ON FARM ASSESSMENT OF MANAGEMENT PRACTICES, PRODUCTIVE AND REPRODUCTIVE PERFORMANCE AND ON-STATION PERFORMANCE EVALUATION OF NAKED NECK AND NORMAL FEATHERED CHICKEN IN JIMMA ZONE

MSc THESIS

BY

SAHIBUDIN JEBEL

JUNE 2020

JIMMA, ETHIOPIA

On farm Assessment of Management Practices, Productive and Reproductive Performance and On-Station Performance Evaluation of Naked neck and Normal feathered Chicken in Jimma Zone

By

Sahibudin Jebel

A Thesis

Submitted to the Department of Animal Science, Jimma University, College of Agriculture and Veterinary Medicine School of Graduate Studies Jimma, Ethiopia, In Partial Fulfillment of the Requirements for the Degree of Master of Science in Animal Production

Major Advisor: Waseyehon Hassen (PhD. Candidate)

Co-advisor: Ahmed Seid (Assistant Professor, MSc)

June 2020

Jimma, Ethiopia

Jimma University

College of Agriculture and Veterinary Medicine

Thesis Submission for External Defense Request Form (F-07)

Name of Student: Sahibudin Jebel Shehusen ID No. _____

Program of Study _____

Title : On farm Assessment of Management Practices, Productive and Reproductive Performance and On-station Performance Evaluation of Naked neck and Full feathered chickens in Jimma Zone

I have incorporated the suggestion and modifications given during the internal thesis defense and got the approval of my advisers. Hence, I hereby kindly request the Department to allow me to submit my thesis for external thesis defense.

Sahibudin Jebel

Name & signature of student

We, the thesis advisers have verified that the student has incorporated the suggestions and modifications given during the internal thesis defense and the thesis is ready to be submitted. Hence, we recommend the thesis to be submitted for external defense.

	Name	Signature	Date
Major Advisor:	Wasyehun Hassen		10/6/2020
Co-Adviser:	Ahimed Seid		10/6/2020

Only PhD Student

	Name	Signature	Date
Co-Adviser 2 :			10/6/2020

Decision/suggestion of Department Graduate Council (DGC)

_____

_____

Abdo Mohammed Ali

Department of Animal Science

	Signature	Date
Chairperson, DGC		10/6/2020
Chairperson, CGS		

DEDICATION

This manuscript was dedicated to my beloved parents Jebel Shehusen and Zemzem Abafita for nursing me with affection, love and for their dedicated partnership in the success of my life, who passed away without seeing any of my achievements. May the Almighty ALLAH grant His soul with His Blessings and place them in Janna!

STATEMENT OF THE AUTHOR

By my signature below, I declare that this thesis is my own original work and I have not previously in its entirety or part submitted to any institution for the award of any academic degree, diploma or certificate. Thesis is deposited in the Jimma University Library and is made available to borrowers under rules of the Library. I also believe that all sources of materials used for this thesis have been appropriately acceptable. In all other instances, however, permission must be obtained from the author of the Thesis.

Name: Sahibudin Jebel Signature: _____

Date of Submission: _____

School/Department: Animal Sciences

BIOGRAPHICAL SKETCH

The author was born on June, 1988 at Jimma Zone of Oromia National Regional State Sokoru district. He attended his elementary school at Basso elementary school and then he attended his junior secondary school at Kera junior School. Then he attended his senior Secondary High School at Jiren Secondary school. After successfully passing Ethiopian School Leaving Certificate Examination (ESLCE), he joined Alage Agricultural TVT collage in 2005 and awarded Diploma in Animal science on June 2007.

Soon after his graduation, he was employed at Jimma Zone Sokoru district Livestock and Fish Resource Development Office and serves as development agent and supervision from July 2007 to August 2009. He then joined Jimma University in 2010 and awarded B.Sc. in Animal Science on June 2011.From August 2011 to December 2018 he was employed at Jimma zone Sokoru district at Sokoru Livestock and Fish Resource Development Office and served as animal science Expert, extension group team leader and Office leader position. Then in 2018, he joined Jimma University School of graduate studies for the degree master of science in Animal Production.

ACKNOWLEDGEMENT

First of all, I would like to praise the Almighty ALLAH for his priceless gift of full health, strength, patience, hope and protection throughout my study.

This study would not have been real without the honest and valuable support, guidance, and encouragement of advisors, friends, families and institutes. I would like to express my deepest thanks to my major advisor Mr. Waseyehon Hassen and co-advisors Mr. Ahmed Seid for their demonstrative guidance, comprehensive advice, and encouragement from the beginning of the idea to the end of the study. They contributed patience to me and life to my thesis.

I am strongly grateful to the Government of Oromiya National Regional State (GONRS) for offering the opportunity to follow my M.Sc. study. I would also like to thank Jimma University College of Agriculture and Veterinary Medicine (JUCVAM) for making conducive environment for learning process. Special thanks also for my friend Taju Siraj for his help in providing important articles and guidance during the proposal and thesis writing.

Finally, I would like to thank my beloved wife Foziya Kemal, for her boundless support and encouragement right from the beginning of my M.Sc. study and all my sisters and brothers for their uninhibited and incalculable love and moral support.

LIST OF ABBREVIATIONS

AH	Albumen Height
ANOVA	Analysis of Variance
ANRO	Agriculture and Natural Resource Office
Cm	Centimeter
CRD	Completely Randomized Design
CSA	Central Statistical Agency
EW	Egg Weight
FAO	Food and Agriculture Organization of the United Nations
FCR	Feed Conversion Ratio
NF	Normal feathered
FGD	Focus Group discussion
gm	Gram
GDP	Gross Domestic Product
GLM	General Linear Model
HDEP	Hen Day Egg Production
HH	Households
HU	Hough Unit
JZANRO	Jimma Zone Agricultural &Natural Recourse Offices
SWLFRDO	Sokoru Wareda Livestock and Fish Resource Development Office
SWLUAO	Sokoru Wareda Land Use and Administration Office
MDBWG	Mean Daily Body Weight Gain
MDFI	Mean Daily Feed Intake
Mm	Millimeter
NN	Naked neck
NCD	Newcastle Disease
NLH	Non-laying hens
SAS	Statistical Analysis System
SE	Standard Error
SPSS	Statistical Package for Social Science
TEC	Total Egg Collected
TFI	Total Feed Intake
USAID	United States Agency for International Development
YI	Yolk Index

TABLE OF CONTENT

Contents

LIST OF TABLES

LIST OF APPENDIX

LIST OF FIGURE

On farm assessment of management practices, productive and reproductive performance and on station performance evaluation of naked neck and normal feathered chicken in Jimma Zone

ABSTRACT

The study was conducted in Jimma Zone of sokoru district to investigate the status of naked neck and normal feathered chicken followed by on station evaluation of their performance from December, 2019 to March, 2020 at Jimma University College of Agriculture and Veterinary Medicines. For on farm assessment a total of 285 households were included. Data on flock size, management practice, and productive and reproductive performance were collected by questioner. A total of 150 day old chicks (75 chicks from each genotype) were hatched for experimental study. Data were collected on hatching weight, body weight, final body weight gain, feed intake, age at first mating and age at first egg laying, egg production, carcass characteristics and external and internal egg qualities. The on farm assessment result revealed that; the overall mean flock size of chickens per household for naked neck was 4.6 while for normal feathered was 10.6. Less market reference is stated as a major reason for less availability of naked neck. Regarding the average age at first egg laying, mean number of clutches, egg production per year per hen and disease and stress resistance ability the naked neck ecotype was significantly higher than normal feathered chickens. However, household interviewed prefer meat from normal feathered chicken than the naked neck once. Correspondingly, the on station result of this study pointed out that, in hatching weight, body weights at all growing stages, average daily body weight grain and feed conversion efficiency the naked neck chicken was higher than the normal feathered. With respect to egg quality parameters, the naked neck chicken significantly ($P \leq 0.05$) higher in egg weight (48.4gm), albumen width (57.67 mm), albumen height (5.14 mm), albumen weight (26.42 g), yolk weight (16.10 g), yolk height (17.41 mm) and Hough Unit (75.07mm) while normal feathered eggs recorded highest in egg length (5.41cm) and albumen length (7.11 mm) only. Likewise, the naked neck had significantly higher ($P \leq 0.05$) dressing percentage (73.61) than normal feathered chicken (67.44). In conclusion, the naked neck was superior to those normal feathered chicken in disease and stress resistance ability, productive and reproductive traits while this ecotype was recognizes as less preferred at market which might be due to their physical appearance, cultural taboo and less availability to the market. As a result, creating awareness to change the cultural taboo, increasing the flock size, and enhancing the availability of the naked neck to the market could be ideal decisions to increase the efficient use of this resource. Furthermore, further research is recommended to evaluate their performance in different agro ecologies and conservation should be necessary to maintain the sustainability of those naked neck chickens.

Keywords: On-Station Evaluation, Performance, Naked neck, Normal feathered

1. INTRODUCTION

Agricultural development is considered as a main concern by the government of Ethiopia for inspiring overall economic growth, reducing poverty and achieving food security (Shapiro *et al.*, 2017). Thus, the agricultural sector contributed a significant importance to the country with about 42% of GDP and between 80–85% of employment. In the same manner, the livestock subsector also provides an opportunity for further development that directly contributes 17% and 39% of total and agricultural GDP (Shapiro *et al.*, 2017), respectively, 60-70% livelihoods of the population (USDA, 2016). Poultry production, as one segment of livestock production has a peculiar privilege to contribute to the sector due to their small size, fast reproduction, limited competition for scarce land resources and eco-friendly nature, compared to most other livestock, and their fitness to the concept of small-scale agricultural development (Mekonnen, 2007). In most tropical countries, mainly the scavenging production systems make substantial contributions to household food security (Muchadeyi *et al*., 2007).

Indigenous chickens play a key role to sustain the livelihood in developing countries by providing immediate income source and improving the nutritional status. Similarly, they are the primary affordable nutrient of animal protein source since they cannot inquire the cost of small and large ruminants' price (Melesse, 2014). Additionally, the indigenous breeds contribute significantly to poultry meat and egg production and consumption in developing countries (Aberra *et al.*, 2013). Furthermore, small farming families, land-less laborers and people with incomes below the poverty line were able to raise village birds with low inputs and harvested the benefits of eggs and meat via scavenging feed resources (Sonaiya, 2005). As a result, these chickens have been reported to adapt very well to the traditional small-scale production system of the rural community (Fisseha *et al, 2010a*; Aberra and Tegene 2011). Moreover, indigenous chicken is known to possess desirable characteristics such as thermo-tolerance, resistance diseases, good egg and meat taste, high fertility and hatchability as well as high dressing percentage (Aberra, 2000. Mostly, chicken production represents a significant part of the national economy of Ethiopia (Aberra, 2000). However, the economic involvement of the sector is still not comparative to the huge chicken numbers, attributed to the presence of many technical, organizational and institutional constraints. Likewise, in the

entire developing world, this traditional chicken production was characterized by their low-input, low output poultry-husbandry systems (Besbes, 2009).

According to CSA (2018), the chicken population of Ethiopia is being estimated about 56.06 million of heads. Out of these 88.19, 6.45 and 5.36% of the total poultry population were indigenous, hybrid and exotic, respectively. The indigenous chicken are considered as gene reservoirs of the future populations in the country, hence the CSA (2018) report indicated most of the chicken population was local ones. Correspondingly, the indigenous full feathered chickens have evolved many unique and interesting features, that allowing them to adapt and radiate into various ecological niches. They display a great degree of diversity in feathers and other body parts (Abdulkadir, 2015). Likewise, feathers provide insulation in cold weather but inhibit heat loss in hot weather. Fully feathered chickens have a well-covered body, which protects them from losing body heat in cold weather (Cahaner *et al*., 2008). Thus, under warm conditions, birds do not reach their full genetic potential for growth, body weight and egg production because the feathers hinder dissipation of excessive heat produced internally (Cahaner *et al.*, 2008).

On the other hand, those naked neck(Na) are described as one of the major genes in local chickens of the tropics that are considered to have desirable effects on heat tolerance and produce increased quantities of egg (Akhtar Uz-Zaman, 2002). In other study, Garces *et al.*, (2001) and Younis and Galal, (2006) reported that the naked-neck birds also reached sexual maturity earlier when compared with the full feathered birds. Additionally, they were found to be better in body weight than those of other indigenous chickens (Aberra and Tegene, 2011). Likewise, Njenga (2005) and Islam and Nishibori (2009) also recognized that among the indigenous birds the naked neck was superior in terms of body weight, egg weight, eggshell thickness, egg production and survivability. Moreover, the naked neck genotype was more suitable for the tropical climatic conditions and their superiority was greater with increasing heat stress (Mathur, 2003); where, the naked neck nature of those chickens was due to presence of "*Na"* gene that reduces feather coverage around the neck region and facilitates body heat dissipation during hot weather (Deeb and Cahaner, 2001). Thus, those chickens carrying this gene are likely more beneficial in the lowland areas of the country where the

heat stress situation could be a major problem for small-scale poultry production (Aberra and Tegene, 2011).

Although, those naked neck chickens are known by their superior productive, reproductive and disease resistance ability of chicken ecotypes for traditional production systems, there are no detailed studies conducted in the study area. Likewise, there is a limited number of research works done in case of on station evaluation and comprehensiveness of the past studies that means working both on farm and on station evaluation of both ecotypes. Moreover, the few research and development projects carried out were unsatisfactory and failed to meet their objectives to improve the population, reproduction and production potential of this indigenous chicken. As a result, appropriate information and proper documentation will play a vital role to improve the drawbacks. Consequently, clearly identifying and documenting the detailed information on the performance of these ecotypes under on farm and on station management conditions is the crucial task to overcome the problems. Therefore, the current study was designed to assess management practices, productive and reproductive performances of naked neck and normal feathered chickens and evaluation of their performances under on station management condition.

Research question

- What are the management practices for naked neck and normal feathered chicken in Sokoru district?
- Do the productive and reproductive performances of naked neck and normal feathered chicken under farmer's management conditions different?
- Do the productive and reproductive performances of naked neck and normal feathered chickens differ under on station management conditions?

2.1. Objectives

1.1.1. General objective

- To assess on farm management practices, productive and reproductive performance of naked neck and normal feathered chickens and to evaluate their performance under on station management condition.

1.1.2. Specific objective

- 🕮 To identify management practices for naked neck and normal feathered chickens under village production system in Sokoru districts.
- 🕮 To assess productive and reproductive performances of naked neck and normal feathered chickens under village production system.
- 🕮 To evaluate productive and reproductive performances of naked neck and normal feathered chickens under on station management condition.

2. LITERATURE REVIEW

2.2. Poultry population and distributions in Ethiopia

Poultry include all domestic birds kept for the purpose of human food production (meat and eggs) such as chickens, turkeys, ducks, geese, ostrich, guinea fowl and doves and pigeons. In Ethiopia ostrich, ducks, guinea fowls, doves and pigeons are found in their natural habitat (wild) whereas, geese and turkey are exceptionally not common in the country. Thus the word poultry population is synonymous with chicken population under the present Ethiopian conditions (Halima, 2007).

According to Tadelle *et al.* (2003), family chicken production is a suitable system that makes the best use of locally available resources. In sub-Saharan Africa, 85% of all households keep chicken under free range/extensive system, with women owning 70% of it, providing scarce animal protein in the form of meat and eggs for human consumption as well as a consistent source of cash income (Sonaiya and Swan, 2004; Abubakar et al. 2007). About 99.27 % of the chickens are managed under a traditional or extensive chicken management system in northern parts of Ethiopia (Halima, 2007). Relatively latest estimate show there are about 60 million chickens in the country of which 94.3% are local chickens (CSA, 2015/2016) indicating the significance of local chickens as potential Farm Animal Genetic Resources in the country. According to CSA (2017), the chicken population of Ethiopia is being estimated about 59.49 million of heads. Out of these 90.85, 4.39 and 4.76% of the total poultry population were indigenous, hybrid and exotic, respectively. In Ethiopia indigenous chicken represents a significant part of the national economy in general and the rural economy in particular and contribute to 98.5% and 99.2% of the national egg and chicken meat production, respectively (Aberra, 2000).

There is no recorded information indicating the exact time and locations of introduction of the first batch of exotic breeds of chickens into Ethiopia. It is widely believed that the importation of the first batch of exotic poultry was probably done by missionaries. Meanwhile, four breeds of exotic chicken (Rhode Island Red, Australop, New Hampshire and White Leghorns) were imported to Jimma and Alemaya (now Haramaya) in 1953 and 1956, respectively under USAID project (Solomon, 2007). On behalf of thus, the Ministry of Agriculture established

several exotic chicken breeding and multiplication centers at different parts of the country to enhance the national poultry extension activities. As indicated in table 1, the population of indigenous chickens for all flock type revealed that there is greater opportunity of using by exploiting their best performances where naked neck as one of the local ecotype are the Nobel opportunity to use improve the production and productivity of Ethiopian poultry production.

Table 1: Estimated number of chickens in Ethiopia

Types of chicken	Total chickens		Indigenous		Exotic		Hybrid	
	Number	%	Number	%	Number	%	Number	%
Cocks	5,842.973	9.82	5,282,575	8.88	258.287	0.43	302,11	0.51
Cockerels	3,296,265	5.54	2,997,315	5.04	101,860	0.17	197,090	0.33
Pullets	16,246,339	10.5	5,416,423	9.1	436,711	0.73	393,205	0.66
NLH	1,628833	2.74	1,506,439	2.53	58,759	0.1	63,636	0.11
Chicks	22,568,284	37.93	21,498,960	36.14	239,614	0.4	829,758	1.39
Laying hens	19,912,284	33.47	17,352,213	29.17	1,515,251	2.55	1,044,820	1.76
Overall	59,495,026	100	54,053,925	90.85	2,610,482	4.39	2,830,619	4.76

Source: CSA (2017). NLH: non laying hens

2.3. Chicken flock demography

In Ethiopia, the number of chicken flocks per household in most rural communities is small; constituting an average of 7–10 mature chicken, 2–4 adult hens, a male bird (cock) and a number of growers of various ages (Tadelle and Ogle 2001). Similarly, a number of mean flock size were reported by different authors like Asefa (2007), Mekonnen (2007), Azage *et al.* (2010) and Melese (2014) that reported 8.8 in Awassa Zuria, 9.2 Dale Woreda, 13 and 12 in Bure and Fogera woreda and 13 chickens in East Gojam zone of Ethiopia, respectively. More recently, the study conducted by Taju (2017) also revealed that 10.28 of chicken per household. As a result, the flock demography of chickens in Ethiopia indicated that, there is a great variation between households in different areas of the countries. Correspondingly, the average flock size of African village household also reported about the range of 5 to 20 fowls.

