.79[d]	18.72 ± 1.35
Keel length	9.23 ± 0.82	9.16 ± 0.79	9.72 ± 0.56[c]	8.93 ± 0.79[d]	9.19 ± 0.81

N= number of chicken measured, M±SD, M= Mean, SD= standard deviation. A, b, c, d = significant at P<0.05.

4.4.4. Correlations between body weight and linear body measurements

All correlation coefficients between body weight and other body measurements are positive and significant (Table 26). This indicates body measurements are parallel to body weight. The correlations among the rest of body measurements are also positive. The highest correlation coefficient (0.591) was observed between body weight and shank length while the correlation between body weight and comb length was the lowest (0.414).hence, Body length, back length, shank length, shank circumference, comb length, keel bone length, spur length, and wattle length have high degree of positive correlation ($p<0.05$) with body weight of chicken. Therefore, the results of present study is in agree with the suggestion of Muhiuddin (1993) who recommended the selection for any of these trait will improve the other as a correlated response. Similarly, Alabi et al (2012) reported positive and significant correlation between body weight and linear body measurement traits from Nigeria local chickens.

Table: 33. Correlation coefficients of body weight and body measurements of local chickens

Trait	SHL	SHC	WSL	BkL	BL	CL	KL	WL	BW
ShL	1								
ShC	0.589**	1							
WSL	0.636**	0.467**	1						
BkL	0.454**	0.535**	0.425**	1					
BL	0.541**	0.397**	0.787**	0.399**	1				
CL	0.486**	0.387**	0.357**	0.338**	0.414**	1			
KL	0.437**	0.41**	0.362**	0.445**	0.418**	0.414**	1		
WL	0.551**	0.434**	0.466**	0.470**	0.455**	0.403**	0.441**	1	
BW	0.591**	0.486**	0.514**	0.449**	0.497**	0.414**	0.486**	0.465**	1

*** P< 0.05*

SHL = shank length, BW =body weight, ShC=shank circumference, WSL= wingspan length, BL= body length, CL=Comb length, WL=Wattle length, BkL=back length, KL= keel length.

4.5. Evaluation of Internal and external egg quality parameters

The overall average egg length, egg width, egg weight, Shell thickness, albumen height and Hough unit score measurements were not significant (p>0.05) different between study woredas (Table: 34). The current study result is agreed with the finding result of Aberra *et al*. (2013) who reported average egg weight, egg length and egg width of 39.6g, 51.3mm and 37.5mm respectively in different agro ecology of southern Ethiopia.

The overall albumen height of current study was closely agreement with the finding result of Nonga *et al*. (2010) who reported 3.92mm from Tanzania. But, higher than 3.41mm average albumen height reported by Afolabi *et al*. (2012) from Nigeria. The Hough unit value in the current study was in closely agreement with the study result of Shabbir *et al*. (2013) from Pakistan; but was lower than report of Abera *et al*. (2013) from Ethiopia.

The yolk height (13.6mm) in the current study was agreed with the report of Shabbir *et al*. (2013) from Pakistan. The mean yolk colour in this study was lower that the finding result of Aberra *et al*. (2010) who reported 9.26.

Table: 35. Evaluation of egg qualities parameters in the study area. (Mean ± SE)

Parameter	Heban Arsi Woreda(120)	Negelle Arsi woreda(120)	Total(120hh)	P-value
External egg quality				
Egg weight (gm)	40.25±0.59	39.50±0.5	39.88±0.40	0.349
Shell thickness (mm)	0.293±0.002	0.290±0.003	0.291±0.002	0.442
Egg width (mm)	37.75±0.22	37.84±0.19	37.80±0.14	0.734
Egg length (mm)	50.88±0.28	50.39±0.31	50.64±0.21	0.251
Egg shape index	74.26±0.45	75.18±0.35	74.72 ±0.29	0.111
Internal egg quality				
Albumen height (mm)	3.97±0.10	4.07±0.09	4.02±0.07	0.471
Yolk height (mm)	13.82±0.14	13.68±0.15	13.75±0.10	0.518
Yolk width (mm)	37.17±0.26	36.91±0.22	37.04±0.17	0.458
Yolk color	6.93±0.17	6.60±0.20	6.77±0.13	0.211
Haugh unit	68.79±1.04	69.96±0.75	69.37±0.64	0.362

