ADDIS ABABA UNIVERSITY

COLLEGE OF VETERINARY MEDICINE AND AGRICULTURE

ASSESSMENT OF LAYER HUSBANDRY PRACTICES, NUTRIENT EVALUATION OF LAYER COMMERCIAL FEEDS AND THEIR EFFECTS ON PRODUCTION PERFORMANCE AND EGG WEIGHT IN BISHOFTU TOWN, ADA'A AND LUME WOREDAS, ETHIOPIA.

MSC THESIS

BY

HAWENI ASFEWU FIDA

DEPARTMENT OF PARASITOLOGY, MICROBIOLOGY AND POULTRY HEALTH

MSC. PROGRAM IN POULTRY HEALTH AND MANAGEMENT

JUNE, 2025

BISHOFTU, ETHIOPIA

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As members of the Examining Board of the final MSc open defense, we certify that we have read and evaluated the thesis prepared by Haweni Asfewu Fida;

Titled: **Assessment Of Layer Husbandry Practices, Nutrient Evaluation Of Layer Commercial Feeds And Their Effects On Production Performance And Egg Weight In Bishoftu Town, Lume And Ada'a Woredas, Ethiopia**; and recommend that it be accepted as fulfilling the thesis requirement for the Master of Science in Poultry health and management.

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DEDICATION

This thesis is dedicated to my beloved families, my wife Mrs. Chaltu Adimasu for her love, encouragement, and moral support throughout my life; my mother-in-law, whose love and support have made a difference in my lives; and my daughter Qaro Haweni for her unreserved love.

STATEMENT OF THE AUTHOR

First, I declare that this thesis is my own work and that all sources of materials used for this thesis have been properly acknowledged. It has been submitted in partial fulfillment of the requirements for MSc. Degree at Addis Ababa University, college of veterinary medicine and agriculture, and is deposited at the university library to be made available to borrowers under rules of the library. I seriously declare that this thesis is not submitted to any other institution anywhere for the award of any academic degree, diploma or certificate. Brief questions from this dissertation are allowable without special permission provided that accurate acknowledge of the source is made. Requests for permission for extended quotation from or reproduction of this manuscript in whole or in part may be granted by the head of the graduate studies when in his or her judgement the proposed use of the material is in the interests of scholarship. In all other instances, however, permission must be obtained from the author.

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ACKNOWLEDGEMENT

First, I would like to thank almighty God for giving me strength, healthy, ability and opportunity to accomplish my MSc. study and the research work successfully. I am exceptionally great full to my major advisor Ewonetu kebede for his constructive comments, professional guidance, support, suggestions, and excellent cooperation starting from proposal development and until the last time of this thesis. Next, gratitude thanks to my co-advissors Dr. Abdi Feyissa and Dr.Samuel Mulatu for their encouragement, constructive, and valuable comments

I would like to express my deepest gratitude to Addis Ababa university, College of Veterinary medicine and Agriculture for hosting and givng me opportunity of pursuing my MSc. Education. I would like to express also my deepest and sincere gratitude to "MINE "project for granting this Thesis research.

I would like to extend my heartfelt gratitude to Dr. Amanu Marama, Dr. Zemenu Tsehay and Milki Mojo for their technical support. I sincerely appreciate the Commercial layer farm owners who generously took the time to respond to my questionnaire and granted me access to their farms. Additionally, I extend my heartfelt thanks to the Ada'a, Lume, Bishoftu local administrators who supported me in identifying and reaching chicken farms, ensuring the success of my research.

My heartfelt thanks is also forwarded to a very special person, my wife Chaltu Adimasu Yadeta for her continuous love and moral support. I also appreciate my daughter Qaro Haweni Asfewu for abiding my ignorance and the patience she showed during my study. I am forever indebted to my mother-in law Mrs. Kuluche Nemera for her support in all direction.

ABBREVIATIONS

ANOVA	Analysis of Variance
AOAC	Association of Official Analytical Chemist
CF	Crude Fat
CF	Crude Fiber
CP	Crude protein
DM	Dry Matter
EW	Egg Weight
FCR	Feed Conversion Ratio
HDEP	Hen Day Egg Production
IBD	Infectious Bursal disease
ME	Metabolizable Energy
NCD	Newcastle disease
NFE	Nitrogen Free Extract

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ABSTRACT

The productivity and efficiency of layer chickens are heavily influenced by husbandry practices and the quality of feed. A Cross sectional study design was conducted in Bishoftu town, Ada'a and Lume Woredas, from October, 2024 to May, 2025 to assess layer husbandry practices, nutrient evaluation of layer commercial feeds and their effects on production performance and egg weight. A total of 89 layer farms, 67, 13, and 9 small, medium and large-scale layer farms, respectively, were purposefully selected using a snowball sampling method. Data was gathered through questionnaires, and feed samples were analyzed to determine their chemical composition. Daily records were kept on egg production and feeding practices, while egg weight was determined by weighing sample eggs from each farm. Descriptive statistics and Analysis of variances (ANOVA) were used to analyse the results. The findings of this study indicated that intensive layer keeping system (100%), commercial mash feed forms (100%), and thrice-feeding frequency (82%), controlled feeding method (100%), and supplement vitamins (100%) are all used by the layer farmers in the study area. Commercial layer feed from the same suppliers was utilized by 52.81% of layer farmers in the research area because of personal quality perception (48.31%), nearby availability (52.81%), and cheaper price (5.62%). Due to a lack of laboratory access, not all layer farmers in the study area evaluated feed quality (100%). Eight hens per square meter are provided by the commercial layer producers, who also use a deep litter housing system (94%), dispose of litter material at the end of the laying cycle (92%) and use natural ventilation (100%). Despite frequent power outages (100%), commercial layer farmers use electric power (100%) to provide a photoperiod of 12–16 hours. The Newcastle disease (73%) mostly affects the commercial layer farmers though they administer vaccine against the disease (76.4%). Feed analysis result revealed that the nutrient composition of layers feed: Crude protein, Crude fat, crude fiber, total ash, metabolizable energy and nitrogen free extract were statistically significant ($p < 0.05$) among different feed sources. The analysis revealed that 91.09-92.25% dry matter, 14.51-19.96% crude protein, 3.87 to 5.60% crude fat, 3.72-5.26% Crude fiber, 11.0-17.76% ash and 2742.50 to 2914.07 kcal/kg metabolizable energy for commercial layer diet processed by different feed processing plant. The study showed that the effects of different feed sources on the hen- day egg production, egg weight and feed intake were not statistically significant ($p > 0.05$). By providing 107-122 g of feed per day, the commercial layer farmers achieve 58-94% hen-day egg production with 57-60.6 g egg weight, resulting in a feed conversion ratio of 1.1-2.9. This study confirmed that commercial layer farmers that rear the same breed and identical laying stages feed layer chickens obtained from different feed processing plants result in layer diets with variable nutritional contents, which affects the weight and egg production of the layers. Therefore, there should be training for poultry farm owners on husbandry practices, strict regulation of layers feed producing companies on the composition of the feed and strict regular vaccination schedule should be applied.