2.4. Feed resource and feeding of chickens

The smallholder free range scavenging production is the most commonly practiced type of village poultry production system in Ethiopia. In many developing countries chicken

production is based mainly on traditional extensive production systems with local chicken ecotypes and low purchased-inputs (Gueye, 2000 and Garcia, 2007). The feed resource base for village flock was reported to be scavenged material from the immediate environment, food left over and small amount of grain provided by the house wife (Tadelle *et.al,* 2001; Desalew, 2012). The birds scavenge from morning to evening except around midday in hot sunny condition and on very rainy days (Tadelle, 2001). Provision of other inputs such as housing, additional feed and health care vary considerably among and within regions depending on the socioeconomic circumstances of the farmers (Halima, 2007; Melikamu, 2013).

The type and amount of supplemental feed provided for local chicken are variable since it depends on season and type of agriculture (Melikamu, 2013). Provision of feed to chicken was practiced by 97.5% of respondents in Bure district of North West Ethiopia (Moges *et al*., 2010) and 97.23 % of respondents in Sokoru district of Jimma zone (Mengesha *et al*., 2011). Similarly, Meseret (2010) also reported about 50%, 25% and 25% of respondents that offered supplementary green materials, homemade and scavenging on top of purchased commercial poultry ration to their chickens, respectively, in Gomma woreda of Jimma zone. Moreover, almost all (99.28 %) of the farmers in Northwest Ethiopia provided supplementary feeding to their chickens and different age groups were fed together.

Generally, feeds and feeding systems have a potential for intervention since the majority of the farmers practiced supplementary feeding with locally produced feeds (Mapiye and Sibanda, 2005). The scavenging feed resource should cover at least to their maintenance need plus the first 40 to 50 eggs, and is a system that makes the best use of source of food resource, which otherwise be wasted (Tadelle, 2003). Melese *et al*. (2014) also pointed out that although the supplementary feed is not satisfactory in terms of quality and quantity still of supplementing their chicken was done in order to improve the productivity performance.

2.5. Housing

Some of households who own indigenous chickens construct separate poultry houses as a small enclosure outside the house outside the house, and the poultry night shelter is occasionally cleaned by the house wife, depending on her work load, but such houses in have no proper ventilation and light or other facilities (Maleku, 2016; Taju, 2017). However, some

of chicken owners also keep their chicken at various night sheltering places in the main house including perches inside the house and perches in the kitchen. These sites are obviously the most secure overnight locations to avoid predators and theft. Moreover, the finding of different authors recognized that the provision of special house for traditional poultry keeping is not usual in most developing countries including in Ethiopia.

2.6. Disease and predation

According to Mekonnen (2007) the indigenous flocks are said to be disease tolerant and adapted to their habituating environment. But, the survival rates of the Ethiopian indigenous chicks kept under natural brooding conditions were considered low. Another study conducted in all zones of Southern Nation Region (Aberra and Tegene, 2011) indicated that the major problems of poultry production in the study areas were; Fowl Cholera (28.8%), New Castle Disease, Coccidiosis, Fowl influenza (Infectious Bronchitis) (15.4%), Fowl pox (3.4%), Fowl typhoid (3.4%) and Salmonella (1.4%). The prevalence of fowl cholera was considerably higher in the mid-altitude while fowl typhoid was a major problem in low altitudes accounting for the overall mortality. According to Hunduma *et al* (2010) most of the time the occurrence of these diseases is seasonal where the highest chicken death rate was observed during the rainy season (June to August) (80%) followed by March to May (14.4%).

Likewise, Halima (2007) reported that diseases and predators were the first and the second major factors that cause loss of chicken in North West Ethiopia. The major predators which cause loss of chicken were cat and Wild birds in east Gojam zone (Melese and Melkamu, 2014). Solomon *et al.* (2013) reported that both incidences of chicken disease and predator attacks were found to be higher in the wet season (May to November) than in the dry season (October to April).

2.7. Productive and reproductive performances of indigenous chickens

Local chickens are kept in many parts of the world irrespective of the climate, traditions, life standards, religious taboos relating to consumption of eggs and chicken meat like those for pig meat. Studies by Tekleweld *et al*., (2006) and Nigussie *et al.,* (2010) indigenous chickens comprise about 80% of the national flocks in Africa and Asia. Traditional poultry production

in Ethiopia represents a significant part of the national economy in general and the rural economy in particular, and contributes 83.5% of the national egg and meat products (CSA, 2016).

According to Muchadeyi (2007), Mwacharo *et al*. (2007) and Halima (2007) biodiversity of indigenous chickens in many parts of Africa revealed the presence of high genetic variability between and within populations, thereby revealing the potential for genetic improvement of these chickens through selective breeding. Studies undertaken in different parts of the country indicated variability in productivity between and within populations. For instance, the average numbers of egg production/hen/ clutch and mean annual egg production/hen in north Wollo were 12.6 and 49.5 respectively (Addisu, 2013). Likewise, Meseret (2010) and CSA (2016) reported that the mean egg number per hen per clutch was 12.92 and 12 (national average of egg production per hen per clutch), respectively. Generally, the average annual egg production of indigenous chicken ecotype under extensive management condition ranges from 30 to 60 eggs, however, it might be improved to 80-100 eggs on station with improved management (Nigussie and Ogle, 2000; FAO, 2004; Aberra and Tegene, 2011). This improvement of indigenous chicken productivity might be attributed with improvement of exposure to risks that influence their survival and productivity under extensive management.

The report by Gueye, (2000) indicated that the adult weight of male and female African village chicken range from 3.2 to 1.2 kg respectively. Local male may reach 1.5 kg live weight at 6 months of age and female about 30% less. An indigenous chicken in Ethiopian weighs 1.25 kg at slaughter age in village management condition (GAIN, 2017). Similarly, Mekonnen (2007) reported that the mature body weight of cocks and hens at farmer's management condition in Wonsho, Loka abaya and Dale districts of Southern Ethiopia were 1.58kg and 1.30kg, respectively. Moreover, birds reared under extensive systems perform poorly because they face many challenges such as insufficient feed, poor quality feeds, high ambient temperatures, high light intensity and also long distances walked while searching for feed. In addition, Kingori et al., (2010) indicated that under extensive management system local chickens perform poorly with low body weight gain mostly because of the harsh condition of this system characterized by low quantity and poor quality of feeds.

Similarly, Halima (2007) recognized that the percentage of fertile eggs and hatchability percentage of the fertile eggs for chickens managed under intensive conditions ranged from 85.1 to 100 % and 50 to 80.3 %, respectively. Additionally, this author reported the eggs laid by the scavenging birds had fertility and hatchability percentage ranging from 53.1 to 69.3 and 60.7 to 82.1, respectively. The above result shown that, the percentage variation is the best solution to improve those traits. In similar manner, Kayitesi (2015) and Abalaka *et al.* (2013) also reported the higher mortality rate for extensive system than in intensive management system. As a result, variation in management condition (like on farm and on station management condition) significantly affect the productive and reproductive performance of indigenous chickens.

2.8. Trait preference of chicken producers

Study conducted in different parts of country informed that the influences of morphological appearances, particularly plumage color and comb types are significantly important for price variations of the marketable chicken of various chicken-ecotypes (Mammo *et al.,* 2008; Bogale, 2008; Fisseha, 2009). In the same way, the marketable chicken both male and female of red and white plumage colors with pea shaped comb types have always 15 to 35% higher price values than those similarly matured chicken but endowed with neither of the combinations of such qualitative traits. Similarly, chicken ecotype has effect on the preference of producers and consumers. Both producer–sellers and intermediary traders attached less preference for naked neck chickens at all by the society in a country (Mammo M. and Wude T., 2011). Similarly, around 41.26% producers and 46.03% consumers disliked naked neck chickens due to their superstition, dull and sickly appearance, lower disease resistance, generally rarity, shortage of roosters, and higher feed requirement in Bangladesh (Ahmed F., *et al*., 2012). Additionally, Aberra and Tegene (2011) reported that consumers in urban markets have neglected live chickens carrying Na gene because of cultural reasons that are possibly linked with the absence of feather coverage around the neck region.

On the other hand, the preference of naked neck chickens was 58.73% for producers and 53.96% for consumers due to their better appearance, larger size, exotic looks rarity, larger egg size and high vigor. In addition, Duah (2016) reported that among three indigenous

chicken genotypes studied, the naked neck was preferable to the other genotypes due to its high meat proportion, meeting the preference of those consumers looking for chicken in this niche market. Consequently, it is strongly recommended that there should be a conscious effort to develop and commercialize the naked-neck birds in Ghana.

2.9. Egg quality traits

According to Bain (2005), it is evident that beneficial egg quality traits are of enormous importance to poultry breeding industries. Besides, embryonic development of hen's egg is dependent on traits like egg weight, yolk and albumen weights and age of the hen (Onagbesan *et al*., 2007). The overall quality of the chicken egg is determined by the egg external and internal qualities. Both of them are of paramount importance to the egg industry (Roberts, 2004). The appearance of the egg is important for consumer appeal. In fact, egg shell quality is based on egg size, egg specific gravity, shell color, shell breaking strength, shell deformation, shell weight, percentage shell, shell thickness and shell ultra-structure (Roberts, 2004).

2.9.1. External egg quality

As reported by Bain (2005), the external quality of the egg is determined by features such as the size and shape of the egg as well as the structure, thickness and strength of the shell, which are highly affected by breed of chicken, age of chicken, level of nutrition, stress, prevalence of disease, the type of chicken production system. Adedeji *et al. (*2015) reported that the Naked neck eggs had highest egg weight (44.86g), egg length (7.03mm) and yolk weight (14.57mm) than its counterpart genotype in Nigeria. Aberra *et al.* (2005) reported an average egg weight of 42g and 49g for Ethiopian naked neck chicken and their F1 crosses with New Hampshire breeds, respectively, reared under improved management conditions. The Ethiopian naked-neck chickens under intensive management produced eggs with an average weight of 44.4 g (Aberra, 2000). Similarly Njenga *et al.* (2005) reported that the Naked neck produced significantly heavier eggs (45.8 g) compared to eggs produced by the Normal feathered (42.5) birds from four agro ecological zones in the tropics.

According to the findings of Welelaw *et al.* (2018) the mean shell thicknesses was 0.33(mm) for indigenous chickens reared under traditional management system in Ethiopia. Desalew et al. (2015) also reported 0.31(mm) average shell thicknesses in East Shewa, Ethiopia. Similarly, Melesse et al. (2010) reported that, shell thickness value of (0.37 mm) in Ethiopian Naked neck chickens reared under improved production system. On the other hand, Fisseha et al. (2010) reported shell thickness of (0.26 mm) in northwestern Ethiopia whereas.

2.9.2. Internal egg quality

According to Tugcu (2006), the food products from villages, which are particularly advertised as natural and fresh, are in the focus of consumers' preferences. Besides, the positive effects of eggs, which are not produced under suitable conditions or are not consumed, when they are fresh can cause severe health problems (Avan and Alisarli, 2002). Extended storage time and higher storage temperature decrease the albumen height, and thus degrade the internal quality of the egg (Scott and Silversides, 2000; Raji *et al.*, 2009). The management and nutrition of the hen do play a role in internal egg quality, egg handling and storage practices do have a significant impact on the quality of the egg reaching the consumer (Gerber, 2012).

As reported by Welelaw *et al.* (2018) the mean albumin weight was 23.1 (gm) for indigenous chickens reared under traditional management system in Ethiopia. Likewise, Chatterjee et al. (2007) found albumin weights of (23.46-26.67 gm) in indigenous fowls of Andaman Albumin weight ranged from 28.6-31.1 gm was reported by Niranjan *et al.* (2008) in rural varieties developed for backyard poultry. On other hand, Rajkumar *et al*. (2009) reported yolk weight of (17.05 and 17.78 gm) in naked neck and normal feathered chickens in India. Yakubu *et al.* (2008) also reported yolk weight of (16.95 gm) in naked neck birds. However, Islam et al. (2001) observed (13.1gm) yolk weight in naked neck birds. According to the finding of Melesse *et al.* (2010) yolk height of indigenous naked neck chicken. Was (16.9 mm). Rajkumar *et al*. (2009) also found that the yolk height of (14.24 and 4.98mm) for naked neck and normal feathered chicken in India. In contrary, Meseret (2010) reported 11 mm yolk height for fresh eggs and 9.1 for market purchased eggs in Northwest Ethiopia.

2.10. Carcass characteristics

According to Owens *et al*. (2000), the poultry carcass can be described as the empty body of the chicken post slaughter which is used for eating purposes or further processing. The yield of edible parts can be described as the relative contributions of portions, namely the breast, leg (drumstick), thigh and wing, to the total carcass weight. In short, carcass composition is effectively described by the dressing%, portion percentage yields, and dissection characteristics of the portions (Zhao *et al.*, 2012).

Chickens of different strains of broiler showed significant ($P<0.05$) difference in terms of carcass weight (Karima and Fathy, 2005). Similarly, Nakarin et al. (2014) reported significant difference between three chicken breeds in Thailand. Franco et al. (2012) reported that carcass weights clearly differ between two genotypes due to the lower growth rate of one of the breed. However, Jaturasitha et al. (2008) reported no significance difference ($P>0.05$) in carcass yield of four indigenous chickens. Management system of birds is one of the factors which influence the performance of chickens and their meat characteristics (Kayitesi, 2015). However, Dou et al. (2009) reported that no difference in eviscerated carcass, breast and thigh percentages among three raising systems. Similarly, Sanka and Mbaga, (2014) reported there was no difference between intensive and semi intensive systems on breast, thigh and drumstick meat of local chicken was also reported in Tanzania. Likewise, Kgwatalala *et al.* (2013) reported the naked-neck males of indigenous Taswana chickens had the highest weights for the all carcass parameters (primal cuts and giblets weight) investigated, followed by the normal males. More recently, Welelaw *et al*. (2018) also reported the average slaughter weight, dressed carcass yield and dressing percentage of adult male indigenous chicken was about 1449gm 966gm and 66.7%, respectively under traditional management system in Ethiopia.

3. MATERIALS AND METHODS

3.1. Study area description

The on-farm study was conducted in Jimma zone at Sokoru district. Geographically, Sokoru district is found in Oromia Regional State, Jimma Zone at about 100 km East of Jimma town and 255 km southwest of Addis Ababa. The altitude of the study sites was 1,183 to 1,550 m above sea level (SWLUAO, 2017). The district is located between 7° 55'-7°.92' N latitude and 37° 25' -37°.42' E longitude (CSA, 2010). Maximum and minimum temperature of the district was 28.3ºC and 12.1ºC respectively while the average annual rainfall was 1,458 mm. It has 40 kebeles administrations; 37 located in rural kebeles and 3 urban kebeles (JZLUMO, 2017). The total poultry population of the district is 156,686 out of this about 96.9% were local chickens (SWLFRDO, 2010). The observed proportion of naked-neck chickens of the district were 3.1% of chicken population (Taju, 2017).

The on-station experiment was conducted at Jimma University College of Agriculture and veterinary medicines' poultry farm. An experimental study was conducted between December 2019 to March, 2020 at Incubation and Brooding house of poultry farm of Jimma University College of Agriculture and Veterinary Medicines (JUCAVM). It has an altitude of 1710 meter above sea level and receives a mean annual rainfall of about 1819.8mm. The annual mean maximum and minimum temperature 31.5 and 8.5°C respectively (NMA, 2015).

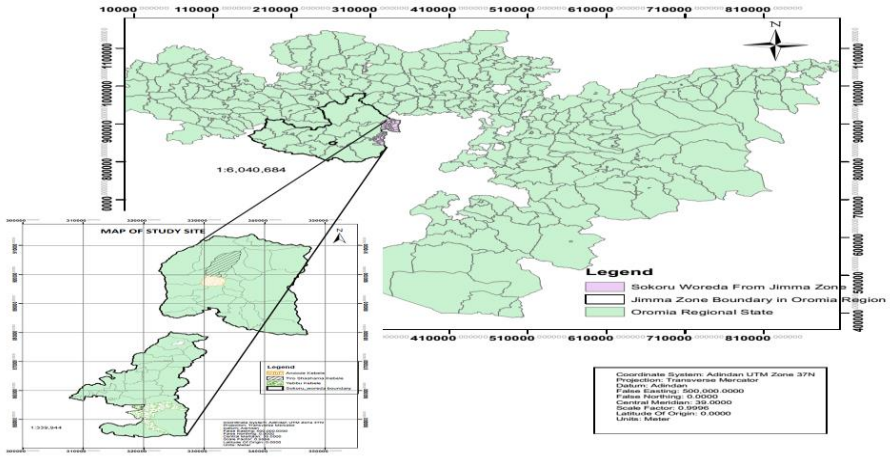

Figure 1: Map of study area

3.2. Assessment of management practices, productive and reproductive performances of naked neck and normal feathered chickens in Sokoru district

3.2.1. Sampling techniques and Sample size determination

The study district was selected purposively based on the availability of naked neck and normal feathered chicken. Before the start of the survey, discussion was made with Sokoru district Livestock and Fishery Resource Development Office to identify kebeles which have large naked neck and normal feathered chicken population. Accordingly, three representative kebeles (Shashema, Handode and Yebbu) were selected purposively. Then, farmers in each selected kebeles were grouped in to two categories (farmers which have naked neck and normal feathered chicken and which have not). The total number of sample households was determined by using the formula used by Yemane (1967) as follow:

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

Where:

n=required sample size

N= total of the household's numbers in three kebeles/ population size (992)

e=level of precision (0.05)

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

Sample size (n) $= \frac{992}{1+992(0.05)^2} = \frac{992}{1+992(0.0025)} = \frac{992}{3.48} = 285$

Thus, a total of 285 households (95 respondents from each selected kebele) were included for this study.