Number in the bracket represented evaluated eggs; a, b = significant at $P < 0.05$

5. SUMMARY AND CONCLUSIONS.

Summary

The research was conducted in two purposively selected areas of west Arsi zone namely Heban Arsi and Negelle Arsi woredas. Subsequently, Six Kebeles (three from each woreda) were purposively selected and production system was assessed using semi-structured questionnnaire. Of households that possess at least five mature local chickens and have more than three years of chicken rearing experience, 120 were purposively selected. Characterizations of production system, qualitative and quantitative traits were done through interview, observation and taking measurement of physical and body linear traits of 360 adult chickens of one and more years of age. External and internal egg quality traits were evaluated on 240 eggs of indigenous chickens (2 eggs per respondent).

About 98.3 % of interviewed households were undertaking extensive chicken production whereas 1.7% of them were engaged in semi-intensive system in the study woredas. Most of the interviewed households (99.2%) provided supplementary feed to their flock and the most of supplementary feed given for chicken were both grain and kitchen wastes. The forms of feed offer for different age groups of chicken were ground grain, injera firfir, dabo firfir and duket firfir whereas whole grain is fed to mature chickens alone. About 23.3% of the respondents rest their flock at night in purposively made chicken house whereas significant number of households (76.7%) still shared family dwellings. The mean age at sexual maturity of hens and cockerels were 6 and 5.86 months respectively. Disease, predators and feed shortage are vital constraints of chicken production in the study woredas.

Majority of body feather colour of indigenous chickens were red and red brownish /Kokima followed by white, black with white tips/Teterma, black, grayish/Gebsima and multicolor/Ambasma in the woredas. All of chickens possessed normal feathers with the dominant white and red ear lobe colors, yellow shank colors, pea and single comb with plain as well as flat head shape. Variations of color trait of indigenous chicken have good potential and opportunity in selecting breeder chicken to improve breed in extensive production system in the study woredas. The overall mean body weight of chickens was 1.3kg. The Wingspan length, shank length, shank circumference, comb length, wattle length, body length, back length and keel length measurements were 32.58, 7.74, 3.82, 3.35, 1.44, 30.79, 18.72 and 9.19cm respectively in the woredas. Body weight and other body measurements were positively correlated and can be good estimator of body weight and have their own contributions in selection of breeder chicken in the woredas. The mean egg weight of chickens was 39.88 g while the mean egg width and length was 37.8 mm and 50.64 mm, respectively with an average shape index value of 74.72%. The mean shell thicknesses and albumen height were 0.291mm and 4.02mm with an average Haugh unit score of 69.37%. Yolk color was 6.77 color fan of 1-15. Yolk width and height were 37.04mm and 13.75mm respectively.

Conclusion

Similar proportion of indigenous chicken possessing comb type, head shape, spur presence, earmark and shank feather were observed across study woredas. However, majority of male chicken possessed rose comb type and plain head shape while most of observed female owned pea comb and plain head shape. All males and more than half of female possessed spur and earmark whereas only a few males alone owned shank feather. Higher number of observed indigenous chicken in Heban Arsi had red, Kokima and black body feather color whereas Red, Kokima and Teterma found common feather color in Negelle Arsi woreda. Red followed by white was the dominant body feather color of male chicken whereas Kokima and red color found common in female chickens. In all indigenous chicken, the linear body Measurement traits of male were higher than those of females chicken. There was a positive and significances correlation between body weight and linear body measurements. All the measured values of egg quality trait of indigenous chicken were similar across study woredas.

Recommendations

- There is a necessity of building producers awareness on modern chicken management practice.
- Producers should construct predator proof chicken house, vaccinate and treat sick chicken using modern drug.
- There is a necessity of recommending producers not to eat and sale sick chickens.
- Appropriate market information and strong market linkage should be created for chicken and egg marketing to upturn interest of producers in increasing and improving chicken production.
- A detailed molecular characterization is recommended to assess variation of morphological traits of indigenous Chickens of the study woredas.