Key-words: *Commercial feeds, Egg weight, Feed conversion ratio, Hen Day Egg Production, Husbandry practice, Poultry production, proximate analysis*

1. INTRODUCTION

Poultry production is a vital subsector of worldwide agriculture contributing to food security and economic development, and it is dominated by chickens (Erdaw and Wude, 2022). Raising poultry for meat, eggs and feathers has been vital to food production since the beginning of agriculture (Grzinic *et al.,* 2023). The global poultry population has seen consistent growth due to increasing demand for affordable protein sources like chicken meat and eggs, and also it is a vital component of the Ethiopian agriculture (Fekadu *et al.*, 2023). Rearing poultry can be in different management and production system in Ethiopia. Depending on the objective, housing, biosecurity, technology, flock size, breed, feeding poultry production system is divided in to small scale, medium and large scale commercial poultry production system (Amare and Tesfaye, 2020). Eggs and meat from poultry are two of the most popular foods consumed worldwide (Govoni *et al.,* 2021). Eggs, as nutrient reach poultry products, can help combat stunning in children suffering nutrient deficient diets.

Ethiopia has a huge demand for chicken meat and eggs, which has resulted in the development and growth of modern, organized poultry farms throughout the country, especially in peri-urban and urban areas (Sime, 2022). This sector plays a critical role in creating jobs, enhancing family nutrition, and giving access to the economy (Tirfie, 2021). Egg is reach in high quality protein, vitamins and minerals, which are crucial for growth and development. A lack of these nutrients can lead to stunting and developmental delays in children, can increase susceptibility to infections, and can affect brain development and cognitive function, muscle weakness and poor bone health (Larson *et al.,* 2024), So it is better to note that the cheapest way with the least environmental impact, of covering the human body's daily need for animal protein is with egg (Molna, 2020)

Optimal husbandry practices are crucial for efficient and sustainable production (Habte *et al.,* 2017). These practices aim to create optimal conditions for chicken optimal performance which can be achieved by preventing diseases, maintaining feed efficiency, using appropriate breed, proper handling of chicken house, and ensuring proper hygiene in poultry houses (Tsegaye *et al.,* 2024). Good husbandry practices are that includes monitoring health, maintaining appropriate growth and egg-laying conditions in the poultry house, administering recommended vaccinations, and implementing a feeding program (Attamah *et al*., 2023). Poultry production is a popular choice due to its efficiency and high feed conversion rates, but they require high-quality feeds, often incorporating a balance of proteins, carbohydrates, fats, vitamins, and minerals, which are essential for maximizing performance and ensuring the health of the chicken (Fekede *et al.,* 2021). According to Shah and Cetingul (2021), poor husbandry practices can significantly impact the production and productivity of layers (egg laying poultry) since it can affect health, reduce production , increase mortality rate, economic losses and also has environmental impact since mismanagement of waste(manure).

The use of scientifically formulated feeds is a standard practice in commercial poultry production; layer feeds are formulated to enhance egg production, egg weight, and shell quality (Alhotan, 2021). The formulation of these feeds often involves precise calculations to ensure that all nutritional requirements are met, optimizing feed efficiency, and minimizing waste (Belkhanchi *et al.*, 2023). Among the major constraints of commercial poultry production is the mixed feed used is generally poor and most feed formulations do not have vitamin or mineral premixes (Abadula *et al.,* 2022). Akinola and Ekine (2018) noted that commercial layer feed must be analyzed from time to time to keep the farmers abreast of the composition of what they are feeding their birds since some commercial feed manufacturers tend to be less careful about meeting the required standard of the different feeds.

Feeds for layers specifically is formulated to meet the nutritional needs of egg laying hens insuring optimal health, productivity and egg quality (Waters *et al.*, 2024). The quality and composition of feed are fundamental factors influencing layers egg production and egg weight but imbalanced nutrients and poor quality feeds negatively impacts egg production, lower egg quality, and even health issues. (Akinola and Ekine, 2018). Wang, *et al.*, *(*2017) reported that the balance of nutrient like protein, calcium, phosphorus and energy in the feed significantly impacts egg production and quality.

1.1 Statement of the Problem

Husbandry practices in poultry production are essential for maintaining the health, productivity, walfare and others (Premier, 2015). These practices are housing, health care management, sanitation, lighting, nutrition and proper selection of breeding are the most important practices for poultry production. However, challenges persist in optimizing these practices to balance animal walfare with production efficiency (Shah and Cetingul (2021). For example, cage system, while efficient, and restrict hen's natural behavior. The productivity and efficiency of layer chickens are heavily influenced by husbandry practices and the quality of feed provided (Shah and Cetingul 2021; Tarekegn, 2019). In many regions including Ethiopia, there is a lack of standardized husbandry practices and leading to sub optimal production performance and egg quality.

Commercial feeds are the primary source of feed for chickens used by the majority of commercial poultry producers. Feed accounts 60-70% of the cost of raising chickens, indicating that the quantity and quality of nutrients as well as feeding science play a major role in determining whether raising chickens is economically feasible (Wen *et al.*, 2018). Negash (2020) indicated that due to high costs and limited access to laboratories, the majority of feed manufacturers never examine their most crucial quality control method or raw material analysis. This implied that different feed processing plants produce poultry ration with varying nutrient levels for use by the same breed of chickens within the same stage of production while they are expected to take chicken breeds and stage of production into account (Muleta, 2024).

There is limited recent research that broadly evaluated the interplay between husbandry practices, feed quality and their combined effects on production performance and egg quality (weight). According to Melesse *et al*. (2023), nutrient composition of chickens compound feed recorded below the base mark of the Ethiopin Standard Agency. This directly impacts egg production and egg weight, presenting significant challenges for the commercial poultry industry by leading to suboptimal poultry performance (Tarekegn, 2019). So in order to produce current information on the nutritional qualities of the compound feeds, evaluation and laboratory analysis of feeds are necesery. (Nasir *et al.*, 2022). Additionally , commercial poultry farming challenged with errors that happen in husbandry practices such as housing system (high stocking densities, lighting management), and improper environmental control (temperature regulation, humidity, and poor ventilation) and feed quality which affect overall poultry production and welfares (Fekede *et al*., 2021; Laca *et al.*, 2021). Hence, assessing and evaluating the husbandry techniques used by commercial chicken farms allows one to understand the impact of the compound feed these farms use on the quality and efficiency of their output. This, in turn, helps to raise awareness among farmers and the relevant institutions responsible for overseeing and regulating feed quality in relation to the standards established for the various animal groups and species in the country (Gashaw and Defar, 2017).