3.2.2. Data sources and data collection methods

Both primary and secondary data were used to achieve the objectives of the study. Semi-structured questionnaire was used to collect data from primary source which mainly comprised of households and development agents. Secondary data was obtained from reports

of Zonal and District Livestock and Fishery Resource Development Office, published and unpublished materials prepared by different governmental and nongovernmental organizations. Finally, data on poultry population and flock structure, management practices followed, breed preference and productive and reproductive performance (number of clutches, age at first egg and age at first mating, egg production etc…) were collected using the questionnaires prepared to collect the data. Group discussion (FGD) was used to undertake informal discussion with groups composed of key informants like; development agents, experts of Livestock and fishery Development Office, elders, women delegates, youth delegates and model farmers who have naked neck and normal feathered chicken.

3.2.3. Data types for survey

Household socio-economic characteristics: Sex, age, family size and education level were collected.

Chicken production and management system: Data on availability of naked neck and full feathered chicken, chicken flock characteristics, disease and stress resistance ability, feeding, housing, watering, ecotype preference to rear, population trends and over all constraints chicken production.

Reproductive and productive performance: such as age at first mating, age at first egg, average length of inter clutch period, average length of single clutch, average number of eggs per clutch, clutch interval, egg production, clutches per year, fertility and hatchability of eggs, survivability(mortality) of chicks.

3.3. On-station performances evaluation of naked neck and normal feathered chickens

3.3.1. Sources of experimental chickens

For this study, a total of 90 chickens (45 chickens of each ecotype) for the parent stock were purchased from study sites (from Shashema, Handode, and Yebu of sokoru district) and kept for one month for environmental adaptation. These birds were maintained in a wire-mesh partitioned deep litter pens by having appropriate male to female ratio of 1:5 males to females

of both ecotype. Each pen was properly cleaned and disinfected and provided with laying nests.

Following their environmental adaptation, the experimental fertilized eggs were collected in egg trays twice a day. All collected eggs were stored at temperature 10-13^{0}c with their broad ends up for 10 days. A total of 300 fertile eggs (150 eggs of each ecotype) were collected and incubated at JUCAVM hatchery units for hatching of experimental chicks. The incubation temperature, humidity and turning device was adjusted according to the recommendations of the manufacturer. Candling was done on the 7th and 18th day of incubation. Prior to transfer of eggs from the setter to the hatchery (i.e., at day 18), hatchery trays were well cleaned, disinfected and partitioned to prevent chicks from mixing during the hatching process.

3.3.2. Experimental design and chicks management

A total of 150 day old chicks (75 chicks for each ecotype) of naked neck and normal feathered chicks were hatched in JUCAVM hatchery and transferred to the brooder house. The chicks were individually weighed and each of the two ecotypes was divided into 3 groups (replication), each with 25 chicks. Completely randomized design (CRD) was used since the populations were homogenous.

Table 2: Layout of the experiment design

Treatments (ecotype)	No. of chicks /Treatments	No. of Replication	No. of chicks /Replication
Naked neck /Treatment 1	75	3	25
Normal feathered/Treatment 2	75	3	25
Total	150		

The chicks were placed in 6 separate pens and vaccinated against some common diseases at recommended application and clean water was made available at all times. Starting from the age of 20 weeks, the male and female chickens with the ratio of 1:5 chickens from each group (replication) were selected and randomly assigned to six (6) individual pens with a laying nest using the same experimental design and experimental housing as used for the growing period. The chicks were provided with standard commercial starters; grower's and layer's ration purchased from the Kality animal feeds processing plant at brooding, grower and layer stages

respectively. In addition, at the age of 24 weeks, a total of 18 male Birds (9 birds from both ecotypes) were selected and slaughtered to measure their carcass characteristics.

3.3.3. Experimental data types

For both groups of ecotype (naked neck and normal feathered) relevant information on productive and reproductive performance of chickens were collected. The data collected included hatching weight, gain per bird per day, final body weight, daily and cumulative feed intake, feed conversion ratio, age at first mating, age at first egg, total collected eggs, hen day production (HDP%) and mortality rates of chicks were recorded to determine the production performance of the experimental chicks.

Hatching weight of chicks was taken individually and body weight taken at weekly and then, at fifteen (15) days interval. Cumulative feed intake (pen, weekly) and mortality rate was recorded from day one to 48 week's duration. Body weight gain was calculated as a difference between final body weight of birds and day old chick weight. Average daily weight gain calculated as difference of initial body weight and final body weight (difference between weights measured in consecutive measurements). Feed intake per bird per day was the difference between total feed intake and feed refused divided number of live birds. Data on growth performance was summarized at week 8, 16, and 24 on all chickens in a pen during the growing period (0-24 weeks) on station. Egg number produced by each chicken was recorded every day. Hen day egg production (HDEP) in percent is calculated as described by Mussawar *et al.* (2004), using the following formula:

$$\text{HDEP}=\frac{\text{Number of eggs laid/day}}{\text{Number of live hens in a pen}}\times 100$$

3.3.4. Egg quality determination

A total of 270 eggs (135 eggs per ecotype) of eggs were collected for evaluation of both external and internal egg qualities. The external egg quality traits studied included egg weight, egg shell weight, shell thickness and egg shape index. The internal egg qualities included albumen weight, albumen height, albumen width, albumen length, yolk weight, yolk width, yolk length, yolk height, and yolk colour. Eggs were numbered first and then weighed and

measured using sensitive balance. Consequently, the length and width of egg was measured by using digital caliper.

To measure internal egg qualities, eggs were broken on a table and its contents poured onto a plate and immediately measured for shell weight by including the shell membrane using sensitive balance and shell thickness was taken as the average thickness at the broad, middle and narrow points of the egg using a digital caliper. Albumen and yolk heights were measured by tripod micrometer (calibrated in mm) (Safaa *et al*., 2008). Then the yolk was separated from the albumen. Moreover, yolk colour measured by adjusting the egg yolk with the Roche Colour Fan (1 = very pale to 15= deep orange. Haugh unit was calculated according to Haugh (1937) by fitting the average albumen height and egg weight in to the following the equation:

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

Where, AH = observed albumen height in mm and EW = egg weigh in gram

3.3.5. Fertility and hatchability measurement

A total of 90 eggs (45 eggs per ecotype) of an experimental fertilized eggs were collected and stored at a temperature of 10-13^{0}c for a period of 10 days for comparative evaluation of fertility and hatchability. Those eggs were selected against abnormal shape; size (small and big) and undesirable shell structure were incubated using JUCAVM hatchery. Finally, fertility and hatchability was calculated as follows:

$$\% \text{ Fertility} = \frac{\text{Total number of fertile eggs}}{\text{Total number of eggs Set}} \times 100$$

$$\% \text{ Hatchability} = \frac{\text{Total number of chicks hatched}}{\text{Total number of fertile eggs set}} \times 100$$

3.4. Statistical analysis

Survey data; like socioeconomic, management practices (feed and feeding practices, watering, housing system, health care), fertility and hatchability, color of egg yolks and consumer's preferences were analyzed for simple descriptive statistics like frequencies, percentage using

Statically Package for Social Sciences (SPSS. version, 23). A Chi-square test was employed to identify differences among categorical variable.

Data on body weight, feed intake, egg weight, age at first mating and age at first egg, egg production carcass yield and egg quality were subjected to t- independent test to evaluate fixed effect of ecotypes using the procedure of SAS program (SAS, version 9.2, 2008).

Model 1: Model for survey

$$Y_{ij}=\mu+A_i.+\varepsilon_{ij}$$

Where:

Y_{ij} =the production and reproduction performance of birds among the i^{th} ecotypes

μ =overall mean of the respective variable

A_i = the fixed effect of ecotype on the respective variable

$Є_{ij}$ =random error term

Model 2: Model for designed experiment

$$Y_{ij} = \mu + T_i + \varepsilon_{ij}$$

Where:

Y_{ij} = the production and reproduction performance of birds

μ = overall mean of the respective variable

T_i = the fixed effect of T_i ecotype (i= 1-2 i.e. 1 naked neck, 2 normal feathered)

ε_{ij} = random error term

4. RESULTS AND DISCUSSION

4.1. Socioeconomic characteristics of respondents

4.1.1. Household characteristics

The household characteristics of interviewed indigenous chicken owners are presented in table 3. Among the total interviewed indigenous chicken owners in the study area, most of them were male (81.4%). Less number of female-headed households involved in the response of the current study might probably be due to cultural issues that females were not actively involved in different meetings and discussions. Concerning, the educational status of the respondents in chronologically descending percentages about 28.1, 26.7, 23.5, 13.3, 5.3 and 3.2% were reported for basic education (write and read), illiterate, primary school (1 to 8), secondary high school (9 to 12) and attended college, respectively. Similarly, the average family size of the interviewed respondents in the study area was about 5.64 per households.

Table 3: Household characteristics of respondents in study areas

Variables	Ecotype		Overall mean	X^{2-} value	*P*-value
	Naked neck	Normal feathered			
Sex of respondent (%)					
Male	89.3	80.5	81.4		0.194
Females	10.7	19.5	18.6		
Age of respondents (Mean±SE)	45.9±2.1	42.9±0.7	43.3±0.6		0.190
Family size (Mean±SE)	5.9±0.3	5.6±0.1	5.6±0.1		0.325
Education status of respondents (%)					
Illiterate	28.6	26.5	26.7		
Religious	10.7	13.6	13.3		
Basic education /write and read	17.9	29.2	28.1	18.21	0.057
Primary School (1-8)	32.1	22.6	23.5		
High School (9-12)	7.1	5.1	5.3		
Others	3.6	3.1	3.2		

SE=standard error

4.1.2. Flock structure and size

As shown in table 4, the normal feathered chickens were significantly higher ($p<0.05$) than that of the naked neck in mean number per household in all flock types of the interviewed respondents. As a result, 10.7 and 4.6 are reported as the overall mean flock size per household of the respondents for normal feathered and naked neck chicken, respectively. The current result of overall mean flock size for normal feathered was comparable with the mean flock sizes per household of 10.28 in Jimma Zone, 10.4, in Gobu-Sayo, Bako-Tibe and Danno woredas of Western Oromia and 11.9 in Tiyo, Hetossa and Dodota woredas of Eastern Oromia that reported by Taju (2017), Feyera (2016) and Negassa *et al*. (2014), respectively. Similarly, lower average flock size was also reported by Meseret (2010) and Eskindir (2013) who indicated that mean flock sizes of 6.3 and 6.23 chickens per household from Gomma woreda and Jarso woreda, respectively These flock size variations might be attributed due to the preference, agro ecological variations and or availabilities of those naked neck chickens in the area.

Table 4: Chicken flock size per households (Mean±SE)

Flocks	Ecotype		Overall Mean	*P-values*
	Naked neck	Normal feather		
Chicks	1.7±0.2	2.9±0.1	2.8±0.1	0.010
Pullets	1.1±0.1	2.0±0.1	1.9±0.1	0.001
Cockerels	0.3±0.1	1.6±0.0	1.5±0.1	0.001
Cock	1.0±0.1	3.3±0.1	3.1±0.1	0.001
Hens	0.3±0.1	0.9±0.0	0.8±0.0	0.001
Total flock	4.6±0.4	10.7±0.3	10.1±0.3	0.001

SE= Standard error

4.1.3. Distribution of naked neck and normal feathered chickens

Distribution of naked neck and normal feathered chickens within studied population is shown in table 5. In the study area the majority (90.2%) of chicken owner have the normal feathered chicken whereas only about 9.8% owns the naked neck chicken. Less ownership of this naked neck chicken was associated with less preference on the market, opportunities of availability and some cultural taboos (like relating this ecotype with un domesticated wild birds, lack of

feather around their neck) that related with their physical appearances. Consequently, there is significant difference (P<0.05) among the two ecotypes in the reason of unavailability where the naked neck chicken significantly unavailable than normal feathered chickens.

Consistent to the current study, Aberra and Tegene (2011) also reported the distribution of naked neck chicken in Gurage, Dawro and Bench maji was about 10–11%. However, the proportion of naked neck chicken in the current study was higher than the report of Taju, (2017) which was 3.1% in Jimma zone. In similar manner, Aberra and Tegene (2011) also recognized that consumers have neglected live chickens carrying Na gene because of cultural reasons that are possibly linked with the absence of feather coverage around the neck region.

Table 5: Distribution of naked neck and full feather chicken in study area

Variables	Ecotypes (%)		Overall means	χ^2-values	*P*-values
	NN	NF			
Availability	9.8	90.2	100	285.00	0.001
Reason for unavailability					
Lack of awareness	37.7	54.8	53.0	3.92	0.141
Their low productivity	-	0.4	0.4		
Less market preference	64.3	44.7	46.7		
Production difference among the ecotypes					
Yes	67.9	55.6	56.8	1.5	0.214
No	32.1	44.4	43.2		
Productive ecotypes	56.1	43.9	100	2.7	0.605
Trend of both ecotypes					
Increase	15.0	21.4	19.4	11.9	0.003
Decrease	80.0	35.7	50.0		
Remain the same	5.0	42.9	30.6		

NN= Naked neck, NF= Normal feathered

Not only in their availability but also there is statistically significant difference between the two ecotypes in their productivity. About 56% of the interviewed household that owns both ecotypes reported that the naked neck chickens have high productive performance than normal feathered chickens. The productivity variation between the two ecotypes might be associated with high scavenging and feed consumption abilities of those naked neck chickens. This result was comparable with the result of Nishibori (2009) who reported that, among the

indigenous birds the naked neck was superior in terms of body weight, egg weight, egg production and survivability. Similarly, Addis and Malede (2014) also recognized that naked neck ecotype was found to be better in both productivity and reproductive performances than the normal feathered ecotypes in north Gondar zone.

2.11. Feed resource and feeding of chickens

The feeds of chickens and feed supplement practices of chicken owners in the current study area are presented in table 6. There was no significant difference in supplementary feeding practice between the two ecotypes chickens; however, the feed consumption of the naked neck ecotype was significantly ($p<0.5$) higher than that of the normal feathered (table 6). About 64% of the interviewed respondents recall that naked neck chickens were needs more feed while about 25 and 11% of them reported their less consumption and no variation, respectively. This result is consistent with the findings of Galal and Fathi (2001) who reported that at high ambient temperature, the naked neck was associated with higher feed consumption compared to the normal feathered counterparts.

Table 6: Poultry feeds and feeding practices in the study areas

Variables	Ecotype		Overall means	χ^2 Value	*P*-value
	Naked neck	Normal feathered			
Feed supplement to chicken (%)					
Yes	92.9	91.4	91.5	0.573	0.066
No	7.1	8.6	8.4		
Feed consumption (%)					
More	64.3	6.2	11.9		
Less	25.0	89.1	82.8	85.62	0.001
No variation	10.7	4.7	5.3		

4.1.4. Watering

As indicated in table 7, there is no significant difference in provision and frequency f watering for both of the ecotypes. In the current study, about 96.8% of the respondents provided water to their chicken in year round with particular attention during the dry season in the study area

(table 7). The current study also revealed that hand pump water (41.0%), river (28.1 %), spring (21.1 %) and tap water (9.1 %) was stated as main sources of water for local chickens. Similarly, the result of Shishay (2014) also supported the current study that reported well water (31.7%), tap water (29.1%), river (27.3%), tap water and well water (6.2%), river and tap water (4.2%) as well as river and well water (1.6%) as main water sources of chicken at western Tigray. Additionally, Worku *et al.* (2012) also recognized different sources of water for chickens including springs (60.2 %), pipe (21.4%), river (12.2%) and pond (6.2%) in west Amhara region.

Table 7: Water sources and watering frequency for chickens in the study areas

Variables	Ecotypes		Overall means	χ^2 value	*P*-value
	Naked neck	Normal feathered			
Water supply for chicken (%)					
Yes	96.4	96.9	96.8	0.017	0.895
No	3.6	3.1	3.2		
Frequencies of watering (%)					
Once a day	7.1	9.3	9.1		
Twice a day	25.0	8.2	9.8	8.07	0.18
Adlibtum	67.9	82.5	81.5		
Sources of water (%)					
Rivers	21.4	28.8	28.1		
Spring	32.1	19.8	21.1	9.54	0.023
Hand pump	25.9	43.6	41.0		
Tap water	21.4	7.8	9.1		

4.1.5. Housing system

The result in table 8 indicated that, farmers in the study area kept their chickens in different housing system at night; however, there is not significant ($p>0.05$) difference in night sheltering of the two ecotypes. Similarly, about 14% of the interviewed respondents have separate house for their chickens. However, 35, 28 and 13 of the respondents kept both chicken ecotypes at night in kitchen, perch in house and in livestock house, respectively. This

result was consistent with the result of Maleku (2016) who reported that 15% of households construct separate poultry houses in South Wollo zone. However, higher percentages than the current result was reported by Shishay (2014) and Mearg (2016) those who reported that 59.5 and 65.7% of the total respondents constructed separate chicken houses in Southwest and central zone of Tigray, respectively. Such amount of percentage difference might be attributed with lack of construction materials, lack of awareness and objectives of the production.