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BIOGRAPHY

The author, Desta Gutema was born in 1992 in Arsi Negelle Woreda West Arsi Zone of Oromia region. He attends his elementary and junior school education in Shopa Genet School and his high school education at Heban Degaga Secondary School and Arsi Negelle preparatory school.

After successfully passing EGSSLE (Ethiopian General Secondary school Leaving Examination and entrance examination, he joined Adama science and Technology University in October 2010 and graduated in July 2012 with Bsc degree in field of Animal science. After his graduation he employed in Bekoji ATVET College in Instructor in 2013 and after two years, he employed in Alage ATVET College in 2016. Thereafter, he joined Hawassa University School of graduate studies in June 2017 to purse his MSc degree in specialization of Animal production.

7. APPENDIX

7.1. List of tables in the appendix (ANOVA and other tables)

Table. 36 Seasonal price variation of indigenous chicken and egg marketing in the study woredas (Mean± SE)

Parameter(Km and Birr)	Heban Arsi Woreda(60hh)	Negelle Arsi woreda(60hh)	Total(120hh)
Distance of market place from resident from resident of household by KM	5.87 ± 0.190[a]	7.73 ± 0.272[b]	6.80 ± 0.186
Average unit price of small size male chicken at Christian festival(Birr)	95.35 ± 0.55	94.77 ± 0.51	95.06 ± 0.38
Average unit price of small size female chicken at Christian festival(Birr)	64.5 ± 0.55	64.43 ± 0.87	64.47 ± 0.51
Average unit price of midle size male chicken at Christian festival(Birr)	129.21 ± 0.68[a]	134.1± 0.74[b]	131.65 ± 0.55
Average unit price of midle size female chicken at Christian festival(Birr)	71.58 ± 0.69[a]	69.03 ± 0.72[b]	70.30 ± 0.51
Average unit price of large size male chicken at Christian festival(Birr)	156.56 ± 0.64[a]	161.42 ± 0.49[b]	158.99 ± 0.46
Average unit price of large size female chicken at Christian festival(Birr)	100.38 ± 0.73	100.75 ± 0.73	100.57 ± 0.51
Average unit price of chick/grower chicken at Christian festival(Birr)	36.62 ± 0.61[a]	33.32 ± 0.43[b]	34.97 ± 0.40
Average unit price of Eggs at Christian festival(Birr)	4.00 ± 0.00[a]	4.00 ± 0.00[b]	4.00 ± 0.00
Average unit price of small size male chicken at Muslim festival(Birr)	80.77 ± 0.52	80.35 ± 0.51	80.56 ± 0.36
Average unit price of small size female chicken at Muslim festival(Birr)	45.60 ± 0.63	47.12 ± 0.66	46.36 ± 0.46
Average unit price of midle size male chicken at Muslim festival(Birr)	110.2 ± 0.73	111.08 ± 0.85	110.64 ± 0.56
Average unit price of midle size female chicken at Muslim festival(Birr)	64.42 ± 0.66[a]	60.77 ± 0.50[b]	62.59 ± 0.45