1.2. Objective of the study

1.2.1 General objective of the study

- To assess layer chicken husbandry practices, nutrient evaluation of available layer commercial feeds and their effects on production performance and egg weight.

1.2.2 Specific objective

- To assess commercial layer farm husbandry practices.
- To evaluate and compare nutritional components of different commercial layer feed and
- To assess its effect on production efficiency and egg weight.

2. LITRETURE REVIEW

2.1 Commercial Chicken Husbandry Practices

2.1.1 Housing

The environment in which chickens are kept can greatly impact their productivity (Yusuf Ali, 2021). The main types of commercial poultry keeping systems include deep litter system, cage systems, and free-range systems, (Sosnówka-Czajka *et al.,* 2010). According to Korver (2023),.free range system is the type of poultry house where birds are allowed to forage outside, exhibit their natural behaviors such as pecking, scratching, and dust bathing, which are essential for their health and can enhance their overall welfare and able to engage in activities

The deep litter system involves a floor that is covered by a thick layer of bedding material, such as straw, wood shavings compost, or sawdust which absorbs dampness and manure to control odors and manage waste (Komba, 2017). After the manure is mixed with bedding, microbial activities break down the waste, reducing the levels of unhealthy pathogens and ammonia that can harmfully affect chicken health. Research has shown that well-managed deep litter systems can improve air quality within the poultry house, leading to better general health and output of the flock (Cruz, 2020).

Cage System involves housing chickens in arranged cages, often settled in tiers, within large, surrounded facility which is designed to retain birds in a controlled environment, allowing for better monitoring and maintenance of their health and productivity (Serbessa *et al.,* 2023).This method has been widely adopted in the poultry industry due to its efficiency in production and its ability to reduce labor costs (Karcher and Mench, 2018).

Many scholars shown that type of housing system has effect on hen day egg production and hen housed egg production. For instance (Dedousi *et al*., 2020; Sonkamble *et al*., ., 2020; Zewde and Kebede, 2022); indicated that the egg laying performance ,egg weight and egg mass was higher for the layers kept in cages than those kept on deep litter.

Studies have been indicated flock density, or the number of chickens per unit area significantly influences egg production and egg quality in poultry farming. For instance Kang et al. (2016) high flock density can lead to increased stress, among birds which negatively affects their general health and productivity. The same study observed that the stock density of 5 chickens per square meter had the highest (78.6%) hen day egg production when compared with 6birds per square meter had 78.2%, 7birds per square meter had 77.9%, 10birds per square meter had 75.7%. This means that when stock density increased from 5bird/m^2 to 10 birds/ m^2 the hen day egg production decreased from 78.6% to 75.7%. Similar study by Kang *et al*. (2018) indicated that high density has some negative effects on the laying performance hens.

Researchers reported that environmental conditions can influence production performances and quality. For instance, according to Talukder *et al*.(2010) when temperature of poultry house is high, feed consumption, feed conversion ratio, egg production and egg weight gradually decreased, According to Getabalew and Negash (2020), a suitable rearing environment is important to the optimum metabolic and physiological actions connected with the whole egg production process and a declining of egg weight is mainly due to the impact of heat stress rather than reduced feed intake because high temperature contribute significantly to the weight loss in egg yolk and egg albumin. It was reported that ventilation is one of the environmental conditions which impacts production performances of chickens. For instances, according to Ruzal *et al.* (2011) if the air flow is not managed properly, hens are exposed to high temperature which cause stressful. Serbessa *et al.* (2023) reported that, it is possible to reduce stress and prevent disease through better management of good ventilation since Ventilation brings fresh air into a poultry house and removes heat, moisture, and gases.

Studies have shown that extending the photoperiod can enhance the egg production by stimulating reproduction organs, leading to increased secretion of reproductive hormones

(Demirbas and Kubanc, 2018). Higher light intensities have been related with increased egg production rates. For example, research on Japanese quails verified that birds exposed to higher light intensities produced more eggs compared those under lower intensities. This is because higher light intensity can improve the bird's activity level and feed intake which are essential for optimum egg production. However, over light intensity may lead to stress and adverse effects on egg quality (Ali *et al.*, 2023). According to Demirbas and Kubanc (2018), the egg production was improved under the photoperiod regime of 15 luxes for 20 hrs during laying period. Red and green light have been found to be more effective in promoting egg production compare to blue light. This is attributed to the fact that red and green lights penetrate deeper in to the hypothalamus, thereby more effectively stimulating the release of reproductive hormones (England and Ruhnke, 2020. Intermittent lighting resulting in higher egg production and better feed conversion ratios compared to continuous lighting (Farghly *et al.*, 2019).

2.1.2 Breeding

One of the factors that affect chicken egg production rate is genetic factor (Rakonjac *et al.*, 2021) and according to Hammershoj *et al*. (2021) one of the primary effects of selective breeding is the increase in egg production. By selecting hens that lay more eggs, farmers can gradually increase the average number of eggs produced per hen. According to Komlosi (2022), commercial layer breeds like white leg horn have been developed to produce a high number of eggs with efficient feed conversion rate. Many studies identified breed has effect on egg production and egg weight. The most common and adapted commercial layer breeds include Bovans Brown, Bovans White, ISA Brown, Lohmann Brown, TETRA-SL, and dual-purpose breeds Sasso and Koekoek (Entag, 2020). Assefa *et al.* (2019) reported that koekoek layers breed have high egg production when compared with Sasso and Bovans brown. In another way, Sasso breeds have higher egg weight followed by Bovans brown and koekok. Another study done by Hanusová *et al* (2015) showed that the Oravka layer breed laid higher egg than Rhode Island Red. According to Mengesha et al. (2022), Bovans brown had higher productivity and egg weight followed by Isa brown, Rhode Island Red, and white leg Horne and Fayoumi.

According to Duressa and Betelhem (2022), the egg production performance of Bovans brown was higher than that of white leghorn under small scale production system. In another way, Kejela, et al. (2019) reported that the egg weight of Bovans brown was the highest when compared with local and Sasso breed.

Many studies revealed that chicken egg production in Ethiopia varies significantly between indigenous and exotic breeds. For instance, Abera and Chala (2023) reported that indigenous chicken those are known for their adaptability to local conditions typically produce 30-65 eggs per hen per year and the average egg weight is about 38g. Sebho (2016) also noted that exotic chicken breeds introduced to Ethiopia produce up to 250 eggs per hen per year and the average egg weight is approximately 60grams under optimal management conditions. Similarly, Alemneh and Getabalew (2019), indicated that the egg production per hen per year of indigenous, hybrid and exotic chicken is 30-60,156-200 and 250 respectively. According to Matawork (2018), the egg production of eggs /hen /year for White Leghorn, Red Island Red and Fayoumi chickens was 173,185 and 144 under village household condition respectively.