Table 8: Poultry housing system in study areas

Variables	Ecotypes		Overall means	χ^2-value	*P*-value
	NN	NF			
House construction (%)				0.902	0.241
Yes	82.1	73.9	74.7		
No	17.9	26.1	25.3		
Place of chicken at night (%)				3.72	0.445
Separate house	17.9	14.4	14.7		
Perch in house	35.7	27.2	28.1		
Kitchen	25.0	36.2	35.1		
Veranda	14.3	8.2	8.8		
In livestock house	7.1	14.0	13.3		
Reasons for lack of separate house (%)				10.90	0.001
Lack of awareness	60.9	26.2	29.5		
Lack of construction material	----	35.7	32.4		
Risk of thief	13.0	10.0	10.2		
Risk of predators	26.1	28.1	27.1		

NN= Naked neck, NF= Normal feathered

4.1.6. Diseases resistances

There is statistical significant difference not only in the disease and stress resistance but also in their disease and stress resistance ability of chicken ecotypes in the study area as stated in table 9. About 70.2% of the households confirmed that there is a difference in disease and stress resistances among naked neck and normal feathered chickens. Similarly, about, 86.3 % of the respondents mentioned naked neck had more disease and stress tolerance ability than normal feathered birds. This result was in line with the results of Ajayi (2010) and Egahi *et al.* (2013) those who identified the naked neck ecotype was more disease tolerance than others.

Table 9: Diseases and stress resistances ability of chicken in study areas

Parameters	Ecotypes		Overall means	χ^2-value	*P*-value
	Naked neck	Normal feathered			
Differences in diseases resistance (%)				4.98	0.026
Yes	78.4	62.0	64.3		
No	21.6	35.0	35.1		
Disease resistance ability (%)				7.69	0.021
Good	86.3	66.6	70.2		
Less	9.8	24.4	21.8		
No variation	3.9	9.0	8.1		

4.1.7. Productive and reproductive performance of chickens

The productive and reproductive performances for naked neck and normal feathered chickens in the study area are shown in table 10. As indicated in the table, the naked neck chickens were significantly ($p<0.5$) lower age at first egg than normal feathered chickens. Similarly, the naked neck chickens were statistically ($p<0.5$) better values in number of clutch per year, eggs per clutch, clutch length in days, egg hutched and number of chicks survived than that of normal feathered. As a result, 5.8 and 6.3 months of mean age at first egg laying were reported for naked neck and normal feathered chickens, respectively. The result of current study was comparable with the result of Meseret (2010) who reported that the female local chicken of Gomma woreda of Jimma Zone attained sexual maturity at 6.47 months. Similarly, Solomon *et al*. (2013) also reported 5.2 months of average age sexual maturity for indigenous pullets in Metekel zone of North West Ethiopia. However, study undertake under traditional production systems on naked neck chicken by Getu *et al.* (2014) reported about 4.7 months of mean age at first sexual maturity for female naked neck chickens in North Gondar Zone, Ethiopia.

Regarding mean number of clutches per year and clutch length in days, 4.1 per year with 20.8 days and 3.7 per year with 23.3 days was reported for naked neck and full feathered chicken, respectively. Similarly, comparable clutch length per year for indigenous chickens was reported by Meseret (2010) and Worku *et al*. (2012) that reported 3.4 in Gomma district and

3.2 in west Ahmara region, respectively. Additionally, Addis and Malede (2014) also reported about 3.5 clutches per year for naked neck hen in North Gondar Zone.

Consecutively, the number of eggs laid per hen per clutch and egg production per year for naked neck hen was 17.7 and 64 while 12.5 and 46.9 was reported for normal feathered, respectively. This result was in line with the findings of Melaku (2016) who reported the mean egg production per hen per clutch of 12.81 eggs in South Wollo zone of Ahmara regions. Likewise, Meseret (2010) also reported comparable results in Gomma district of annual egg production per hen is 43.8. However, this result was lower than Fisseha *et al*. (2010) who reported that the total egg production per hen per year of 60, 53 and 55, in Bure, Fogera and Dale districts of Ethiopia, respectively. Additionally, the current result for naked neck annual egg production was in slightly line with the report of Addis and Malede (2014) that reported about 60.2 eggs /hen/year in North Gondar Zone of Amhara region.

Table 10: Productive and reproductive performance of chickens in studies areas

Variables	Ecotypes		Overall means	P-value
	NN	NF		
Age at first egg laying (months)	5.8±0.1	6.3±0.04	6.3±0.03	0.001
Clutch number/year/hen	4.2±0.1	3.7±0.01	3.7±0.01	0.001
Number of eggs /clutch/hen	17.7±0.4	12.5±0.07	13.1±0.11	0.001
Clutch length in days	20.8±0.4	23.3±0.17	23.0±0.16	0.001
Total number of eggs/year/hen	64.0±1.0	46.9±0.22	48.6±0.37	0.001
Number of egg set/hen for hatching	12.9±0.2	10.1±0.07	10.3±0.09	0.001
Number of eggs hatched	10.0±0.2	7.9±0.0.07	8.2±0.08	0.001
Number of chicks survived	6.8±0.2	4.6±0.08	4.9±0.08	0.001

NN= Naked neck NF= Normal feathered

The mean number of eggs set per broody hens and chicks hatched in study area was 12.9 with 10 and 10.1 with 7.9 for naked neck and normal feathered, respectively. Likewise, this result was consistence with the findings of Aberra *et al*. (2013) that reported the average number of eggs incubated per hens was 12.8 and only 10 chicks were hatched.

4.1.8. Selection criteria for brooding hens and eggs

There was significantly ($P<0.05$) difference among the ecotypes in terms of preference to maintain (Table 11). About 83.2% of respondents prefer normal feathered while about 16.8% prefer naked neck chickens. Concerning experiences of eggs selection before incubation about 82.1% recall experience of collection based on egg size (42%), ecotypes (16), cleanness of an egg (15%) and egg color (14). The present finding was in line with the result of Mearg (2016) and Taju (2017) who reported that 87.6% and 68.9% of respondents in the central zone of Tigray and Jimma zone was selected eggs before incubation.

Likewise, the current result also showed that 33.0 % of the respondents reported as eggs size difference between naked neck and normal feathered chicken where about 63% of the respondent's reported the naked neck chickens egg was bigger than normal feathered. This result was similar with the findings of Gregory (2013) who reported that difference in egg weight between the naked neck and the normally feathered birds in Ghana.

Table 11: Selection criteria for broody hens and eggs in the study area

Variables	Ecotypes		Overall mean	χ^2-value	*P-values*
	NN	NF			
Breeds preferences (%)	16.8	83.2	100	153.3	0.005
Reason for preferences (%)				17.12	0.002
Egg production potential	21.8	14.8	16.1		
Meat production potential	36.4	29.1	30.5		
Market preferences	7.3	29.6	25.3		
Diseases resistances	29.1	15.2	17.9		
Ease to management	5.4	11.3	10.2		
Egg selection experience (%)				2.44	0.089
Yes	92.9	80.9	82.1		
No	7.1	19.1	17.9		
Criteria for egg section (%)				10.28	0.031
Ecotypes types	30.8	14.4	16.2		
Egg size	46.2	41.8	42.3		
Cleanness of egg	-	16.8	15.0		
Color of egg	15.4	13.5	13.7		
Egg shape	7.7	13.5	12.5		
Egg size difference (%)				20.76	0.001
Yes	71.4	28.8	33.0		
No	28.6	71.2	67.0		
Large egg size ecotypes (%)	63.8	36.2	100	10.69	0.001
Broodiness characters				71.76	0.001
Common	14.3	82.5	76.5		
Sometime	75.0	17.1	22.1		
Rare	10.7	0.4	1.4		
Temperament behavior				42.26	0.001
Docile moderate	21.4	1.9	3.9		
Tractable	67.9	37.0	40.0		
Aggressive	10.7	61.1	56.1		

NN= Naked neck NF= Normal feathered

4.1.9. Egg preference of consumers

The current survey study revealed that the consumer's egg preference based on ecotypes in studies area is presented in Table 12. About 80.7% of the respondents have preferred eggs of normal feathered and 19.3 % of respondents prefer for egg of naked neck. There was

significant ($p<0.01$) difference between the two ecotypes in egg preferences of respondents. The main reason for variations of respondents to prefer the egg of normal feathered indicate that about 74.8 % them for egg taste while reason for the choice of naked neck egg 54.5 % of them preferred egg size. The reasons for preference of the producers and consumers for naked neck chickens was for its larger egg size reported by Ahimed *et al*. (2012) in Bangladesh. Similarly, Tadelle *et al.* (2003) reported that farmers, in Tepi region preferred to keep naked neck chicken for egg production.

Table 12: Consumers egg preference in the study areas

Parameters	Ecotypes (%)		Overall means	χ^2 Value	*P*-Value
	NN	NF			
Preferences of egg based on ecotype	19.3	80.7		285.00	0.001
Reasons for preference				73.56	0.001
Taste of egg	16.4	74.8		63.3	
Egg color	29.1	14.6		17.4	
Egg size	54.5	10.6		19.2	
Market preference	23.9	76.1		150.85	0.001
Reason for egg preferences				11.18	0.004
Taste of egg	54.5	76.5	72.3		
Egg color	14.5	9.1	10.2		
Egg size	30.9	14.3	17.5		

NN= Naked neck NF= Normal feathered

4.1.10. Consumers preference of chickens for slaughtering

Consumers preference of chicken for slaughtering based on ecotypes show that about 82.1% of household prefer meat from normal feathered chicken while about 17.9% of them preference to meat from naked neck. The reasons for less preference of the producers and consumers naked neck for meat might be absence of feather coverage around the neck, which means that the physical appearances of the naked neck was not attractive to consumers. Moreover, the reason of respondents to choice meat of normal feathered in studies area about 69.2 % meat flavors, 24.8 % carcass yield while 6.0% is availability of the chickens. Similarly, the reason of respondents to choice meat of naked neck, 72.6 % carcass yield and

25.6 % taste of meat. Similarly, Tadelle *et al*. (2003) recognized that the naked neck types are present in some areas but are not preferred and also fetch lower prices when sold for meat in local markets. However, Duah (2016) reported that the naked neck was preferable to the other genotypes due to it has high meat proportion in Ghana.

Table 13: Consumer's preference of chicken for slaughtering in the study areas

Parameters	Ecotypes (%)		Overall means	χ^2 Value	*P*-Value
	Naked neck	Normal feathered			
Preferences to consume meat	17.9	82.1	100		0.005
Reasons for preference				53.76	0.001
Carcass yield	78.4	24.8	34.4		
Taste of meat	21.6	69.2	60.7		
Availability	---	6.0	4.9		
Consumers preference for meat	21.8	78.2		50.04	0.001
Reason of consumers prefer meat				47.09	0.001
Carcass yield	72.6	25.6	35.8		
Taste of meat	27.4	70.9	61.4		
Availability	---	3.6	2.8		

4.2. On station evaluation of production and reproduction performances

4.2.1. Growth performance of the experimental chicks at brooding stage

Production and reproduction performance of naked neck and normal feathered chickens were evaluated under on station management condition. The mean of body weight and body weight gain from hatching to week eight for naked neck was significantly ($p<0.5$) higher than the normal feathered chicken (Table 14). The result of this study revealed that, 30.2 and 25.7g is the hatching weight of naked neck and normal feathered, respectively. Similarly, the total body weight gains and mean daily gain from hatching to 8^{th} weeks of age was 474.72g and 8.47g/day/bird for naked neck while 374.82 g and 6.69g/day/bird for normal feathered chickens, respectively. The result of this study pointed out that naked neck has better potential to grow fast during brooding period than the normal feathered chickens.

This result is in agreement with Mahrous *et al*. (2008) who reported that the hatching weight of naked neck chicken was 30.26 while the normal feathered 28.00gm in Egypt. Faruque *et al*. (2013) reported mean body weight gain and mean daily gain from day old to eight week for naked neck chickens was 351.56 and 6.27 g/bird in Bangladesh, which is slightly lower than the findings observed in the present study. Similarly, comparable result was also reported in South Ethiopia indigenous chickens' with 8.8gm in the Gassay and 11.5 gm. in the Mecha of the mean daily body weight in 5 to 8 weeks of age (Hailma H., 2007).

4.2.2. Feed intake and feed conversion ratio

As shown in table 14, there were significant differences (P<0.05) between naked and normal feathered in average feed intake from hatching to 8th weeks of age. The mean total feed intake for naked neck and normal feathered from hatching to 8th weeks were 1947.12 and 1789.76gm, respectively. Similarly, there was a significant (p<0.05) different in mean daily feed intake and feed conversion ratio from hatching to week 8 for naked neck 34.77gm and 4.10 while 31.96gm and 4.77 for normal feathered chickens. The results are in agreement with Atansuyi *et al.* (2017) who reported that total feed intake and feed conversion ratio from day old to week 8 for naked neck chickens was 1904.03gm and 2.15, respectively in South-Western Nigeria.

Table 14: Mean (LSM±SE) body weight, feed intake and feed conversion ratio of chickens during brooding stages

Parameters	Ecotypes		Overall mean	P-values
	Naked neck	Normal feathered		
MBW at hatching (g)	30.2±0.8	25.7±0.8	27.9±0.6	0.016
MBW at wk.8	504.9±20.5	400.5±20.5	452.7±14.5	0.023
TWG/bird(g) 0-8 wk.	474.7±19.7	374.8±19.7	424.8±13.9	0.019
MDWG/bird(g) 0-8 wk.	8.5±0.3	6.7±0.3	7.6±0.3	0.001
TFI/bird 0-8 wk.	1947.1±70.3	1789.8±70.3	1865.9±49.8	0.031
MDFI/bird(g) 0-8 wk.	34.8±1.2	31.9±1.2	33.3±0.9	0.022
FCR (feed: gain) 0-8 wk.	4.1±1.2	4.8±1.2	4.4±0.9	

MDBWG= Mean body weight gain, TBWG= Total body weight gain, TFI= Total feed intake, FCR= Feed conversion ratio, wk. = Week. LSM= Least square mean, SE= Standard error

4.2.3. Growth performance of chicken from 10th to 16th weeks of age

The average body weights (gm/bird/wk.) of chickens of each ecotype at different weeks are shown in (Table 15). There was significant differences ($P<0.05$) between naked and normal feathered in average body weight (gm/bird/wk.) from 10th to 16th weeks of age. The average body weight of chickens at 10th and 16th week age was 741gm and 1215gm for naked neck while 498gm and 863gm for normal feathered, respectively. Moreover, the total body weight gain recorded for naked neck and normal feathered chicken was 474 and 365gm and also the average daily body weight gain were 7.91gm and 6.09gm, respectively. This result was slightly similar to Adomako (2009) who reported that the mean body weight at 10th and 16th weeks was 693.80 and 1394.70gm for naked neck while 609.9 and 1154.10gm for normal feathered chickens, respectively in Ghana. On the other hand, the finding of Magonka *et al.* (2016) indicated that the average growth rate (from 12 -16 weeks) for naked neck was 9.6gm per day in Tanzania.

4.2.4. Feed intake and feed conversion ratio of chickens from 9th to 16th weeks of age

There was significantly ($p<0.05$) different in the total feed intake and mean feed intake per chicken per day between the naked neck and normal feathered (Table 15). In feed intake per chicken and mean per chicken per day was higher for naked neck than normal feathered chickens in grower stages. The mean total feed intake for the naked neck and normal feathered chicken from week 9th to 16th weeks of age were 4224 and 3740gm with the feed conversion ratio of 10.23 and 8.91 for naked neck and normal feathered chickens, respectively.

Table 15: Mean (LSM±SE) body weight, feed intake and feed conversion ratio of chickens from 9th to 16th weeks of age

Parameters	Ecotype		Overall mean	P-values
	NN	NF		
MBW at wk.10	741.1±36.0	498.1±36.0	619.6±25.4	0.031
MBW at wk.16	1215.8±44.0	863.67±44.0	1039.8±29.0	0.025
TBWG(g) at wk.10-16	474.8±8.0	365.5±8.0	420.2±3.6	0.031
MDWG/bird(g)wk.10-16	7.9±0.1	6.1±0.1	7.0±0.1	0.039
TFI(g) at 9-16 wk.	4224.6±1.2	3740.7±1.2	3982.6±0.9	0.012
MDFI/bird(g) from wk.9-16	70.4±0.0	62.3±0.0	66.4±0.0	0.045
FCR(feed: gain) 9-16 wk.	8.9±0.0	10.2±0.0	9.5±0.2	

MDBWG: mean body weight gain, NN= naked neck, NF= normal feathered, TBWG: total body weight gain, TFI: total feed intake, FCR: feed conversion ratio, wk.: week. LSM: least square mean, SE: standard error

4.2.5. Growth performance of chickens from 18th to 24th weeks of age

The mean body weight of naked neck and normal feathered chickens from 18th to 24th weeks of age are reported in table 16. Overall mean body weight at 18th and 24th week body weights were 1373.15 and 1752.98gm in naked neck while that of normal feathered was 992.97 and 1290.01gm, respectively. Significant differences in total body weight gain recorded from18th to 24th week age for naked neck and normal feathered chicken was 379.79 and 297.03gm while daily body weight gain for naked neck 6.78 and 5.3gm for normal feathered chickens. This result was in agreement with the finding of Adomako (2009) who reported that Body weight and body weight gain of naked neck birds from fifteen to twenty weeks were significantly higher compared to those of normal feathered birds in Ghana. However, slightly lower values were reported by Njenga (2005) for mature body weights that reported 1.40 and 1.30kgm for naked neck and normal feathered birds in Kenya, respectively.

4.2.6. Feed intake and feed conversion ratio of chickens from 17th to 24th weeks

There was significantly ($p<0.05$) different in average feed intake/birds/day among the naked neck and normal feathered (Table 16). The naked neck chickens significantly ($p<0.05$) consumed more feed from week 19th to 24th weeks of age than normal feathered chickens. The mean daily feed intake and feed conversion ratio from 17th to 24th weeks of age was 92.24 and

80.86gm feed intake with the feed conversion ratio of 12.65 and 13.96 for naked neck and normal feathered chicken, respectively. The current result was slightly in agreement with the finding of Halima (2007) who reported at the end of the growth period the feed conversion ratio (feed: gain) was 13.87 for Gassay chicken lines.