Average unit price of large size male chicken at Muslim festival(Birr)	134.08 ± 0.84	133.42 ± 0.79	133.75 ± 0.58
Average unit price of large size female chicken at Muslim festival(Birr)	74.65 ± 0.73[a]	72.30 ± 0.67[b]	73.48 ± 0.51
Average unit price of chick/grower chicken at Muslim festival(Birr)	32.12 ± 0.45[a]	30.52 ± 0.30[b]	31.32 ± 0.28
Average unit price of Eggs at Muslim festival(Birr)	3.50 ± 0.00[a]	3.50 ± 0.00[b]	3.50 ± 0.00
Average unit price of small size male chicken during traditional festivals	62.52 ± 0.65[a]	65.35 ± 0.61[b]	63.93 ± 0.46
Average unit price of small size female chicken during traditional festivals	38.52 ± 0.54	38.10 ± 0.54	38.31 ± 0.38
Average unit price of middle size male chicken during traditional festivals	86.85 ± 0.60	88.32 ± 0.91	87.58 ± 0.55
Average unit price of middle size female chicken during traditional festivals	51.48 ± 0.55[a]	46.35 ± 0.56[b]	48.92 ± 0.46
Average unit price of large size male chicken during traditional festivals	109.62 ± 0.63	109.60 ± 0.66	109.61 ± 0.46
Average unit price of large size female chicken during traditional festivals	64.22 ± 0.71	64.30 ± 0.58	64.26± 0.46
Average unit price of chick/grower chicken during traditional festivals(Birr)	32.13 ± 0.39	31.42 ± 0.29	31.78 ± 0.25
Average unit price of Eggs during traditional festivals(Birr)	3.50 ± 0.00[a]	3.50 ± 0.00[b]	3.50 ± 0.00
Average unit price of small size male chicken during year round festivals	98.37 ± 0.66	98.28 ± 0.75	98.33 ± 0.50
Average unit price of small size female chicken during year round festivals	66.82 ± 0.62[a]	61.38 ± 0.45[b]	64.10 ± 0.45
Average unit price of middle size male chicken during year round festivals	132.87 ± 0.70	132.38 ± 0.69	132.63 ± 0.49
Average unit price of middle size female chicken during year round	84.83 ± 0.63[a]	82.23 ± 0.89[b]	83.53 ± 0.56
Average unit price of large size male chicken during year round festivals	162.32 ± 0.84[a]	172.07± 0.82[b]	167.19 ± 0.74
Average unit price of large size female chicken during year round festivals	102.57 ± 0.67[a]	99.90 ± 0.87[b]	101.23 ± 0.56
Average unit price of chick/grower chicken during year round festivals	32.33 ± 0.41	31.37 ± 0.42	31.85 ± 0.29
Average unit price of Eggs during year round festivals(Birr)	4.00 ± 0.00[a]	4.00 ± 0.00[b]	4.00 ± 0.00
Average unit price of small size male chicken during scarification(Birr)	59.92 ± 0.64	61.60± 0.63	60.76 ± 0.46
Average unit price of small size female chicken during scarification(Birr)	38.2 ± 0.58[a]	34.65 ± 0.39[b]	36.43 ± 0.38

Average unit price of middle size male chicken during scarification(Birr)	85.85 ± 0.51	86.55 ± 0.71	86.20± 0.44
Average unit price of middle size female chicken during scarification(Birr)	49.45 ± 0.52[a]	46.63 ± 0.50[b]	48.04 ± 0.38
Average unit price of large size male chicken during scarification(Birr)	109.50 ± 0.68	107.57 ± 0.90	108.53 ±0.57
Average unit price of large size female chicken during scarification(Birr)	63.43 ± 0.75	63.62 ± 0.69	63.53 ± 0.51
Average unit price of chick/grower chicken during scarification(Birr)	33.03 ± 0.41[a]	23.07 ± 1.89[b]	28.05 ± 1.07
Average unit price of Eggs during scarification(Birr)	3.50 ± 0.00[a]	3.50 ± 0.00[b]	3.50 ± 0.00

hh= interviewed households; ab= across a raw are significantly different ($p < 0.05$).

Table. 37 Age of households

Source of variation	Sum of Squares	Df	Mean Square	F	Sig.
Woreda	240.833	1	240.833	2.188	.142
Error	12988.633	118	110.073		
Total	13229.467	119			

Table. 38 Land holding per households

Source of variation	Sum of Squares	Df	Mean Square	F	Sig.
Woreda	.052	1	.052	.138	.711
Error	44.690	118	.379		
Total	44.742	119			

Table. 39 Up to 14 ages of males members per households

Source of variation	Sum of Squares	Df	Mean Square	F	Sig.
Woreda	.159	1	.159	.603	.440
Error	19.525	74	.264		
Total	19.684	75			

Table. 40 Up to 14 ages of female members per households

Source of variation	Sum of Squares	Df	Mean Square	F	Sig.
Woreda	1.177	1	1.177	2.559	.113
Error	40.014	87	.460		
Total	41.191	88			

Table. 41 Between 15 to 60 ages of males members per households

Source of variation	Sum of Squares	Df	Mean Square	F	Sig.
Woreda	1.674	1	1.674	2.164	.144
Error	81.992	106	.774		
Total	83.667	107			

Table. 42 Between 15 to 60 ages of female members per households.