Another study by Gebremariam *et al.* (2017) reported that the egg production per hen per year for local, exotic and crossbreed chicken is 44.71, 235.86 and 51.09 eggs respectively. According to Eyerus et al. (2024), the egg of Bovans breed had highest (56.57g) weight when compared with local (47.17g) and Sasso breed (56.21g) of egg weight. According to Getabalew (2019), the average weight of eggs for indigenous, hybrid and exotic chickens are 38grams, 49-56grams and 60grams respectively.

2.1.3 Health management

Health care management is a very important aspect of poultry husbandry practices, ensuring the wellbeing and productivity of the flock (Asfaw *et al.*, 2021). The aim of health care management is to provide the conditions that ensure optimum performance of the birds (Serbessa *et al*., 2023). Prevention of disease in commercial poultry operations requires the application of a coordinated program of bio-security, vaccination and hygiene (Asfaw *et al.*, 2021).

Biosecurity refers to a set of practices and measures taken to prevent the introduction and spreading of infectious diseases in the poultry houses and facilities (Scott *et al.,* 2018) which include controlling access to poultry houses, using disinfectants, and implementing strict hygiene protocols (Van Asselt, 2019). A biosecurity program uses a combination of physical barriers such as fences, mesh wire, and directed actions to prevent the introduction or minimize the spread of infectious disease causing agents including the use of footbaths, carwash deep, and disinfection of farm equipment (Aiyedun *et al.,* 2018).

Vaccination for chickens is a crucial component of poultry health management, which help to build immunity against pathogens such as avian influenza, Newcastle disease, and Marek's disease (Zhou *et al.,* 2020). The same study also noted that it is a measure that may be applied wherever a high risk of introduction and further spread of a contagious poultry disease has been identified. The use of vaccination in the absence of any outbreak of disease, together with the application of effective bio-security measures, could maximize poultry protection whenever a risk of exposure exists (Efsa *et al.,* 2023).

2.1.4 Feed and feeding practices of poultry

Feeding is a critical aspect of poultry husbandry and directly impacts health, growth and productivity of the flocks (Vaarst *et al.,* 2015). Poultry have different nutritional requirement at various stages of their life cycle such as chick, grower, pullets and finisher phases (Zegeye *et al.,* 2023). For instance, chicks require high protein level for rapid growth, while mature birds need a balanced diets to maintain their health and productivity (Vaarst *et al.,* 2015).The formulation of poultry feed involves selecting and combining various ingredients such as grains, Proteins, vitamins and minerals. The quality and composition of these ingredients are crucial for ensuring that the feed provides adequate nutrition (Bailey, 2020). Studies have shown that hens fed three or four times a day tend to have higher egg production rate compared to those fed only once daily. For instance, Soltanmoradi et al. (2013) and Tadesse *et al*. (2017) noted that hens fed twice or thrice a day produced more eggs than those on a once a day feeding schedule and had higher egg weight.

Many studies reported that the physical form of the feed such as mush, pellets or crumbles can affect how well hens consume and utilize the nutrients. According to Olawumi (2014), pelleted feeds are generally preferred because they reduce feed wastage and ensure a more uniform intake of nutrients and hens fed with pelleted diets tend to have higher egg production rates and better conversion ratios compared to those fed with mash diets. But Ege *et al*. (2019) and Wan *et al*. (2021) reported that hens fed with the mash form of feed had higher egg production and egg weight than those fed with crumble form of feed. Additionally the nutrient density can influence the egg weight. According to Wu *et al.* (2007), the hens fed with high nutrient density laid highest egg weight when compared with the hens fed with medium and low nutrient density.

Feed intake plays a crucial role in determining egg production and egg weight in laying hens (Bailey, 2020). The same researcher reported that the actual feed intake should match the nutrient requirements in all stages of chicken development and adequate and balanced feed intake is essential for hens to maintain optimal health and productivity. Alaraji (2024), noted that the nutrients provided by the feed are directly utilized for egg formation and overall reproductive health. The same researcher noted that the hens fed with a daily feed intake of 112 gram produced more eggs compared to those with a lower intake. According to Belkhanchi *et al*. (2023) laying hens need fat content (2-7%) and ash (10% max) to support egg production. Many researchers also indicated that the composition of the feed is equally important as the quantity. As Rutten (2016) noted, feeds rich in protein, vitamins and minerals contribute to better egg production and quality.

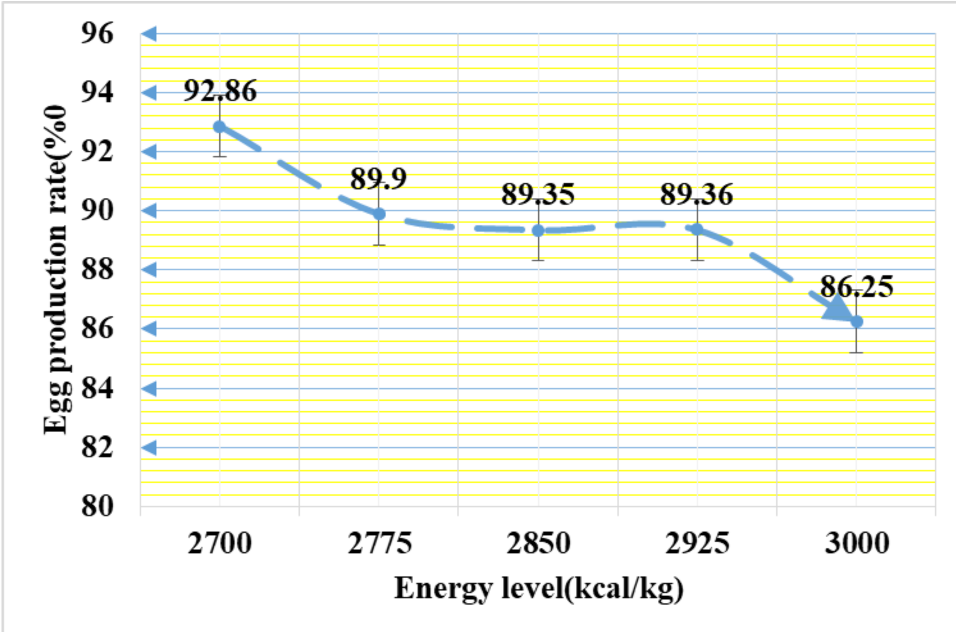
Proper water management is also essential for the health and productivity of poultry since hens require clean water to stay hydrated and maintain optimal health. Water plays an important role in the digestion and metabolism of the fowl, additionally; it serves as a media to administer some important vaccines. Studies have been conducted by focusing on the frequency of watering, season and frequency of providing water for chicken. (Bekele *et al.,* 2016; Dinka *et al.,* 2010; Getu and Birhan, 2014; Halima *et al.,* 2007; Mekonnen, 2007).