Table 16: The mean (LSM±SE) body weight, feed intake and feed conversion ratio of chickens from 17th to 24th weeks

Parameters	Ecotypes		Overall	*P*-
	Naked neck	Normal feathered	Mean	Value
MBW at wk.18	1342.1±45.1	974.1±45.0	1158.13±31.8	0.044
MBW at wk. 24	1750.3±58.4	1298.384±58.4	1524.3±41.3	0.024
TWG(g) wk.18-24	408.2±13.3	324.281±13.3	366.2±9.4	0.031
MDWG(g)/day/bird 18-24	7.3±0.2	5.8±0.2	6.5±0.1	0.040
TFI(g) wk.17-24	5534.7±1.5	4852.2±1.5	5195.9±1.1	0.014
DFI(g)/day/bird wk.18-24	92.2±0.02	80.9±0.0	86.6±0.02	0.024
FCR(feed: gain) wk.17-24	12.6±0.1	13.9±0.1	13.2±0.1	

MDBWG: mean daily body weight gain, TBWG: total body weight gain, TFI: total feed intake, FCR: feed conversion ratio, wk.: week, LSM: least square mean, SE: standard error

4.2.7. Productive and reproductive performances of experimental chickens

The mean performance of some reproduction traits for both ecotypes on station management condition was stated in Table 17. There was significantly different on reproductive variables among naked neck and normal feathered chickens. The overall mean age at first mating was 4.63 months for naked neck while for full feathered was 5.12 months. Although the mean age at first egg for naked neck ecotypes was 5.54 months which is lowers than for normal feathered (5.95 months). This result was in line with the result that reported by Halima *et al.* (2007) for local chickens (157 days) and Melesse *et al.* (2011b) for Ethiopian naked-neck chickens (156 days) reared under intensive management conditions.

Moreover, data on fertility and hatchability of naked neck and normal feathered chickens were also shown statistically significant difference. As indicated in (Table 19), the fertility of the naked neck was 84.40% higher than that of normal feathered 80.00 %. This result is comparable with Aberra *et al.* (2005) who reported the value of fertility for naked neck chickens was 86.6%. In contrast, normal feathered chickens had shown higher hatchability

value from fertile eggs with 69.4% while 59.3% is for naked neck chickens. Similarly, Moreki *et al. (*2014) was reported that significantly higher value of hatchability value for normal feathered chickens (74.074%) than naked neck chickens (48.148%) in Botswana. However, Melesse (2005) reported higher hatchability value of 70.7 and 81.7 from total egg set and fertile eggs set for naked neck chickens, respectively.

Table 17: Fertility and Hatchability of experimental chickens

Parameters	Ecotypes		Overall means	P-values
	NN	NF		
Age at first mating (months)	4.6±0.1	5.1±0.1	4.9±0.1	0.013
Ag at first egg lay (months)	5.5±0.1	5.9±0.1	5.7±0.0	0.001
Total eggs set numbers	45.0±0.0	45.0±0.0	45.0±00	
Fertile eggs (%)	84.4	80.0	82.2	
HTES (%)	49.6	55.5	52.6	
HFES (%)	59.3	69.4	64.4	

HTES: hatchability on total egg set, HFES: hatchability on fertile eggs set, NN= naked neck, NF= normal feathered

4.2.8. Egg production

4.2.8.1. Hen day egg production (HDEP)

The results of ecotype effect on monthly hen day egg production (HDEP) of laying hens at different rearing periods are indicated in (Table 18). There were no significant differences in HDEP among the two ecotypes during the first month of the experimental periods. However, there was significantly different on HDEP among the ecotypes from month two to the final periods. The overall mean HDEP was 39.20 for naked neck while for normal feathered was 33.25. There were significantly (P<0.05) higher HDEP among the two ecotypes during the second, third, fourth, fifth and sixth months of experimental periods that the naked neck was higher with 34.55, 39.08, 42.43, 46.04 and 49.05 while 28.73, 31.56, 36.88, 37.90 and 41.07 had for normal feathered, respectively. The current result was also supported with the findings

of Halima (2007) who reported the HDEP of 39.99, 39.22, 25.06, 42.13, 36.24, 48.04 and 42.28% for Tilili, Gelila, Debre- Elias,Melo- Hamusit ,Gassay/ Farta ,Guangua and Mecha, respectively under intensive management condition in North west Ethiopia.

Table 18: Mean hen-day egg production

Months	Parameter (%)	Ecotypes		Overall mean
		Naked neck	Normal feathered	
1	HDEP	24.1	22.5	23.3
2	HDEP	34.5	28.7	31.6
3	HDEP	39.1	31.6	35.3
4	HDEP	42.4	36.9	39.6
5	HDEP	46.0	37.9	41.9
6	HDEP	49.0	41.1	45.1
MHDEP (over 24 weeks)		39.2	33.2	36.1

HDEP: hen day egg production

4.2.9. Egg quality traits

The analyzed variance of egg quality traits of naked neck and normal feathered chicken was shown in table 19 and 20. There was significant differences ($P<0.05$) among the chickens in egg weight, egg shape index (%), sell weight (gm.), shell thickness (mm), egg length, albumen width, albumen height, albumen weight, albumen length, yolk weight, yolk height and Hough Unit. However, the yolk color, yolk index, yolk length, yolk width, egg width and egg shell strength were no statistically significant difference ($P>0.05$) among the birds.

4.2.9.1. External egg quality traits of chickens

The analyzed external egg quality traits of the naked neck had significantly higher ($P<0.05$) in egg weight (48.40gm), shape index (78.43%), egg width (4.14cm) and shell weight (6.64gm) than normal feathered chickens with egg weight (44.7gm), shape index (74.2%), egg width (4) and shell weight (5.6gm) (Table 19). On contrast, the egg length of normal feathered (5.41cm) was significantly higher ($P<0.05$) than naked neck egg (5.26cm). Similarly, comparable result was reported by Yakubu *et al*. (2008), who reported egg weight of 43.04 vs. 40. 83gm, egg width of 3.84 vs.3.54 cm, egg shape index of 74.68 vs. 72.60 and shell thickness of 0.38 vs. 0.34 mm for Nigerian indigenous chickens of naked necks and normal feathered, respectively. Consequently, the egg length in the present study was comparable with the result of

Kgwatalala *et al*. (2016), who reported 5.27 and 5.31cm egg length for naked neck and normal strains of Tswana chickens of Botswana, respectively. In contrast to this finding, Dakpogan *et al*. (2012) and Yakubu *et al*. (2008) also reported significantly longer eggs in the naked neck than in the normal strain of Benin and Nigerian indigenous chickens, respectively.

Table 19: External egg quality traits measurements of chickens

Parameters	Ecotypes		Over-all mean	*P*-Value
	Naked neck	Normal feathered		
Mean egg weight(gm)	48.4±0.3	44.7±0.3	46.5±0.2	0.001
Egg width(cm)	4.1±0.0	4.0±0.0	4.1±0.0	0.018
Egg length(cm)	5.3±0.0	5.4±0.0	5.3±0.2	0.004
Breaking strength(kgf)	3.4±0.1	3.4±0.1	3.4±0.0	0.640
Shell weight(gm.)	6.6±0.1	5.6±0.2	6.2±0.3	0.008
Shell thickness(mm)	0.4±0.1	0.4±0.1	0.4±0.0	0.468
Egg shape index (%)	78.4	74.2	76.3	

4.2.9.2. Internal egg quality traits of chickens

There was a significant variation in internal eggs quality among the studied ecotypes where naked neck eggs had highest albumen width (57.67mm), albumen height (5.14 mm), albumen weight (26.42gm), yolk weight (16.10gm), yolk height(17.40mm) and Hough Unit (75.07) than normal feathered. However, the egg of full feathered ecotype was recorded highest in albumen length (7.63 mm) than naked neck chickens (Table 20).

This result is in lined with the result of Yakubu *et al.* (2008) who reported that albumen weight (20.53 and 17.61gm), albumen height (4.65 and 4.29mm), yolk weight (16.95 and 16.05gm), yolk height (1.19 and 1.05cm), yolk width (2.35 and 2.16cm), and Hough Unit (73.22 and 71.40) for Nigerian naked neck and normal chickens strains, respectively. Likewise, the mean yolk height of naked neck eggs in the current study was comparable with the findings of Melesse *et al*. (2010) who reported 16.9mm yolk height in eggs of naked neck indigenous chicken. However, Rajkumar *et al*. (2009) reported higher albumin weight (35.11gm) for naked neck chicken of India.

Table 20 Internal egg quality traits measurement of chickens

Trait parameters	Ecotypes		Overall mean	*P*-value
	Naked neck	Normal feathered		
Yolk Color(Roche fan)	5.2±0.1	5.3±0.1	5.3±0.1	0.789
Yolk Length(mm)	4.0±0.1	3.9±0.1	4.0±0.1	0.722
Yolk Width(mm)	35.9±0.6	34.9±0.6	35.4±0.4	0.267
Yolk Height(mm)	17.7±0.2	16.5±0.2	17.1±0.1	0.001
Yolk Weight(gm)	16.1±0.2	15.1±0.2	15.6±0.2	0.004
Yolk Index	48.7±0.4	47.4±0.4	48.0±0.3	
Albumen Length(mm)	7.1±0.3	7.6±0.1	7.4±0.2	0.222
Albumen Width(mm)	57.7±0.6	55.3±0.3	56.5±0.6	0.025
Albumen Height(mm)	5.1±0.1	4.5±0.2	4.8±0.2	0.038
Albumen Weight(gm)	26.4±0.6	23.9±0.3	25.2±0.6	0.023
Hough Unit	75.1±0.8	70.8±1.1	72.9±1.1	

gm=gram, mm= millimeter

4.2.10. Carcass characteristics

The result of the analyzed carcass characteristics data revealed that there were significant differences ($P < 0.01$) among ecotypes table 21. In pre-slaughter weight and dressing percentages, the naked neck chickens (1715.47gm for pre-slaughter weight and 73.6% for dressing percentage) significantly higher than the normal feathered with 1487.92gm of pre-slaughter weight and 62.9% for dressing percentage. Similarly, the naked neck ecotype significantly higher with the values of thigh and drumstick weight (494.15gm), breast weight (371.90gm) and neck weight (62.95gm) than normal feathered chicken with 401.02gm of thigh and drumstick weight, 279.77gm of breast weight and 53.38gm of neck weight.

The current result was slightly consistent with the finding of Adomako (2009) who reported that the dressing percentage of (70.87 and 66.68 %), breast muscle weight (0.24kg and 0.18kg) and thigh and drumstick weight (0.35 and 0.32kg) for naked neck and normal feathered in Ghana, respectively. The result of the present study indicated that the naked neck chickens had a higher dressing percentage than the normal feathered chickens which might be associated with the higher body weight and less losses due to the reduced feathers in the naked-neck phenotypes (Hagan and Adjei, 2012).

Table 21 Mean values for carcass and organ characteristics of male chickens at the age of 24 weeks

Parameters	Ecotypes		Over-all Mean	*P*-value
	Naked neck	Normal feathered		
Live body weight(gm)	1715.5±33.9	1487.9±33.9	1601.7±23.9	0.002
Dressed Weight(gm)	1262.7±18.8	1003.5±18.8	1133.0±13.3	0.001
Dressing percentage (%)	73.6	67.4	70.5	
Breast(gm)	371.9±8.2	279.8±8.2	325.8±5.8	0.001
Thigh & Drumstick(gm)	494.1±7.2	401.0±7.2	447.6±5.1	0.001
Wings(gm)	151.1±4.6	124.2±4.5	137.6±3.2	0.013
Back(gm)	181.5±14.3	147.8±14.3	164.6±10.1	0.172
Neck(gm)	62.9±0.9	53.4±0.9	58.2±0.6	0.002
Skin(gm)	96.0±3.6	78.2±3.6	87.1±2.5	0.025
Heart(gm)	8.1±0.3	7.1±0.3	7.6±0.2	0.072
Gizzard(gm)	32.8±0.4	31.8±0.4	32.3±0.3	0.155
Liver(gm)	29.7±0.5	28.2±0.5	28.9±0.3	0.082

4.2.11. Mortality

Mortality in different age groups under the on station management condition was stated table 22. There was no significant difference in mortality rates between the ecotypes during the brooding stage of trial period; however, the naked neck ecotype was significantly ($P<0.05$) lower in mortality rates during the grower and layer stages than normal feathered chicken. Similarly, Yakubu *et al.* (2015) also recorded higher mortality for normal feathered genotype (36.85%) than naked neck (28.60%) in Nigeria. To support this study Melesse et al. (2013) also reported lower value of mortality the rate than the current result during the brooding, post brooding and adult stage in local Kei chickens of 3.75, 17.8 and 4.17%, respectively.

Table 22 Mortality Percentage of chickens at different growing stage

Age of birds (%)	Ecotypes		Over-all mean
	Naked neck	Normal feathered	
Brooding Stage	5.6	12.2	8.9
Grower Stage	8.9	14.4	11.7
Laying Stage	3.3	10.0	6.7
Mean mortality	5.9	11.5	8.7

5. CONCLUSION AND RECOMMENDATIONS

The result of this study pointed out that, under on-station and on-farm management conditions, the naked neck chickens exhibited relatively better values in most of the productive, reproductive and disease and stress resistance except for market preference that was comparatively lower than expected. Correspondingly, the carcass traits of the naked neck chicken was also generally worthy with relatively high pre-slaughter and dressing percentage along with better proportions of valuable carcass components under on-station management condition. Consequently, naked neck chickens also revealed significant variations in most of egg quality parameter performances.

Based on the above conclusions, the following recommendations are stated:

- Further detailed studies should be conducted to evaluate the productive and reproductive performances under different agro ecologies and at different temperature of naked-neck chickens which were not covered in this study to understand genetic basis of the variations;
- The major criticism of consumers' low preferences for naked neck chicken could be need awareness creation to change the attitude of the consumers;
- The naked neck birds performed well at both management systems in terms of their productive and reproductive performances. Therefore, conservation should be necessary to maintain the sustainability of those naked neck chickens.

REFERENCES

Abalaka, G.O., Mkpado, M., Ugwu, S.O.C., 2013. Rearing methods, seasons of the year and survivability of rural poultry enterprise in Nigeria. Journal of Agriculture and Sustainability 3(1): 27–55.

Abdelqader, C.B.A. Wollny & M. Gauly, 2008. On-farm investigation of local chicken biodiversity and performance potentials in rural areas of Jordan. *Animal Genetic Resources Information,* **43:49**-57.

Abdulkadir, A., 2015. Comparative Evaluation of Growth and Biochemical Metabolites of Three Types of Indigenous Chickens and Their Crosses with Hubbard Broiler, a Thesis Submitted to the School of Postgraduate Studies, Ahmadu Bello University, Zaria, p 86.

Abera, M., Tegene, N., 2007. Study on the characterization of Local Chicken in Southern Ethiopia. Proceedings held in Awassa, March 16-17.

Aberra Melesse. 2000. Comparative studies on performance and physiological responses of Ethiopian indigenous (”*Angete-melata”)* chicken and their F1 crosses to long term heat stress. Ph.D Thesis. Martin-Luther University, Halle-Wittenberg, Halle, Germany. Berlin. 4-5.

Aberra, M. and Tegene, N., 2011. Phenotypic and morphological characterization of indigenous chicken population in Southern region of Ethiopia, *Animal Genetic Resource an international Journal,***49**: 19-31.

Aberra, M., 2007. Poultry Production and Management in the Tropics: Teaching material, Hawassa University, Collegue of Agriculture, Hawassa, Ethiopia. 77-192.

Aberra, M., Misba, A., Yonas, T., 2013. Evaluating the reproductive and egg production traits of local chickens and their f1 crosses with Rhode Island Red and Fayoumi breeds under farmers‟ management conditions, Ethiopia. Iranian journal of Animal Science 3(2); 379-385.

Aberra, M., Von Lengerken, G., Maak, S., 2005. The Performance of Naked Neck and their F1 crosses with Lehman White and New Hampshire chicken breeds under long term heat stress conditions. Ethiopia Journal of Animal Production 5(1): 91-106.

Aberra, M., Zemene, W. and Yosef, T (2013). Assessment of the prevailing handling and qualityof eggs from scavenging indigenous chickens reared in different agro-ecological zones of Ethiopia. Journal of Environmental Occupation Sciences; 2(1):1-8

Aberra, M., Zemene, W. and Yosef, T.2012.Assessment of the Prevailing handling and Quality of Eggs from Scavenging Indigenous Chickens Reared in Different Agro-ecological Zones of Ethiopia. Research Journal of poultry Sciences, 5(4-6):64-70.

Addis,G., and Birhan M., 2014. Chicken production systems, performance and associated constraints in North Gondar Zone, Ethiopia. World Journal of Agricultural Science, 10: 25-33.

Addisu, H., Hailu, M., and Zewdu, W., 2013. Indigenous chicken production system and breeding practice in North Wollo, Amhara reg ion, Ethiopia. Scholarly Journal of Agricultural Science, 3(10):433-444.

Adedeji, T.A., Amao, S.R., Popoola, A.D, Ogundipe, R.I., 2015. Fertility, Hatchability and Eggs Quality Traits of Nigerian Locally Adapted Chickens in the Derived Savanna Environment of Nigeria. LadokeAkintola University of Technology, Ogbomoso, Oyo State, Nigeria. ISSN 2224-3208 (Paper) ISSN 2225-093X (Online) Vol.5, No.17.

Adomako, K., Hagan J.K. and Olympio O.S. (2009). Potentials of indigenous naked neck and frizzle birds in the Ashanti region of Ghana. Proceedings of the sixteenth Biennial Conference of the Ghana Society of Animal Production (GASP). Pp 177-180.

Ahmed, F.M., Nishibor, I.M. and Islam, M.A. 2012. Production and price of indigenous naked neck and full feathered chicken reared under rural scavenging system in Bangladesh. Journal of Agricultural Extension and Rural Development, 4 4: 92-97.

Ajayi, F. O. 2010. Nigerian indigenous chicken: a valuable genetic resource for meat and egg production. Asian Journal of Poultry Science, 4:164–172.

Ajayi, F.O., Agaviezor B.O., Torukuru, S. 2008. Fertility and Hatchability of Indigenous Chicken as influenced by Major Genes in The High Rainforest Zone of Nig. 13th Annual Conference of the Animal Science Association of Nigeria. Sept. 15-19. Pp 81-83.