Source of variation	Sum of Squares	Df	Mean Square	F	Sig.
Woreda	.422	1	.422	.379	.540
Error	127.190	114	1.116		
Total	127.612	115			

Table. 43 Cattle owned per household (last year)

Source of variation	Sum of Squares	Df	Mean Square	F	Sig.
Woreda	.054	1	.054	.006	.938
Error	981.045	109	9.000		
Total	981.099	110			

Table. 44 Small ruminant owned per household (last year)

Source of variation	Sum of Squares	Df	Mean Square	F	Sig.
Woreda	.133	1	.133	.019	.891
Error	836.667	118	7.090		
Total	836.800	119			

Table. 45 Equine owned per household (last year)

Source of variation	Sum of Squares	Df	Mean Square	F	Sig.
Woreda	.287	1	.287	.768	.383
Error	35.917	96	.374		
Total	36.204	97			

Table. 46. Chicken owned per household (last year)

Source of variation	Sum of squares	Df	Mean square	F	Sig.
Woreda	3.333	1	3.333	.696	.406
Error	565.033	118	4.788		
Total	568.367	119			

Table. 47. Age at sexual maturity of hen (month)

Source of variation	Sum of Squares	Df	Mean Square	F	Sig.
Woreda	0.133	1	0.133	0.282	0.597
Error	55.867	118	0.473		
Total	56	119			

Table. 48. Age at sexual maturity of cockerel

Source of variation	Sum of Squares	Df	Mean Square	F	Sig.
Woreda	0.208	1	0.208	0.469	0.495
Error	52.383	118	0.444		
Total	52.592	119			

Table. 49. Number of times the hen hatches in the year

Source of variation	Sum of Squares	Df	Mean Square	F	Sig.
Woreda	0.408	1	0.408	0.956	0.33
Error	50.383	118	0.427		
Total	50.792	119			

Table. 50. Average number of eggs per clutches

Source of variation	Sum of Squares	Df	Mean Square	F	Sig.
Woreda	4.033	1	4.033	1.935	0.167
Error	245.933	118	2.084		
Total	249.967	119			

Table. 51. Average number of days per clutches

Source of variation	Sum of Squares	Df	Mean Square	F	Sig.
Woreda	2.133	1	2.133	0.46	0.499
Error	547.833	118	4.643		
Total	549.967	119			

Table. 52. Average number of eggs per set

Source of variation	Sum of Squares	Df	Mean Square	F	Sig.
Woreda	0.408	1	0.408	0.156	0.693
Error	308.583	118	2.615		
Total	308.992	119			

Table. 53. Number of chicken hatched per batches

Source of variation	Sum of Squares	Df	Mean Square	F	Sig.
Woreda	0.133	1	0.133	0.057	0.811
Error	275.067	118	2.331		
Total	275.2	119			

Table. 54. Hatchability

Source of variation	Sum of Squares	Df	Mean Square	F	Sig.
Woreda	4.07	1	4.07	0.041	0.839
Error	11651.63	118	98.743		
Total	11655.7	119			

Table. 55. Number of chicks surviving to adulthood

Source of variation	Sum of Squares	Df	Mean Square	F	Sig.
Woreda	0.208	1	0.208	0.196	0.659
Error	125.717	118	1.065		
Total	125.925	119			

Table. 56. Distance of market from households' resident (km)

Source of variation	Sum of Squares	Df	Mean Square	F	Sig.
Woreda	104.533	1	104.533	31.57	0
Error	390.667	118	3.311		
Total	495.2	119			

Table. 57. Shank length

Source of variation	Sum of Squares	Df	Mean Square	F	Sig.
Woreda	233.814	1	233.814	373.107	.000
Error	224.347	358	.627		
Total	458.161	359			

Table. 58. Shank circumference

Source of variation	Sum of Squares	Df	Mean Square	F	Sig.
Woreda	61.425	1	61.425	260.873	.000
Error	84.295	358	.235		
Total	145.720	359			

Table. 59. Wingspan length

Source of variation	Sum of Squares	Df	Mean Square	F	Sig.
Woreda	1844.160	1	1844.160	244.727	.000
Error	2697.736	358	7.536		
Total	4541.896	359			