2.2 Compound Feed Nutritional Quality and Its Effect on Egg Production Rate and Production Quality

According to Jacob et al. (2014), the availability of high quality feed is critical for the expansion of poultry industry and nutrients required by birds vary according to age and the purpose of production whether the birds are kept for meat or egg production. Ibrahim (2019) and Stadelman (2017), reported that laying chickens require a completely balanced diet to sustain maximum egg production over time and inadequate level of nutrition such as energy, protein or calcium can cause a drop in egg production. The same studies indicated that deficiencies in these nutrients and their quality can lead to reduced egg production and poor egg quality. According to Belkhanchi *et al.* (2023) laying hens need fata content (2-7%), and ash (10% max) to support egg production. Many researchers also indicated that the composition of the feed is equally important as the quantity. As Rutten (2016) noted, feeds rich in protein, vitamins and minerals contribute to better egg production and quality.

2.2.1 Energy

Many researchers noted that energy is a critical nutritional component that significantly impacts egg production and egg quality in laying hens. According to Belkhanchi et al. (2023) laying hens need diets that are lower in energy (2700 kcal/kg.). For instance, figure (1) showed that as energy levels increased from 2700 to 3000 kcal/kg of feed egg production linearly decreased from 92.86 to 86.25%



Source: Ribeiro *et al*. (2014)

Figure 1: Effect of Energy Level on Egg Production performance.

Also, the dietary energy level of 2775 kcal/kg had higher egg weight (60.12g) than others. Similarly, Kim and Kang (2022) indicated that the hen fed with the metabolizable energy level of 2800kcal/kg had higher hen day egg production and Hen-Housed egg production reaching 90.09 and 88.58% respectively, compared to those fed 2700kcal/kg which achieved 89.48 and 88.50%. The same authors indicated the hen fed with the dietary energy level of 2800kcal/kg laid higher egg weight (64.49g) than the hen fed with 2700kcal/kg which laid 62.38g of egg weight. Adeyemo (2015) reported that laying birds fed with diets containing 2500 kcal ME/kg of energy exhibit d higher egg production(71.2%) when compared with 2600kcal/kg, 2700kcal.kg and 2650kcal/kg of 53.6, 50.1, and 61.3% of hen day egg production respectively. The same study reported that laying birds fed with diets containing 2500 kcal ME/kg of energy laid highest egg weight (61.35g) than 2600kcal/kg,2700kcal.kg and 2650kcal/kg of 60.49g, 59.95g and 61.22 egg weight respectively. Dzomba et al. (2020) highlighted that hens receiving 12.5MJ/kg energy diets produced more eggs (83.71%) compared to those received lower energy diets (11.7MJ/kg) produced 83.39% of egg production. The same study indicated that the hens receiving 11.70 MJ/kg of energy diet laid higher egg weight (66.07g) than the hens received energy level of 12.5KJ/kg, which laid 65.12g.

Excessive energy levels without adequate protein can lead to reduced egg size conversely; Excessive energy intake in laying hens can have significant effects on both egg production and egg weight (Kleyn and Ciacciariello, 2023). When hens consume more energy than required for their maintenance and egg production, it can lead to an increase in body weight (Laughlin, 2011).The same author indicated that this excess body weight can negatively impact egg production by causing an abnormal ovarian structure, which in turn can depress the overall egg production rate. Essentially, the hens become less efficient at converting feed in to eggs leading to fewer eggs being produced. Balancing the energy intake of laying hens is crucial for optimizing both the quantity and quality of egg production. Proper management of feed and energy levels ensures that hens maintain an optimal body weight, which supports consistent egg production and maintains egg quality (Kleyn *et al.*, 2022).

2.2.2 Proteins

Protein feed plays a crucial role in enhancing both egg production and egg weight in poultry (Nys, 2017).Studies indicated that providing high protein to pullets in their growth and egg-laying phase showed positive effects on egg mass and yolk weight (Babiker *et al.*,2011). According to Belkhanchi *et al*. (2023) laying hens need protein (14-16% CP) but Dzomba et al. (2020) reported that the hens fed with 17% of crude protein level had higher egg production level (83.55%) when compared with 16CP% and 18CP% which had 81.87% and 82.62% of egg production respectively. But the egg weight of the hen fed with 18CP% is higher (65.94g) when compared with 16CP% (62.61g) and 17CP %(64.23g).The intake of protein, particularly amino acids, significantly influences the size and quality of eggs (Nys, 2017).

2.2.3 Vitamins

Vitamin is crucial to improve the productivity and healthy of poultry.According to (Abdela *at al.,* 2009); Elsherif (2017) and Hailu *et al*. (2022), increasing level of vitamin A significantly increase egg production, egg weight and egg mass. The same studies reported that the 50,000 IU of vitamin A /kg for layers showed production improvement.

Supplementing laying hens' diets with vitamin C and vitamin E has been shown to support their egg production and overall egg quality (El- Sheikh and Salama, 2010).vitamin D plays a crucial role in calcium and phosphorus metabolism which are essential for proper egg shell formation. Research indicates that adequate level of vitamin D3 in the diet can enhance both egg production and egg weight, while deficiencies may lead to decrease egg output and smaller eggs. The recommended dietary inclusion of vitamin D3 for laying hens ranges from 3500-5000IU/Kg of feed (Ahmadi and Rahimi, 2011). Furthermore, vitamin E, widely recognized for its antioxidant properties contributes significantly to egg production. Studies suggest that dietary supplementation of vitamin E improves production traits. For instance research on laying partridges found that various levels of vitamin E supplementation enhanced feed intake fertility rates and hatchability. Additionally vitamin E plays a critical role in maintaining reproductive health, which is vital for sustained egg production (Sengul *et al.*, 2008).