Akhtar-Uz-Zaman, M. 2002**.** Eggs Production Performance of Crossbred Birds in Bangladish. Sylhet Government veterinary College, Tilagorh Sylhet- 3100, Bangladesh.

Aschalew, A., Birhan, M., Demoz, Y., and Addisu, S. 2014. Non-Conventional Feed Resources and their Utilization Practice in North Gondar, North West Ethiopia. Academic Journal of Nutrition, 3 (3): 26-29. IDOSI Publications.

Asefa, T. 2007. Poultry management practices and on farm performance evaluation of Rhode Island Red (RIR), Fayoumi and local chicken in Umbullo Wachu watershed.

Atansuyi, A.J., Lasore, C.O. and Chineke, C.A. 2017. Growth Performance Characteristics and Linear Body Measurements of Four-Chicken Genotypes Raised Under Intensive Management System in South-Western Nigeria. Volume 22, No. 1, 122-127.

Avan, T, M. A. 2002. The effects of storage conditions on the physic Chem. Microbiol. Quality of the Egg I. Veterinary Facult. YYIJ. 13(1-2): 98-107.

Bain, M. 2005: Recent advances in the assessment of egg shell quality and their future application. World's Poult. Sci. J., 61:268-277.

Banerjee, S. 2012. Morphological characterization of indigenous chickens of Sikkim and West Bengal, India. Animal Genetic Resources, 51: 57-71.

Besbes, B. 2009. Genotype evaluation and breeding of poultry for performance under suboptimal village conditions, *World's Poultry Science Journal,* **65**:260-27.

Bogale, K. 2008. In Situ characterization of local chicken eco-type for functional traits and production system in Fogera woreda, Amhara regional state, M.Sc. Thesis Submitted to Haramaya University, Haramaya, Ethiopia. pp. 123

Cahaner, A., Ajuh, J.A., Siegmund-Schultze, M., Azoulay, Y., Druyan, S. and Zarate, V. 2008. Effects of genetically reduced feather coverage in naked-neck and featherless broilers on their performance under hot conditions. *Poultry Science* **87**:2517-2527.

Chatterjee, R.N., R.B. Rai, A. Kundu, S. Senani and J. Sundar, 2007. Egg quality traits in indigenous breeds of chicken of Andaman. Ind. Vet. J., 84: 206-208.

CSA., 2010 Results for Oromia Region, (1): Tables 2.1, 2.5, 3.4. Retrieved 3th January, 2018 from https://en.wikipedia.org/wiki/Oromia_Region.

CSA., 2015/16. Agricultural Sample Survey 20015/16. Report on Livestock and Livestock Characteristics,vol.2. Statistical Bulletin No. 468. Addis Ababa, Ethiopia.

CSA., 2016/17. Central Statistical Agency (CSA). Agricultural sample survey. Report on livestock and livestock characteristics. The Federal Democratic republic of Ethiopia, Statistical Bulletin 585, Addis Ababa, Ethiopia, April, 2017.

CSA., 2017/18. Central Statistical Agency (CSA). Agricultural sample survey. Report on livestock and livestock characteristics.Vol.2 The Federal Democratic republic of Ethiopia, Statistical Bulletin 587, Addis Ababa, Ethiopia, April, 2018.

Dakpogan, H.V., Salifou, S.,Gbangboche, A.B. and Chrysostome, C.A.A. 2012.Laying performance of five local hen phenotypes in improved rearing conditions. J. Anim. Plant Sci. 15:2130-2134.

Dana, N, Dessie, T, Van der Waaij, HL, and Arendonk, AMJ 2010. Morphological features of indigenous chicken populations of Ethiopia. Anim Genetic Resour 46: 11-23

Deeb, N. and Cahaner, A. (2001): Genotypic-by-environmental interaction with broiler genotype differing in growth rate: 2. The effect of high ambient temperature on dwarf versus normal broilers. Poult. Sci., 80:541-548.

Desalew, T. 2012. Management Practices, Productive Performances and Egg Quality Traits of Exotic Chickens under Village Production System in East Shewa, Ethiopia. MSc thesis. Addis Ababa University, College of Veterinary Medicine and Agriculture, Debre Zeit, Ethiopia. 58p.

Desalew, T., Wondimeneh, E., Mekonnen, G. and Tadelle, D. 2015. Comparative study on egg quality traits of exotic chickens in different production systems in East Shewa, Ethiopia. African J. Agric. Res. 10(9), 1016-102.

Dou, T., Shi, S., Sun, H., and Wang, K. 2009. Growth rate, carcass traits and meat quality of slow-growing chicken grown according to three raising systems. Animal Science Paper and Report 27: 361–369.

Duah, K., 2016. Effect of the Naked Neck Gene (Na) on Marketability, Carcass Traits, Haematological and Serum Biochemical Indices of Cockerels, thesis submitted to the Kawame Nkrumah University of Science and Technology, Kumasi, Ghana, pp 128.

Egahi, J., O., Dim, N. I. and Momoh, O M. 2013. The effect of plumage modifier genes on egg quality indices of the Nigerian local chicken. Journal of Agricultural and Veterinary Science 2(2): 04–06.

FAO, 2004. Manual Small Scale Poultry production technical guide by Sonaiya E.B and Swan S.E. J. FAO Animal Production and Health Series No.1. Available at Animal Production and Health http://www.fao.org/docrep/0008/y5169e/y5169e00.HTM.

Faruque, S., Islam, M.S. Afroz, A.and Rahman, M.M.2013. Evaluation of the Performance of Native Chicken and Estimation of Heritability for Body Weight. Journal of Bangladesh Academy of Sciences, Vol. 37, No. 1, 93-101.

Feyera, B. 2016. Phenotypic Characterization of Indigenous Chicken and Their Production System in Gobu Sayo,Bako Tibe and Danno Districts of Western Oromia, Ethiopia'. M.Sc. Thesis submitted to the Haramaya University, Haramaya .pp . 130.

Fisseha, M. 2009. Studies on production and marketing systems of local chicken ecotypes in Bure district, North-West Amhara. M.Sc. Thesis submitted to Hawassa University, Ethiopia. pp.185.

Fisseha, M., Aberra, M., and Tadelle, D. 2010. Assessment of village chicken production system and evaluation of the productive and reproductive performance of local chicken ecotype in Bure district, Northwest Ethiopia. *African Journal of Agricultural Research*. 5(13):1739-1748.

Fisseha, M., Aberra, M., Tadelle., D 2010. Assessment of village chicken production system and evaluation of the productive and reproductive performance of local chicken ecotype in Bure district, Northwest Ethiopia. Afri. J. of Agri. Res. 5:1739-1748.

Fisseha, M., Azage, T. and Tadelle, D. 2010. Indigenous chicken production and marketing systems in Ethiopia: Characteristics and opportunities for market -oriented development. IPMS (Improving Productivity and Market Success) of Ethio pian Farmers Project Working Paper 24. Nairobi, Kenya, ILRI.

Fraga, L. M., Berrio, I., Febles, M., Cardenas, M. and Rodriguez, J. L. 1999. Anote on the naked neck gene and resistance in poultry. Cuban Journal of Animal Science. 33(3): 279-281.

Franco, D., Rois, D., Vazquez, J.A. and Lorenzo, J.M. 2012. Comparison of growth performance, carcass components, and meat quality between Mos rooster (Galician indigenous breed) and Sasso T-44 line slaughtered at 10 months. Poultry Science 91:1227–1239.

Galal, A. and Fathi, M. M. 2001. Improving carcass yield of chicken by introducing naked neck and frizzle genes under hot prevailing conditions. *Egypt Poultry Science*, 21: 339-362.genes on growth and egg production of laying hen chickens. Egyptian Poultry Science, 26: 17-38.

Garcia, J.C., M.E. Lopez, Suarez-Oporta, J.M. Pinos-Rodriguez, and G.A. Warez-Fuentes. 2007. Egg components, Lipid fraction and Fatty acid composition of Creole and

Plymouth Rock x Rhode Island Red Cross hens fed with three diets. World Poultry Science Journal, 63 (3): 473-479.

Gerber., 2012: Factors affecting egg quality in the commercial laying hen. A review. Availablefrom:http://]eggfarmers.org.nz/eggfarmers/wpcontent/uploads/2012/04/ factors_affecting_egg_quality.pdf.

Getachew, B. 2014. On-farm Phenotypic Characterization of Indigenous Chicken and Their Production System in Bench Maji Zone, Southwestern Ethiopia. MSc. Thesis, Haramaya University, Haramaya, Ethiopia.

Global Agricultural Information Network (GAIN)., 2017. Ethiopia's Demand for Chicken Meat is Expected to Grow. This report contains assessments of commodity and trade issues made by USDA staff and not necessarily statements of official U.S. government policy. USDA Foreign Agricultural Service.

Gracès, A. Casey, N.H. and Horst, P. 2001. Productive performance of naked neck, frizzle and dwarf laying hens under various natural climates and two nutritional treatments. South African Journal of Animal Science, 31: 174-180.

Gregory, T. D., 2013. The Effect of the Naked Neck (*Na*) and Frizzling (*F*) genes on the Fertility, Hatchability, Egg Quality and Pterylosis of Locally Developed Commercial Layer Parent Lines, thesis submitted to university of Kwame Nkrumah University, pp 127.

Gueye, E., 2000: The role of family poultry in poverty alleviation, food security and the promotion of gender equality in rural Africa. *Outlook on Agri.*, 29 (2): 129-136.

Gueye, E.F., 2000. Women and family poultry production in Africa. Development in Practice, 10:98–102.

Hagan, J. K.l and Adjei, A. I.2 2012 Evaluation Of The Growth And Carcass Yield characteristics Of Crossbred Naked-Necka Nd Frizzle Cockerel Phenotypes Reared Under Hot And Humid Environments, ARPN Journal of Agricultural and Biological Science, VOL. 7(8) ;576-582.

Halima, H., 2007: Phenotypic and Genetic Characterization of Indigenous Chicken Populations in Northwest Ethiopia. PhD Thesis; University of the Free State, Bloemfontein, South Africa, p. 186.

Halima, H., Neser, FWC. Kock, A., Marle-Köster E., 2009. Study on the genetic diversity of native chickens in northwest Ethiopia using microsatellite markers. Afr. J. Biotech., 8:1347-1353.

Hammerle, J.R. 1969. An Engineering Appraisal of egg shell strength evaluation techniques. *Poultry Science*, 48: 1708-1717.

Haugh, R., 1937. The Haugh unit of measuring egg quality. U.S. Egg Poultry Magazine, 43, 552-555.

Hunduma, D., Chala, R., Dawo, F., Bekana, E. and Leta, S. 2010. Major constraints and health Management of village poultry production in Rift Valley of Oromia, Ethiopia. Am.-Euras. J. Agric. Environ. Sci., 9(5): 529–533.

Islam, M. A. and Nishibori, M., 2009. Indigenous naked neck chicken:a valuable genetic resource for Bangladesh. Worlds Poult. Sci. J. 65: 125-138.

Islam, M.A., S.M. Bulbul, G. Seeland and A.B.M.M. Islam, 2001. Egg quality of different chicken genotypes in summer and winter. Pak. J. Biol. Sci., 4: 1411-1414.

Jaturasitha, S., Srikanchai, T., Kreuzer, M., and Wicke, M. 2008. Differences in carcass and meat characteristics between chicken indigenous to Northern Thailand (Black-Boned and Thai Native) and imported extensive breeds (Bresse and Rhode Island Red). Poultry Science 87: 160–169.

John, C. M. Galepelo, M. M. and Gothamang, P.N.2014. .Hatchability traits of normal feathered and naked neck Tswana chickens reared under intensive system. Botswana College of Agriculture, Private Bag 0027, Gaborone, Botswana. ISSN: 2319-7706Volume 3Number 5 pp. 395-401.

Karima, A.S. and Fathy, A.E. 2005. Effects of breed, sex and diet and their interactions on carcass composition and tissue weight distribution of broiler chickens Archiv Tierzucht Dummerstorf 48(6): 612–626.

Kayitesi, A. 2015. Management Systems and Location Effects on Growth and Carcass Traits of Kuroiler and Local Chickens. Thesis Submitted to Degree of Master of Science in Animal Science of Makerere University.

Kgwatalala, M., Moremedi, N., and Shalaulani, J.2012. Nsoso. Growth performance of different strains of indigenous Tswana chickens under intensive management system. African Journal of Agricultural Research Vol. 7(16), pp. 2438-2445, 26 April.

Kgwatalala, P.M. and Segokgo, P. 2013. Growth performance of Australorp x Tswana crossbred chicks under an intensive management system. International Journal of Poultry Science. 12:358-361.

Kgwatalala, P.M., Molapisi, M., Thutwa, K., Sekgopi, B., Selemoge, T.P., Nsoso, S.J 2016. Egg quality characteristics and phenotypic correlations among egg quality traits in the naked neck, normal and dwarf strains of Tswana chickens raised under intensive management system**,** International Journal of Environmental & Agriculture Research (IJOEAR), Vol-2 : 2454-1850

Kingori, A.M., Wachira, A.M. and Tuitoek, J.K. 2010. Indigenous chicken production in Kenya: a review. International Journal of Poultry Science 9: 309–316.

Mahrous, M., Galal, A., Fathi, M. Zein, M. and El-Dein, A. 2008. Impact of naked neck (Na) and frizzled (f) Genes on growth performance and Immunocompetence in chickens. International Journal of Poultry Science 7(1):45-54.)

Maleku, T. 2016. On farm Phenotypic Characterization of Indigenous Chicken Population and Their Production System at Wogdi, Borena and Legambo Districts in South Wollo Ethiopia. M.Sc .Thesis Submitted to the School of Animal and Range sciences, of Haramaya University. pp. 106.

Mammo, M., Berhan, T. and Tadelle, D.2008.Village chicken characteristics and their seasonal production situation in Jamma District, South Wollo, Ethiopia. J. Livest. Res. Rural Dev., Vol. 20. Number 8 August 2008.

Mammo, M., Birhan, T. and Tadelle, D. 2011. Village Chicken Constraints and Traditional Management Practices in Jamma District, South Wollo,Ethiopia. Livestock Research for Rural Development, 23(37).

Mapiye, C. and Sibanda S. 2005. Constraints and opportunities of village chicken production systems in the smallholder sector of Rushinga districts of Zimbabwe. Livest. Res. Rural Dev. 15(1). Available at http://www.cipav.org.co/lrrd/lrrd17/10/mapi17115.htm.

Mathur, P. K. 2003**.** Genotype- Environment Interactions: Problems Associated with Selection for Increased Production. In Poultry Genetics, Breeding and Biotechnology edited by M.W. Muir and S.E. Aggrey. CABI Publishing, UK, P. 546.

Mearg, F., 2016. Phenotypic Characterization of Local Chicken Ecotypes in the Central Zone of Tigray in Northern Ethiopia. M.Sc. Thesis Submitted to graduate study of Jimma University. pp. 148.

Mekonnen, G. E. 2007. Characterization of smallholder poultry production and marketing system of Dale, wonsho and loka abaya woredas of southern Ethiopia. MSc. Thesis presented to the School of Graduate Studies of Hawassa University.

Melese, G. and Melkamu, B. 2014. Assessment of Chicken Production under Farmers Management Condition in East Gojam Zone, Amhara Regional State, Ethiopia. *Greener Journal of Animal Breeding and Genetics*: Vol. 1 (1): 001-010.

Melesse, A., Maak, S. and von Lengerken G.2010 Effect of long-term heat stress on egg quality traits of Ethiopian naked neck chickens and their F1 crosses with Lohmann White and New Hampshire chicken breeds. Livest. Res. for Rural Development 22 (4), http://www.lrrd.org/lrrd 221/4/mele22071.htm.

Melesse, A., Maak, S. and Von Lengerken, G. 2011b. Effects of genetic group × ambient temperature interactions on performance and physiological responses of Naked-Neck chickens and their F1crosses with Lohmann White and New Hampshire laying hens. J. Anim. Feed Sci. 20,588-60.

Melesse, A., Zemene, W. and Yosef, T.2013. Assessment of the prevailing handling and quality of eggs from scavenging indigenous chickens reared in different agro-ecological zones of Ethiopia. J. Environmental and Occupational Sci. 2(1), 1-8 .

Melkamu B. and Andargie Z., Performance evaluation of local chicken at Enebsie Sar Midir Woreda, Eastern Gojjam, Ethiopia. Unique Res. J. 1(2), 6-10 (2013).

Mengesha, M.,. and Tsega,W. 2011. Phenotypic and genotypic characteristics of indigenous Chickens in Ethiopia: A review. African J. Agri. Res., 6(24): 5398-5404.

Meseret, M. 2010. Characterization of village chicken production and marketing system in Gomma woreda, Jimma zone, Ethiopia. M.Sc Thesis. Jimma University, Ethiopia.

Muchadeyi, F.C., Wollny, C.B.A., Eding, H., Weigend, S., Makuza, S.M. & Simianer, H., 2007, 'Variation in village chicken production systems among agro-ecological zones of Zimbabwe', *Tropical Animal Health and Production* 39, 453–461.

Mussawar,S., Durrani, T.M., Munir, K., Zahoor-ul-Haq Rahman, M.T. and Sarbiland, K., 2004. Status of layer farms in Peshawar division, Pakistan. Livestock Research for Rural Development,16(5).

Nakarin, P., Wiwat, P., Montri, P. and Tawatchai, T. 2014. Carcass characteristics and meat quality of Thai inheritance chickens. Journal of Agricultural Science 6(2): 182.

Nega, M., Aklilu H/Michael, Haimanot D. 2016. Reproductive and Productive Performance of Poultry Kept in Rural, Peri-Urban and Urban Settings in Assosa District, Benishangul Gumuz Region, Western Ethiopia. Nature and Science**41 (1**):8-14

Negassa, D., Aberra, M. and Sandip., Banerjee. 2014. Phenotypic characterization of indigenous chicken populations in Southeastern Oromia Regional State of Ethiopia. Animal Genetic Resources 55:101–113.