Table. 60. Back length

Source of variation	Sum of Squares	Df	Mean Square	F	Sig.
Woreda	285.013	1	285.013	275.689	.000
Error	370.108	358	1.034		
Total	655.120	359			

Table. 61. Body length

Source of variation	Sum of Squares	Df	Mean Square	F	Sig.
Woreda	1727.011	1	1727.011	240.148	.000
Error	2574.537	358	7.191		
Total	4301.548	359			

Table. 62. Comb length

Source of variation	Sum of Squares	Df	Mean Square	F	Sig.
Woreda	654.177	1	654.177	3372.665	.000
Error	69.439	358	.194		
Total	723.617	359			

Table. 63. Keel bone length

Source of variation	Sum of Squares	Df	Mean Square	F	Sig.
Woreda	49.823	1	49.823	97.722	.000
Error	182.524	358	.510		
Total	232.347	359			

Table. 64. Wattle length

Source of variation	Sum of Squares	Df	Mean Square	F	Sig.
Woreda	619.385	1	619.385	6408.799	.000
Error	34.599	358	.097		
Total	653.984	359			

Table. 65. Body weight

Source of variation	Sum of Squares	Df	Mean Square	F	Sig.
Woreda	.910	1	.910	40.639	.000
Error	8.018	358	.022		
Total	8.929	359			

Table. 66. Egg weight

Source of variation	Sum of Squares	Df	Mean Square	F	Sig.
Woreda	16.875	1	16.875	0.883	0.349
Error	2256.25	118	19.121		
Total	2273.125	119			

Table. 67. Egg length

Source of variation	Sum of Squares	Df	Mean Square	F	Sig.
Woreda	7.033	1	7.033	1.331	0.251
Error	623.301	118	5.282		
Total	630.334	119			

Table. 68. Egg width

Source of variation	Sum of Squares	Df	Mean Square	F	Sig.
Woreda	0.29	1	0.29	0.116	0.734
Error	295.466	118	2.504		
Total	295.756	119			

Table. 69. Egg shell thickness

Source of variation	Sum of Squares	Df	Mean Square	F	Sig.
Woreda	0	1	0	0.596	0.442
Error	0.037	118	0		
Total	0.037	119			

Table. 70. Egg shape index

Source of variation	Sum of Squares	Df	Mean Square	F	Sig.
Woreda	25.172	1	25.172	2.585	0.111
Error	1148.996	118	9.737		
Total	1174.168	119			

Table. 71. Yolk height

Source of variation	Sum of Squares	Df	Mean Square	F	Sig.
Woreda	0.533	1	0.533	0.42	0.518
Error	149.967	118	1.271		
Total	150.5	119			

Table. 72. Yolk width

Source of variation	Sum of Squares	Df	Mean Square	F	Sig.
Woreda	1.971	1	1.971	0.553	0.458
Error	420.356	118	3.562		
Total	422.327	119			

Table. 73. Albumen height

Source of variation	Sum of Squares	Df	Mean Square	F	Sig.
Woreda	0.3	1	0.3	0.523	0.471
Error	67.667	118	0.573		
Total	67.967	119			

Table. 74. Hough unit

Source of variation	Sum of Squares	Df	Mean Square	F	Sig.
Woreda	41.121	1	41.121	.836	.362
Error	5805.746	118	49.201		
Total	5846.867	119			

Table. 75. Yolk color

Source of variation	Sum of Squares	Df	Mean Square	F	Sig.
Woreda	3.333	1	3.333	1.585	.211
Error	248.133	118	2.103		
Total	251.467	119			

7.2. List of figures in the appendix

Table 76: Image of common body colors of indigenous chicken in study area

Table 77: Image of some head shape of indigenous chicken in the study woredas

Crest (Gutya) head | Plain head | Crest (Gutya) head

Table 78: Image of some Comb type of indigenous chicken in the study woredas

Rose comb | Single comb | Rose comb

Table 79: Image of some morphometric traits measurements

Live body | Comb length | Wattle length | Back length | Wingspan length

Table 80: Image of some night enclosure and bedding material in the study woredas

Separate chicken house | Bedding materials