2.2.4 Minerals

Minerals are essential components in the diet of laying hens, significantly influencing both egg production and egg shell quality. Among the critical minerals, calcium, phosphorus, zinc, manganese, and copper play pivotal roles (Alagawany *et al.*, 2021). Calcium (Ca) is a major element in poultry nutrition. It is an important component for mineralization of bones and shells, blood-clot formation and muscle contraction (Talpur *et al.*, 2012). Diets with 3.2% to 3.5%*of* calcium have been recommended for laying hens to ensure the great egg production and the high quality egg shells during the laying periods (Swiatkiewicz *et al*., 2015). Whereas a 2.5% dietary Ca level has been demonstrated to be sufficient for broiler breeders to maintain their egg production and egg shell quality (Moreki *et al.,* 2011). In layers chicken rearing, the transition period when pullets become laying hens is very important which will decide the production performance of the flock thereafter. So, supplement of 2.5 to 3.5% ca to the pullets diets about 2 to 4 weeks before they inter the laying phase recommended to ensure the calcium balance and to facilitate the medullary bone development in birds (Pavlovski *et al*., 2012)

Phosphorus is another essential mineral, which is important for the egg shell formation. Although an inconsiderable amount of phosphorus can be found in the egg shells, this mineral can interact with Ca throughout of the process of bone formation (Amy, 2016), a high level of phosphorus might reduce egg shell quality (Galea, 2011).The same author indicated that the effect of dietary phosphorus levels (0.44 % and 0.49%) on the egg production and egg shell quality of tetra- SL layers throughout 17 layers months. As this results, the egg shell strength was significantly decreased while the egg weight was significantly increased when hens were fed with the 0.44% phosphorus diet.

Dietary trace minerals like zinc, manganese, iron copper and selenium might have some effects on egg shell quality by impacts on biochemical properties of the egg shell membrane (Galea, 2011).Some studies also indicated that, hens fed diets with organic mineral such as manganese, Zink and Copper tend to produce eggs with greater shell thickness and breaking strength compared to those fed with inorganic mineral diets (Abdallah *et al.,* 2014).According to Stefanello *et al.*(2014),dietary trace mineral levels had a quadratic effect on the egg weight and egg mass. Practically, the source of trace minerals are not equally available. Thus these nutrients are typically supplied in the form of premixes (Stefanello *et al.*, 2014).

3. MATERIAL AND METHODS

3.1 Study Area

The study was carried out in selected districts and a town in Central Ethiopia: Bishoftu town, and the Ada'a and Lume districts. Bishoftu is situated at 9°N latitude and 40°E longitude, 45 kilometers southeast of Addis Ababa, at an altitude of 1,850 meters above sea level. It receives an average annual rainfall of less than 900 mm. The highest and lowest average temperatures are 28.6°C and 12.9°C, respectively. The short rainy season occurs from March to April, while the long rainy season extends from June to September (Sayee *et al.*, 2019).

Ada'a district is located at 9°N latitude and 40°E longitude, 47 kilometers southeast of Addis Ababa. It lies within the Great Rift Valley and is bordered on the south by Dugda Bora district, on the west by the West Shoa Zone, on the northwest by Akaki, on the northeast by Gimbichu district, and on the east by Lume district. The district's altitude ranges from 1,500 to 2,250 meters above sea level (Abera, 2019).

Lume district is situated between 8°22'30''N and 8°50'42''N, and between 39°01'30''E and 39°15'35''E, with an altitude range of 1,500 to 2,300 meters above sea level. It is located about 75 kilometers southeast of Addis Ababa. With a total land area of 703.03 square kilometers, the district lies in the central region of Ethiopia, extending from 8°12'N to 8°50'N and from 39°01'W to 39°17'W. Of the 38 Kebelles in the district, 35 are rural and three are urban (CSA, 2020).

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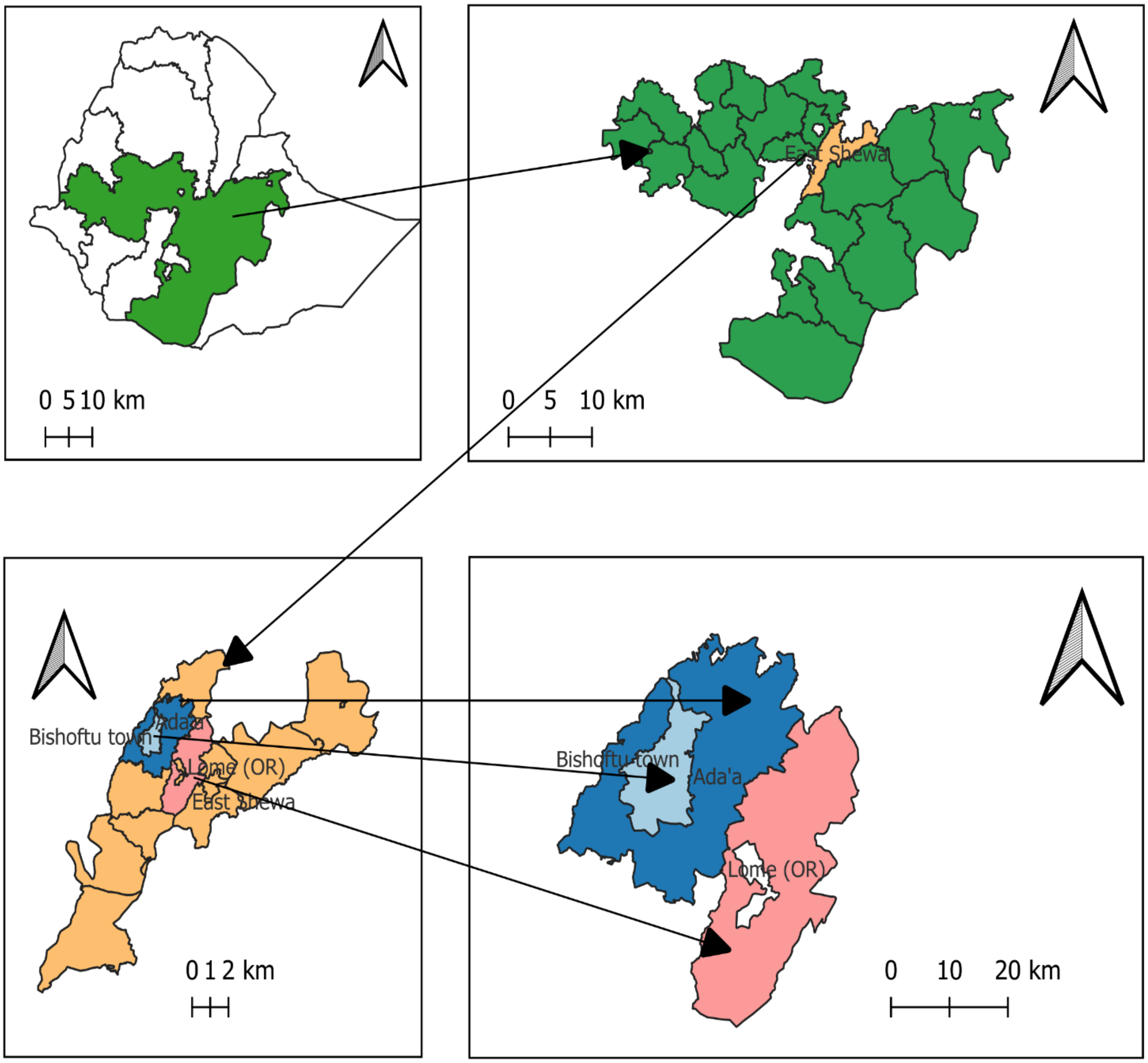

Source: (Developed with QGIS software).