Nigussie Dana, Alemu Y., Tadelle, D. and Samue,l W. 2003. On-station and on-farm evaluation of the „hay-Box chick brooder" using different insulation materials at Debre Zeit Agricultural Research Center and Denbi village, Adaa woreda. In: *Proceedings of the 10th annual conference of the ESAP*. Addis Ababa, Ethiopia. Pp. 211–216

Nigussie, D. and Ogle, B. 2000. On farm evaluation of the performance of local and Rhode Island Red breeds of chicken maintained under different management regime in central high altitudes of Ethiopia. In proceedings of 8th annual conference of the Ethiopian society of animal production (ESAP), Addis Abeba, Ethiopia. pp. 123-134.

Nigussie, D., L.H. Van der Waaij, T. Dessie, and van Arendonk, J.A.M. 2010 b. Production objectives and trait preferences of village poultry producers of Ethiopia: Implications for designing breeding schemes utilizing indigenous chicken genetic resources. Trop. Anim. Health Prod., 42: 1519-1529.

Nigussie, D., Tadelle, D., Liesbeth, H., van der, W., Johan, A.M. and van, A. 2010a. Morphological Features of Indigenous Chicken Populations of Ethiopia. Animal Genetic Resources. Food and Agriculture Organization of the United Nations, 46: 11-23.

Niranjan, M., R.P. Sharma, U. Rajkumar, R.N.Chatterjee,B.L.N. Reddy and T.K. Battacharya, 2008. Egg quality traits in chicken varieties developed for backyard poultry farming in India. Livest. Res. Rural Dev., 20.

Njenga, S.K. 2005**.** Productivity and Socio-Cultural Aspects of Local Poultry Phenotypes in Coastal Kenya. Masters of Science Degree Thesis. Network for Smallholder Poultry

Development, the Royal Veterinary and Agricultural University, Dyrlaegevej 2, 1870 Frederiksberg C, Copenhagen, DENMARK.

NMA, 2015. National Metrological Agency, Jimma Station weather report of 2015, Jimma.

Onagbesan, O., Bruggeman, V., Desmit, L., Debonne, M., Witters, Tona, K., Everaert N,Decuypere, E. 2007. Gas Exchange during Storage and Incubation of Avian Eggs: effects on Embryogenesis, Hatchability, Chick quality and Post-hatch Growth. World's Poultry Science Journal. 63: 557-573.

Owens, C.M., Sams, A.R. 2000: The influence of transportation on turkey meat quality. Poult Sci., 79: 1204–1207.

Raji, A. O., Aliyu, J., Igwebuike, J. U., Chiroma, S. 2009. Effect of storage methods and time on egg quality traits of laying hens in a hot dry climate. Journal of Agricultural and Biological Science. 4: 1-7.

Rajkumar, R.P. Sharma, K.S. Rajaravindra, M. Niranjan, B.L.N. Reddy, T.K. Bhattacharya and Chatterjee, R.N. 2009. Effect of Genotype and Age on Egg Quality Traits in Naked Neck Chicken under Tropical Climate from India, *Int. J. Poult. Sci., 8 (12): 1151-1155*.

Riise, J., Permin, A., Mc Ainsh, CV. and Frederickson, L. 2004. Keeping village poultry. A technical manual on small-scale poultry production. Network for small holder poultry development. Chapter 1.

Roberts, J.R., 2004. Factors affecting egg internal quality and egg shell quality in laying hens. The Journal of Poultry Science, 41(3), pp.161-177.

Safaa, H., Serrano, M., Valencia, D.,Frikha, M., Jiménez-Moreno, E. and Mateos, G. 2008: Productive performance and egg quality of brown egg-laying hens in late phase of production as influenced by level and source of calcium in the diet. Poult. Sci., 87:2043-2051.

Sanka, Y.D. and Mbaga, S.H. 2014. Evaluation of Tanzanian local chicken reared under intensive and semi-intensive systems: II. Meat quality attributes Livestock Research for Rural Development 26(9): http://www.lrrd.org/lrrd26/9/sank26156.html

SAS (Statistical Analysis System), 2008. SAS Institute Inc., Cary, NC, USA.v,9.3.

Scott, T. A. and Silversides, F. G. 2000. The effect of storage and strain of hen on egg quality. Poultry Science. 79:1725- 1729.

Shapiro, B.I., Gebru, G., Desta, S., Negassa, A., Nigussie, K., Aboset G. and Mechale.H., 2017. Ethiopia livestock sector analysis. ILRI Project Report. Nairobi, Kenya: ILRI.

Shishay, M., Berhanu, B. and Tadelle, D. 2015. On Farm Performance Evaluation of Three Local Chicken Ecotypes in Western Zone of Tigray, Northern Ethiopia. *Journal of Biology, Agriculture and Healthcare* 5, no. 7: 158-169.

Solomon, D. 2003. Growth Performance and Survival of Local and White Leg Horne chicken under scavenging and intensive System of management in Ethiopia. Jimma College of Agriculture. Jimma Ethiopia.

Solomon, D. 2007. Suitability of hay-box brooding technology to rural household poultry production system. Jimma University College of Agriculture and Veterinary Medicine Jimma Ethiopia. pp. 1-2.

Solomon, Z., Binyam, K., Bilatu, A. and Ferede, A. 2013. Village chicken production systems in Metekel zone, Northwest Ethiopia. Wudpecker Journal of Agricultural Research. 2(9): 256 – 262.

Sonaiya, E. and Swan, S. 2005. Small-scale poultry production, technical guide manual. FAO Animal Production and Health. No.1. Food and Agriculture Organization (FAO), Rome, 2004,

SPSS (Statistical Packages for Social Sciences.) Window 2007 .SPSS User's guide Version 23.0. SPSS Institute Inc., Cary NC.

Tadelle, D. 2001. The role of scavenging poultry in integrated farming systems in Ethiopia. Debre Zeit Agricultural Research Center, Debre Zeit, Ethiopia. Livestock feed resources within 55 integrated farming systems. Pp.377 399. Available from http://www.fao.org/Ag/againfo/resources/documents/frg/conf96 pdf.

Tadelle, D. and Ogle, B. 2000. Nutritional status of village poultry in the central high lands of Ethiopia as assessed by analyses of crop contents. Eth. J. Agri. Sci., 17:47-57.

Tadelle, D., Kijora, C. and Peters, K.J.2003. Indigenous chicken ecotypes in Ethiopia: growth and feed utilization potentials. International Journal of Poultry Science 2: 144-152.

Tadelle, D., Million, T., Alemu, Y. and Peters, K.J. 2003. Village chicken production systems in Ethiopia: 1. Flock characteristics and performance. Livestock Research for Rural Development Vol. 15 (1). pp. 65-74.

Taju,S. 2017. Assessment of management practices and phenotypic characterization of indigenous chicken in Jimma zone. M.Sc. Thesis Submitted to Jimma University, Collage of Agriculture and Veterinary Medicine, Ethiopia.

Teklewold, H., Dadi, L., Yami, A. and Dana, N. 2006. Determinants of adoption of poultry technology: a double hurdle approach, Livestock Research for Rural Development, 18(3).

Tugcu, E. 2006. The village imagery created in commercials and the integrated chickens produced by Avian Flu. Milli Folklar Dergisi, 18 (71): 7 1-74.

USDA, 2016. Foreign Agricultural Service, Global Agricultural Information Network

Welelaw, E., Aberra, M., Mohammed, B., Mestawet, T. 2018. Assessing the Performance, Egg Quality, and Carcass Characteristics of Indigenous Chickens Reared Under Traditional Management System, International Journal of Research Studies in Agricultural Sciences (IJRSAS), *and Volume 4: 27-35.*

Worku, Z., Aberra,M. and T/giorgis, T. 2012. Assessment of Village chicken production system and the performance of local chicken population in West Amhara Region of Ethiopia. Journal of Animal Production Advances, 2 (4):199-207.

Yakubu, A., Muhammed, M.M., Ari, M.M., Musa-Azara, I.S. and Omeje, J.N. 2015. Correlation and path coefficient analysis of body weight and morphometric traits of two exotic genetic groups of ducks in Nigeria. Bangladesh J. Anim. Sci., 44:1-9.

Yakubu, D.M. Ogah and R.E. Barde:2008. Productivity and Egg Quality Characteristics of Free Range Naked Neck and Normal Feathered Nigerian Indigenous Chickens. International Journal of Poultry Science 7 (6): 579-58.

Yamane, T. 1967. Statistics, an Introductory Analysis, 2nd Ed., New York: Harper and Row.

Younis, H.H. and Galal, A. 2006. Impact of dwarf (dw), rapid feathering (K+) and naked neck.

Zhao, J. P., Zhao, G. P., Jiang, R. R., Zheng, M. Q., Chen, J. L., Liu,R. R., and Wen, J. 2012. Effects of diet-induced differences in growth rate on metabolic, histological, and meat-quality properties of 2 muscles in male chickens of 2 distinct broiler breeds. Poult. Sci.91 (1): 23-47.

APPENDIX

APPENDIX 1: Lists of ANOVA table

Appendix Table 1 ANOVA table for Chicken flock size per household by different age and sex groups

			Sum of Squares	df	Mean Square	F	Sig.
Chicks _NF*NN ecotypes	Between Groups	(Combined)	32.650	1	32.650	6.769	.010
	Within Groups		1364.978	283	4.823		
	Total		1397.628	284			
Pullet_NF*NN ecotypes	Between Groups	(Combined)	18.215	1	18.215	11.785	.001
	Within Groups		437.413	283	1.546		
	Total		455.628	284			
Cockerel_ NF*NN ecotypes	Between Groups	(Combined)	35.803	1	35.803	57.203	.000
	Within Groups		177.130	283	.626		
	Total		212.933	284			
Hen_ NF*NN ecotypes	Between Groups	(Combined)	132.620	1	132.620	24.739	.000
	Within Groups		1517.113	283	5.361		
	Total		1649.733	284			
Cock_ NF*NN ecotypes	Between Groups	(Combined)	8.646	1	8.646	20.760	.000
	Within Groups		117.866	283	.416		
	Total		126.512	284			

Appendix Table 2 ANOVA table for Productive and reproductive performance of chickens in studies areas

Source	Dependent Variable	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	Age at First Mating	.350[a]	1	.350	17.894	.013
	Age at First Egg Lay	.248[b]	1	.248	61.000	.001
	Total Egg set	.000[c]	1	.000	.	.
	Fertile Egg	29.570[d]	1	29.570	6.000	.070
	Hatchability on TES	52.747[e]	1	52.747	6.407	.065
	Hatchability on FES	151.504[f]	1	151.504	8.552	.043
Intercept	Age at First Mating	142.594	1	142.594	7281.383	.000
	Age at First Egg Lay	198.145	1	198.145	48724.197	.000
	Total Egg set	12150.000	1	12150.000	.	.
	Fertile Egg	40560.770	1	40560.770	8230.008	.000
	Hatchability on TES	16593.197	1	16593.197	2015.564	.000
	Hatchability on FES	24862.269	1	24862.269	1403.480	.000
Breed	Age at First Mating	.350	1	.350	17.894	.013
	Age at First Egg Lay	.248	1	.248	61.000	.001
	Total Egg set	.000	1	.000	.	.
	Fertile Egg	29.570	1	29.570	6.000	.070
	Hatchability on TES	52.747	1	52.747	6.407	.065
	Hatchability on FES	151.504	1	151.504	8.552	.043
Error	Age at First Mating	.078	4	.020		
	Age at First Egg Lay	.016	4	.004		
	Total Egg set	.000	4	.000		
	Fertile Egg	19.714	4	4.928		
	Hatchability on TES	32.930	4	8.233		
	Hatchability on FES	70.859	4	17.715		
Total	Age at First Mating	143.022	6			
	Age at First Egg Lay	198.409	6			
	Total Egg set	12150.000	6			
	Fertile Egg	40610.054	6			
	Hatchability on TES	16678.874	6			
	Hatchability on FES	25084.632	6			

Appendix Table 3 ANOVA table for Mean body weight, weight gain of chicks during brooding stages

			Sum of Squares	df	Mean Square	F	Sig.
Average Day Old weight * Ecotype	Between Groups	(Combined)	30.150	1	30.150	16.227	.016
	Within Groups		7.432	4	1.858		
	Total		37.583	5			
Average Weekly weight gain * Ecotype	Between Groups	(Combined)	5.549	1	5.549	5.939	.071
	Within Groups		3.737	4	.934		
	Total		9.286	5			
AWG_W2 * Ecotype	Between Groups	(Combined)	165.795	1	165.795	4.560	.100
	Within Groups		145.425	4	36.356		
	Total		311.220	5			
AWG_W3 * Ecotype	Between Groups	(Combined)	284.006	1	284.006	4.480	.102
	Within Groups		253.554	4	63.388		
	Total		537.560	5			
AWG_W4 * Ecotype	Between Groups	(Combined)	3114.937	1	3114.937	26.366	.007
	Within Groups		472.569	4	118.142		
	Total		3587.507	5			
AWG_W5 * Ecotype	Between Groups	(Combined)	1691.089	1	1691.089	13.511	.021
	Within Groups		500.674	4	125.168		
	Total		2191.763	5			
AWG_W6 * Ecotype	Between Groups	(Combined)	4527.056	1	4527.056	7.225	.031
	Within Groups		2506.159	4	626.540		
	Total		7033.215	5			
AWG_W7 * Ecotype	Between Groups	(Combined)	14815.570	1	14815.570	14.385	.019
	Within Groups		4119.688	4	1029.922		
	Total		18935.259	5			
AWG_W8 * Ecotype	Between Groups	(Combined)	16342.777	1	16342.777	13.014	.023
	Within Groups		5022.988	4	1255.747		
	Total		21365.764	5			

Table 4 ANOVA table for Mean daily feed intake of chicks during brooding stages

			Sum of Squares	df	Mean Square	F	Sig.
Average Daily Feed Intake * Ecotype	Between Groups	(Combined)	8.616	1	8.616	10.598	.031
	Within Groups		3.252	4	.813		
	Total		11.868	5			
ADFI_W2 * Ecotype	Between Groups	(Combined)	6.100	1	6.100	.960	.383
	Within Groups		25.422	4	6.355		
	Total		31.522	5			
ADFI_W3 * Ecotype	Between Groups	(Combined)	12.442	1	12.442	1.087	.356
	Within Groups		45.790	4	11.447		
	Total		58.231	5			
ADFI_W4 * Ecotype	Between Groups	(Combined)	53.342	1	53.342	13.266	.022
	Within Groups		16.084	4	4.021		
	Total		69.426	5			
ADFI_W5 * Ecotype	Between Groups	(Combined)	62.727	1	62.727	12.283	.025
	Within Groups		20.427	4	5.107		
	Total		83.153	5			
ADFI_W6 * Ecotype	Between Groups	(Combined)	46.593	1	46.593	31.659	.005
	Within Groups		5.887	4	1.472		
	Total		52.480	5			
ADFI_W7 * Ecotype	Between Groups	(Combined)	31.556	1	31.556	12.743	.023
	Within Groups		9.905	4	2.476		
	Total		41.462	5			
ADFI_W8 * Ecotype	Between Groups	(Combined)	39.270	1	39.270	13.125	.022
	Within Groups		11.968	4	2.992		
	Total		51.239	5			

Appendix Table 5 ANOVA table for Mean body weight, body weight gain and feed intake of chickens from 9th to 16th weeks of age

			Sum of Squares	df	Mean Square	F	Sig.
Average daily feed intakeatweek9 * Ecotype	Between Groups	(Combined)	257.058	1	257.058	4.568	.058
	Within Groups		562.679	10	56.268		
	Total		819.737	11			
ADFI_W10 * Ecotype	Between Groups	(Combined)	315.905	1	315.905	5.270	.045
	Within Groups		599.412	10	59.941		
	Total		915.318	11			
ADFI_W11 * Ecotype	Between Groups	(Combined)	353.276	1	353.276	5.735	.038
	Within Groups		616.045	10	61.605		
	Total		969.321	11			
ADFI_W12 * Ecotype	Between Groups	(Combined)	338.672	1	338.672	5.042	.049
	Within Groups		671.649	10	67.165		
	Total		1010.321	11			
ADFI_W13 * Ecotype	Between Groups	(Combined)	300.500	1	300.500	5.330	.044
	Within Groups		563.745	10	56.375		
	Total		864.245	11			
ADFI_W14 * Ecotype	Between Groups	(Combined)	295.120	1	295.120	5.471	.041
	Within Groups		539.404	10	53.940		
	Total		834.524	11			
ADFI_W15 * Ecotype	Between Groups	(Combined)	417.720	1	417.720	8.070	.018
	Within Groups		517.641	10	51.764		
	Total		935.361	11			
ADFI_W16 * Ecotype	Between Groups	(Combined)	411.958	1	411.958	7.785	.019
	Within Groups		529.166	10	52.917		
	Total		941.124	11			
Average weekly weight gain week10 * Ecotype	Between Groups	(Combined)	177083.826	1	177083.826	6.334	.031
	Within Groups		279569.509	10	27956.951		
	Total		456653.335	11			
AWG_W12 * Ecotype	Between Groups	(Combined)	226163.309	1	226163.309	6.557	.028
	Within Groups		344910.437	10	34491.044		
	Total		571073.746	11			
AWG_W14 * Ecotype	Between Groups	(Combined)	255374.610	1	255374.610	5.578	.040
	Within Groups		457856.868	10	45785.687		
	Total		713231.478	11			
AWG_W16 * Ecotype	Between Groups	(Combined)	393468.732	1	393468.732	6.949	.025
	Within Groups		566193.782	10	56619.378		
	Total		959662.514	11			

Appendix Table 6 ANOVA table for Mean body weight, weight gain and feed intake of chickens from 17th to 24th weeks of age