Figure 2: A map showing Ethiopia and Oromia region, highlighting specific study areas.

3.2 Study Design

A cross sectional study design was carried out from February 2025 to April 2025 on selected commercial layer farms in Bishoftu town, Ada'a and Lume woredas. These farms were assessed to understand their farm husbandry practices and also farm owners or managers were interviewed using structured questionnaire.

3.3 Study Farms and Sampling Methods

This study focused on commercial layer farms within the designated areas. Poultry farms and study woredas were purposefully selected, and the snowball sampling technique was employed to reach commercial layer farms in the areas. The consent of owners were taken based on the willingness of farmers to participate in questionnaires and production stage i.e. only farms rearing layer chickens which are in production were considered.

3.4. Sample Size Determination

The sample size was calculated using Yamane's (1973) simplified formula.

$$n = \frac{N}{1+N\,e^2}$$ ....Yemane (1973)

When;

n = sample size

N = Farm size

e= Error (0.05) reliability level 95% or; e = level of precision always set the value of 0.05.

Accordingly, 89 total farms from study area were selected. Out of 89 total farms selected from study area, 53 from Bishoftu city, 29 from Lume Woreda and 7 from Ada'a Woreda commercial layer farms were selected for this study.

Table 1: Total layer farms and sample sizes in study area

Farm size	Ada'a		Lume		Bishoftu	
	TFE	n	TFE	n	TFE	n
Small	7	7	23	22	42	38
Medium	0	0	4	4	11	9
Large	0	0	3	3	7	6
Total	**7**	**7**	**30**	**29**	**60**	**53**

TFE = Total Farm Exist in the study site, n=sample size, Small farm size=Flock size of 100-1000 birds, Medium = Flock size of 1001–5,000 birds, Large = flock size of > 5,000 birds (Wondmeneh et al., 2017; Amare and Tesfaye, 2020).

3.5. Data Collection

This study was conducted to assess commercial layer husbandry practices that include parameters of commercial feed sources, feeding system (control or *ad libtum*), feed forms (pellet, mash and crumble), feeding frequency, feed offer, farms scale, feed nutrient quality determination, egg weight, breed and their production performances. A semi-structured questionnaire were prepared in English language and translated in to local language (Afaan Oromo and Amharic) and the respondents were interviewed directly by the researchers used to collect survey data from different commercial farms. A record format was prepared and distributed to each study farm to fill record data for daily egg production, feed offered, feed consumed, left over feed, for one month and Egg weight was taken from each study farm using sensitive weighing balance (China, WT50001NF). Five percent (5%) of a farm daily egg production (half % at one visit) were randomly sampled from each farm (Fekede *et al.*, 2021; Clark *et al.*, 2019).

Finally, egg production data were calculated for hen-day egg production and hen-housed egg production using the following formula (Fekede *et al.*, 2021).

Hen- day egg production (HDEP %) $= \frac{\text{number of eggs produced on a day}}{\text{number of hens present that day}} \times 100\%$

Average egg weight = $\frac{\text{Total weight of sampled eggs}}{\text{total number of egg in a sample}}$

Feed conversion ratio (FCR) was calculated for each study farm daily and recorded as a gram of feed consumed per gram of eggs produced each day (Mahrose *et al.*, 2022). It was calculated using the following formula:

$$FCR = \frac{\text{Total g of Feed Consumed}}{\text{Total g of Egg Produced}}$$

FCR=Feed conversion ratio

3.6 Proximate Analysis of Feed

Total of 198 samples of compound (500 g) layers feed were collected. Out of 198 feed samples, 178 from different commercial layer farms and 20 from retailers were collected, well packaged in sealed plastic and transported to Saal-Alema Farm laboratory for nutritional analysis. The collected samples were ground and analyzed with proximate analysis (Niguse *et al.*, 2022). Retch ZM 300 Grinder machine was used for grinding the feed sample and Near-infrared Reflectance Spectroscopy (NIR DS3) machine Evonic Industry, Germany) was used to measure the Dry matter (DM), Crude protein (CP), Crude fat (CF), crude Fiber, Metabolizable energy, Nitrogen free extract, and total Ash, were analyzed and reported by mean values. In the conducting proximate analysis, feed samples were first coded and placed in lab bottles. They were then ground using a 0.5 mm ring sieve after properly cleaning the grinder. Sample cups were cleaned with a microfiber towel and ground samples were stored in small bottles. The cleaned cups were filled with at least 1 cm of sample and placed into an instrument for scanning. Finally, the scanned samples were uploaded and exported for analysis.

3.7 Data Management and Statistical Analysis

All collected data was entered into 2010 Microsoft Excel spreadsheet and was imported to SAS programming software package. Descriptive statistics was used to analyze the frequency and percentage of the husbandry practices of layer farms. Analysis of variances (ANOVA) was used to compare the mean nutritional components of different layers feed and their effects on Hen Day Egg Production, Egg Weight, Feed Conversion

Ratio and Feed Intake. Post hoc test was done to conduct pairwise comparisons using Tukey's test. The value of $P \leq 0.05$ was considered as significant.

4. RESULTS

4.1 Sociodemographic of Respondent

The sociodemographic of respondents revealed that most of the layer farms in study area were owned by private either individual or groups (enterprises) who have majorly lower grade educational levels (Primary and secondary school) (Table 2). The profitability of the sector was revealed by the high level of participation of the majority of private individuals or groups. According to this report, the government and experts with degrees have relatively little engagement in the poultry industry, especially layer farming. The majority of farm owners have less than five years of expertise in the field.

Table 2: Sociodemographic status of layer farm respondents in each study area

Variables	**Category**	**Study Sites**						**Overall**	
		Bishoftu		**Ada'a**		**Lume**			
		LF=53	%	LF=7	%	LF=29	%	LF=89	%
Ownership type	Individual	32	42.7	5	5.6	25	25.8	62	69
	Cooperative	18	20	2	2.2	3	3	23	25.8
	Government	2	2	0	0	0	0	2	2.24
	Company	1	1	0	0	1	1	2	2.24
Educational status	Primary	18	20	2	2.2	10	11.2	30	33.7
	Secondary	17	19	0	0	11	12	28	31.4
	Diploma	7	8	1	1.1	6	6.7	14	15.7
	Degree	11	12	4	4.5	2	2	17	19
Experience (year)	1-5	29	32	7	7.8	19	21.3	55	61.7
	6-10	19	21	0	0	8	9	27	30.33
	>10	5	5.6	0	0	2	2	7	7.8

LF= Layer farms;

4.2 Layer Farm Characterization and Husbandry Practices

4.2.1 Farm characteristics

The study found that most layer farms are categorized into small-scale and medium-scale, with all operating under an intensive farming system. Layer farmers predominantly rear Bovans Browns breeds, indicating their productivity and suitability for the study area, as seen in commercial layer farms of this study (Table 3). The fact that Bishoftu City has more layer farms than other study site may be because there is vaccine-producing institute there.