			Sum of Squares	df	Mean Square	F	Sig.
AWG_W18 * Ecotype	Between Groups	(Combined)	406286.720	1	406286.720	5.331	.044
	Within Groups		762108.766	10	76210.877		
	Total		1168395.486	11			
AWG_W20 * Ecotype	Between Groups	(Combined)	536111.682	1	536111.682	5.478	.041
	Within Groups		978593.516	10	97859.352		
	Total		1514705.198	11			
AWG_W22 * Ecotype	Between Groups	(Combined)	600683.728	1	600683.728	5.804	.037
	Within Groups		1035031.683	10	103503.168		
	Total		1635715.411	11			
AWG_W24 * Ecotype	Between Groups	(Combined)	612826.123	1	612826.123	5.494	.041
	Within Groups		1115533.420	10	111553.342		
	Total		1728359.543	11			
ADFI_W17 * Ecotype	Between Groups	(Combined)	340.800	1	340.800	5.220	.045
	Within Groups		652.829	10	65.283		
	Total		993.630	11			
ADFI_W18 * Ecotype	Between Groups	(Combined)	380.025	1	380.025	7.322	.022
	Within Groups		518.996	10	51.900		
	Total		899.021	11			
ADFI_W19 * Ecotype	Between Groups	(Combined)	566.225	1	566.225	13.633	.004
	Within Groups		415.326	10	41.533		
	Total		981.551	11			
ADFI_W20 * Ecotype	Between Groups	(Combined)	545.940	1	545.940	8.803	.014
	Within Groups		620.205	10	62.020		
	Total		1166.145	11			
ADFI_W21 * Ecotype	Between Groups	(Combined)	616.907	1	616.907	10.025	.010
	Within Groups		615.348	10	61.535		
	Total		1232.255	11			
ADFI_W22 * Ecotype	Between Groups	(Combined)	669.461	1	669.461	11.691	.007
	Within Groups		572.608	10	57.261		
	Total		1242.070	11			
ADFI_W23 * Ecotype	Between Groups	(Combined)	400.207	1	400.207	8.532	.015
	Within Groups		469.051	10	46.905		
	Total		869.258	11			
ADFI_W24 * Ecotype	Between Groups	(Combined)	443.962	1	443.962	7.101	.024
	Within Groups		625.232	10	62.523		
	Total		1069.193	11			

Appendix Table 7 ANOVA table for Fertility and Hatchability of experimental chickens

			Sum of Squares	df	Mean Square	F	Sig.
Age at First Mating * Ecotype	Between Groups	(Combined)	.350	1	.350	17.894	.013
	Within Groups		.078	4	.020		
	Total		.429	5			
Age at First Egg Lay * Ecotype	Between Groups	(Combined)	.248	1	.248	61.000	.001
	Within Groups		.016	4	.004		
	Total		.264	5			
Fertile Egg * Ecotype	Between Groups	(Combined)	29.570	1	29.570	6.000	.070
	Within Groups		19.714	4	4.928		
	Total		49.284	5			
Hatchability on TES * Ecotype	Between Groups	(Combined)	52.747	1	52.747	6.407	.065
	Within Groups		32.930	4	8.233		
	Total		85.677	5			
Hatchability on FES * Ecotype	Between Groups	(Combined)	151.504	1	151.504	8.552	.043
	Within Groups		70.859	4	17.715		
	Total		222.363	5			

Appendix Table 8 ANOVA table for Mean hen-day egg production of experimental chicken

			Sum ofSquares	df	Mean Square	F	Sig.
Month one hen day egg production * Ecotype	Between Groups	(Combined)	3.588	1	3.588	4.130	.112
	Within Groups		3.476	4	.869		
	Total		7.064	5			
Month two hen day egg production * Ecotype	Between Groups	(Combined)	50.983	1	50.983	8.672	.042
	Within Groups		23.517	4	5.879		
	Total		74.500	5			
Month three hen day egg production * Ecotype	Between Groups	(Combined)	84.901	1	84.901	33.761	.004
	Within Groups		10.059	4	2.515		
	Total		94.960	5			
Month four hen day egg production * Ecotype	Between Groups	(Combined)	46.204	1	46.204	28.877	.006
	Within Groups		6.400	4	1.600		
	Total		52.604	5			
Month five hen day egg production * Ecotype	Between Groups	(Combined)	99.471	1	99.471	68.560	.001
	Within Groups		5.803	4	1.451		
	Total		105.274	5			
Month six hen day egg production * Ecotype	Between Groups	(Combined)	95.521	1	95.521	21.164	.010
	Within Groups		18.053	4	4.513		
	Total		113.574	5			

Appendix Table 9 ANOVA table for external egg quality traits measurements of chickens

			Sum of Squares	df	Mean Square	F	Sig.
MeaneggWeight.gm * Ecotypes	Between Groups	(Combined)	20.999	1	20.999	61.073	.001
	Within Groups		1.375	4	.344		
	Total		22.374	5			
E.width.cm * Ecotypes	Between Groups	(Combined)	.027	1	.027	14.848	.018
	Within Groups		.007	4	.002		
	Total		.034	5			
E.length.cm * Ecotypes	Between Groups	(Combined)	.031	1	.031	9.386	.038
	Within Groups		.013	4	.003		
	Total		.044	5			
E.shape. ind * Ecotypes	Between Groups	(Combined)	27.009	1	27.009	41.815	.003
	Within Groups		2.584	4	.646		
	Total		29.592	5			
Shell.wt.gm * Ecotypes	Between Groups	(Combined)	1.731	1	1.731	24.164	.008
	Within Groups		.287	4	.072		
	Total		2.018	5			
Breakingstength.kg.m3 * Ecotypes	Between Groups	(Combined)	.003	1	.003	.255	.640
	Within Groups		.050	4	.012		
	Total		.053	5			
Shellthick.mm * Ecotypes	Between Groups	(Combined)	.000	1	.000	.643	.468
	Within Groups		.003	4	.001		
	Total		.003	5			

Appendix Table 10 ANOVA table for internal egg quality traits measurements of chickens

			Sum of Squares	df	Mean Square	F	Sig.
Y.color * Ecotypes	Between Groups	(Combined)	.002	1	.002	.082	.789
	Within Groups		.110	4	.027		
	Total		.112	5			
Y.length.mm * Ecotypes	Between Groups	(Combined)	.005	1	.005	.146	.722
	Within Groups		.128	4	.032		
	Total		.132	5			
Y.width.mm * Ecotypes	Between Groups	(Combined)	1.707	1	1.707	1.664	.267
	Within Groups		4.104	4	1.026		
	Total		5.810	5			
Y.height.mm * Ecotypes	Between Groups	(Combined)	2.415	1	2.415	68.060	.001
	Within Groups		.142	4	.035		
	Total		2.557	5			
Y.weight.gm * Ecotypes	Between Groups	(Combined)	2.574	1	2.574	37.100	.004
	Within Groups		.278	4	.069		
	Total		2.852	5			
Y.index * Ecotypes	Between Groups	(Combined)	2.441	1	2.441	4.277	.107
	Within Groups		2.283	4	.571		
	Total		4.724	5			
Alb.length.mm * Ecotypes	Between Groups	(Combined)	.407	1	.407	2.093	.222
	Within Groups		.778	4	.195		
	Total		1.185	5			
Alb.width.mm * Ecotypes	Between Groups	(Combined)	8.481	1	8.481	12.258	.025
	Within Groups		2.767	4	.692		
	Total		11.248	5			
Alb.height.mm * Ecotypes	Between Groups	(Combined)	.640	1	.640	9.666	.036
	Within Groups		.265	4	.066		
	Total		.905	5			
Alb.weight.gm * Ecotypes	Between Groups	(Combined)	9.509	1	9.509	13.028	.023
	Within Groups		2.920	4	.730		
	Total		12.428	5			
Haugunit * Ecotypes	Between Groups	(Combined)	27.735	1	27.735	10.037	.034
	Within Groups		11.053	4	2.763		
	Total		38.788	5			

Appendix Table 11 ANOVA table for Mean values for carcass and organ characteristics of male chicken at the age of 24 weeks

			Sum of Squares	df	Mean Square	F	Sig.
Live.wt * Ecotype	Between Groups	(Combined)	77668.504	1	77668.504	22.499	.009
	Within Groups		13808.223	4	3452.056		
	Total		91476.727	5			
Carcass.wt * Ecotype	Between Groups	(Combined)	100752.338	1	100752.338	95.321	.001
	Within Groups		4227.922	4	1056.980		
	Total		104980.259	5			
dressing.percen * Ecotype	Between Groups	(Combined)	57.252	1	57.252	66.444	.001
	Within Groups		3.447	4	.862		
	Total		60.699	5			
Breast.wt * Ecotype	Between Groups	(Combined)	12732.827	1	12732.827	62.960	.001
	Within Groups		808.942	4	202.235		
	Total		13541.768	5			
Thigh.drumi * Ecotype	Between Groups	(Combined)	13010.727	1	13010.727	82.776	.001
	Within Groups		628.722	4	157.180		
	Total		13639.448	5			
Wing.wt * Ecotype	Between Groups	(Combined)	1091.611	1	1091.611	18.271	.013
	Within Groups		238.983	4	59.746		
	Total		1330.594	5			
Back * Ecotype	Between Groups	(Combined)	1702.693	1	1702.693	2.762	.172
	Within Groups		2466.153	4	616.538		
	Total		4168.846	5			
Neck * Ecotype	Between Groups	(Combined)	137.282	1	137.282	59.580	.002
	Within Groups		9.217	4	2.304		
	Total		146.498	5			
Skin * Ecotype	Between Groups	(Combined)	477.934	1	477.934	12.223	.025
	Within Groups		156.408	4	39.102		
	Total		634.342	5			
Heart * Ecotype	Between Groups	(Combined)	1.426	1	1.426	5.913	.072
	Within Groups		.965	4	.241		
	Total		2.391	5			
Gizzard * Ecotype	Between Groups	(Combined)	1.760	1	1.760	3.059	.155
	Within Groups		2.302	4	.575		
	Total		4.062	5			
Liver * Ecotype	Between Groups	(Combined)	3.353	1	3.353	5.351	.082
	Within Groups		2.506	4	.627		
	Total		5.859	5			

Appendix Table 12 ANOVA table for Mortality rates of chickens at different growing stage

			Sum of Squares	df	Mean Square	F	Sig.
Mort. Brood * Ecotype	Between Groups	(Combined)	66.667	1	66.667	7.200	.055
	Within Groups		37.037	4	9.259		
	Total		103.704	5			
Mort. Grower * Ecotype	Between Groups	(Combined)	46.296	1	46.296	12.500	.024
	Within Groups		14.815	4	3.704		
	Total		61.111	5			
Mort. * Ecotype	Between Groups	(Combined)	66.689	1	66.689	12.016	.026
	Within Groups		22.200	4	5.550		
	Total		88.889	5			
Total. Mort * Ecotype	Between Groups	(Combined)	46.265	1	46.265	44.952	.003
	Within Groups		4.117	4	1.029		
	Total		50.382	5			

APPENDIX 2. List of study pictures

Picture of the girl that feed the indigenous chickens at backyard areas

Picture of the experimental chicks at different stages

Picture taken during egg quality measurements of the experimental study

APPENDIX 3. Survey sample questionnaire

1. Socio-economic characteristics

Name of Enumerator _____ Signature ___Date_____

Respondents' name_____ Sex ___Age___ District_____ Kebele _____No____

Educational level (tick one)

Illiterate	
Religious school	
Writing & reading	
Primary (1-6)	
Junior high school (8 -12)	
Other	

Family size living in the house by age and sex.

Age classification	Number	
	Males	Females
<18years		
Between 18-65 years		
> 65 years		

2. Distribution of naked neck and normal feathered chickens in study area

2.1. Is there naked neck chicken in your locality? a)Yes b) No

2.1.1. If no why did they are not there? a) Lack of awareness about them b) their productive and reproductive performances c) less preferred to the market d) religious and cultural taboo d) other

2.1.2. If you maintain both naked neck and normal feathered chicken, do see any difference in egg production potential? a) Yes b) No

2.1.2.1. If yes which type of breed is more productive? a) Naked neck b) normal feathered

2.1.2.2. If you maintain both naked neck and normal feathered chicken, do you see any difference in body weight gain? a) Yes b) No

2.1.2.3. If yes, which type of breed does best in weight gain? a) Naked neck b) normal feathered

3. Production and reproductive performance

3.1. Classify your chicken flock according to their age and production importance

Chicken	Total No.	No. of local chickens	
		Full feathered	Naked neck
Chick(0-8wks)			
Pullet(8-20wks)			
Cockerel(8-20wks)			
Hen(>20wks)			
Cock(>20wks)			

3.1.1. Production status of chicken

Breed	Age at 1st service	Age at 1st egg laying	Nº clutches per year	Nº eggs per clutch	Length of clutch in days	Total egg per year	Nº of eggs		Survival rate	Nº of days in brooding
							Incubated	Hatched		
Fullfeathered										
Naked neck										

3.1.2. Do you grade (select) eggs before incubation?

a) Yes b) No

If yes, what do you observe during selection of eggs?

a) Breed type b) Size of the eggs c) Shape of the eggs d) Cleanness of the eggs (dirtiness) e) Shell condition (crackness) f) Other

3.1.3. Is there any difference in egg size and weight between normal feathered and naked neck chicken? a) Yes b) No

i. If yes which type of breed laid large size and weight eggs? a) Naked neck b) normal feathered

2.4. How would you describe broodiness in your hens?

No	Broodiness characters	Normal feathered	Naked neck
1	Common		
2	Sometimes		
3	Rare		

4. over all managements of chickens

4.1. Do you construct separate house for your chickens? 1) Yes 2) No

4.1.2. If yes, for which type of your chicken breed you construct separate house? 1) Naked neck 2) Normal feathered 3) For both of the breed

4.1.2. What type house you construct for your chickens? A) Iron sheet and wood B) Bamboo cages C) Bamboo/grass with wood D) Wooden made with grass roof

4.1.3. If no, why you did not construct separate house? 1) Lack of awareness 2) Lack of construction 3) Risk of predators 4) Risk of thefts 5)Others(specify)

4. Identifying the responsibilities of household members in chickens production and reproduction management

No	Activities	Adult		<15 year	
		Males	Females	Boy	Girl
1	Chick management				
2	Supplementary feeding				
3	Providing water				

5. How would you describe the temperament of your chickens?

No	Temperament character	Normal feathered	Naked neck
1	Docile Moderately		
2	Tractable		
3	Wild/Aggressive		
4	Unknown		

5.1. Do you provide a supplementary feed for your chicken? a) Yes b)No
5.1.1. If yes, which type of the breed needs more supplementary feeds?
a) Naked neck b) Normal feather c) there is no any difference
5.1.2. Is there any difference in daily feed consumption between naked neck and normal feathered chicken? a) Yes b) No
5.1.3. If yes, which type of breed does consume more feed? A) Naked neck b) normal feathered
5.1.4. Do you provide water for your chickens? 1) Yes 2) No
5.1.5. Is there any difference in the provision of water between the breeds? 1) Yes 2) No
5.1.6. If yes, for which of chicken your breed you provide more water? 1) Naked neck 2) Normal feathered 3) No any difference
5.1.7. For how frequent do you provide water for your chickens? 1) Once a day 2) Twice a day 3)Adlibitum
5.1.7. What are the sources of water during dry and wet season for your chicken breed? 1) Rivers 2) Ponds 3) Springs 4) Rain 5) Others (identify)
5.1.8. Identifying disease and heat stress resistance ability of chicken
5.1.9. Have you observed any variation in disease resistance between naked neck and normal feathered chicken? a) Yes b) no
5.1.10. If yes which type of breed has more disease resistance ability? A) Naked neck b) normal feathered
5.1.12. Have you observed any variation in disease resistance ability between naked neck and normal feathered chicken? a) Yes b) no
5.1.13. If yes which type of breed has more disease ability? A) Naked neck b) normal feathered
6. Identifying rearing, consumption and market preference in your area
6.1. Which breed do you prefer to maintain (rear)?
a) Naked neck b) normal feather c) others
6.2. The reason why you select a, b or c in the above question?
a) Egg production potential b) meat preference c) amount of meat produced d) disease resistance e) feed conversion efficiency f) market preferences of their products g) easiness to manage h) others
6.3. Which type of breed do you prefer to consume their eggs?
a) Naked neck b) Normal feathered c) others
6.4. The reason why you select a, b, or c in the above question
a) Taste of egg b) egg size) c egg color d) egg weight e) other
6.5. Which type of breed does your customer (buyers) wants to buy for consumption of egg?
a) Naked neck b) normal feathered c) other
6.7. The reason why consumers select a, b, or c in the above question
a) Taste of egg b) egg size c) egg color d) egg weight e) other
6.8. Which type of breed you prefer to consume their meat?
a) Naked neck b) Normal feathered c) other
6.9. The reason why you prefer a, b, c in the above question
a) Carcass yield (meat production) b) Taste of meat c) other
6.10. Which type of breed does your customer (buyers) wants to buy for consumption of meat?

a) Naked neck b) Normal feathered c) other

6.11. The reason why consumers prefer a, b, or c

a) Carcass yield (meat production) b) Taste of meat c) other

7. Identify the population trend of naked neck chicken in the area

i. Did your naked neck chicken flock size change during the last years?
   a. No, remained same
   b. Yes, showing increased trend
   c. Yes, showing decreased trend

ii. If it showed the decreasing trend why? Reason out
_____
_____
_

iii. If it showed the increasing trend why? Reason out_____
_____
___

8. Tell us the overall constraints' encountered with production, reproduction and management of naked neck chicken

_____
_____

I. Check List For Focal Group Discussion

1. History and preference of normal feathered and naked neck chickens with its reasons.
2. Social laws
   - ➢ Poultry keeping
   - ➢ Religious taboo
3. Proportion and population trends of naked neck chicken in the area?
4. If there is a reduction trend on the naked neck chicken population, what are the major causes for their loss including its mitigation measures?
5. Indigenous knowledge in evaluating performance of indigenous chickens
   - ✓ Special qualities of indigenous chicken
   - ✓ Good and undesirable character of naked neck chicken compared with others trait preference of naked neck chickens