Table 3: Farm Characterization and husbandry practices

Variables	**Category**	**Study Site**						**Overall**	
		Bishoftu		**Ada'a**		**Lume**			
		LF =53	%	LF =7	%	LF =29	%	LF =89	%
	Small	34	38.2	7	8	20	22.5	61	68. 0
Farm Scale	Medium)	15	16.8	0	0	7	7.8	22	247
	Large	4	4.5	0	0	2	2	6	6.7
Farming system	Intensive	53	60	7	8	29	32	89	100
Breed	Bovans Browns	42	47	7	8	25	28.1	74	83
	Lohmans Bown	11	12.4	0	0	4	4.5	15	17

LF= layer farms

4.2.2 Feeding and vitamin supplementation practices

Table 4 displays the feeding and vitamin supplementing methods used by layer farmers in the study area. Controlled feeding practices are used by all of the layer farms assessed in this study to provide the chickens as much feed as they require in order providing them with the energy and protein they need to lay eggs as efficiently as possible. Commercial layer feed in the form of mash was used by all layer farms. This demonstrated that layer feed is only produced as mash in all feed processing plant. This is due to its simplest way of manufacturing mash feed in its solid form. The majority of layer farmers offered a volume of diet, which ranges between 110-115 g/hen in thrice feeding frequency throughout a day. Dividing their feed in to multiple portions helps them digest feed more efficiently and reduced feed waste. Assuming that the diet is of lower quality, most of the layer farmers conditionally give their hens vitamin supplements during stressful periods (moulting, sickness, extreme weather, and following vaccination) for quick recovery and/or to increase their output.

Table 4: Feeding practices of layers in the study area

Variable	Category	Study sites							
		Bishoftu		Ada'a		Lume		Overall	
		LF	%	LF	%	LF	%	LF =89	%
Type of feed	Commercial feed	53	60	7	8	29	32	89	100
	Home made	0	0	0	0	0	0	0	0
Daily feed offered (g/bird)	110-115	16	18	3	3.37	14	15.7	33	37
	116-120	18	20	3	3.4	8	8.9	29	32.6
	121-125	19	21	1	1.1	7	7.8	27	30.3
Feeding frequency	Twice	8	9	3	3.3	5	5.6	16	17.9
	Thrice	45	50	4	4.5	24	27	73	82
Vitamin supplementation	Yes	53	60	7	32	29	8	89	100
Vitamin supplementation frequency	Conditional	40	45	7	32	17	19.1	64	71.9
	Every 3months	6	6.7	0	0	5	5.6	11	12.3
	Every 2 months	2	2.2	0	0	1	1.1	3	3.37
	Every 2 weeks	5	5.6	0	0	6	6.7	11	12.3
Feeding method	Controlled	53	60	7	32	29	32.6	89	100
Feeding form	Mash	53	60	7	32	29	8	89	100

LF = Layer farms

4.2.3 Feed sources used by different poultry farms

Most of the layer farms included in the study frequently utilize feed produced by “A”, making it the most commonly used brand. A smaller portion of farms utilized ML feed, followed by those using E, and OT types of feeds. Fewer farms reported using D, AM and R while the least commonly used feed sources include FP, J, sale, MR, V, OD MT, EN, O and T with only one farm each reporting their use. When asked about the factors influencing their choice of feed most farms selected their feed sources based on availability and high quality since availability and quality of feed sources critically important for layer farmers because layers need uninterrupted access to balanced nutrition to produce eggs consistent and high Feed quality is essential for maximum egg yield but all of the farm owners unable to conduct feed quality assessment due to the lack of laboratory facilities and the awareness of feed quality was primarily only based on egg yield (Table 5).

Table 5: Sources of feed used by different layer farms in the study areas

Variable	Marketing reputability	Study sites							
		Bishoftu		Ada'a		Lume		Overall	
		LF =53	%	LF =7	%	LF =29	%	LF =89	%
Frequent feed utilized	A	38	42.6	6		2	2.24	46	52.81
	ML	4	4.49	0	0	5	0	9	10.11
	E	3	3.37	1	1.1	1	1.1	5	5.62
	D	2	2.24	0	0	1	1.12	3	3.37
	AM	3	3.37	0	0	0	0	3	3.37
	RT	3	3.37	0	0	0	0	3	3.37
	FP	0	0	0	0	2	1.12	2	2.25
	J	0	0	0	0	2	2.24	2	2.25
	S	0	0	0	0	2	0	2	2.25
	OT	0	0	0	0	2	0	5	5.62
	MR	0	0	0	0	1	1.12	1	1.12
	V	0	0	0	0	1	1.12	1	1.12
	OD	0	0	0	0	1	1.12	2	2.25
	MT	0	0	0	0	1	1.12	1	1.12
	H	0	0	0	0	1	1.12	1	1.12
	EN	0	0	0	0	1	1.12	1	1.12
	O	0	0	0	0	1	1.12	1	1.12
	T	0	0	0	0	1	1.12	1	1.12
Why frequently used	High quality	15	16.8	3	3.3	15	16.8	18	48.31
	Availability	38	42.6 9	2	2.2	10	2.24	46	52.81
	Cheap	5	5.6	2	2.2	4	4.49	5	5.62
Feed quality assessments	Yes	0	0	0	0	0	0	0	0
	No	53	59.5 6	7	7.8	29	32.6	89	100
Reason	Laboratory problem	53	59.5 5	7	7.8	29	32.6	89	100

4.2.4 Housing management and lighting

The study indicated that most commercial layer farms utilize deep litter housing systems with *teff* straw as bedding materials. This could be due to the deep litter houses that provide behavioral comfort for layer chickens such as physical space and increased environmental complexity, such as litter, perches, dust-bathing, pecking, scratching, and egg-laying facilities. Many of the farms adopting a nest box to layer ratio of one nest box for every seven hens and a smaller portion of farms used a ratio of one nest box for every five hens by considering economy in terms of cost.

Many of the farms maintained stocking density of eight bird per square meter which is a common practice in intensive poultry production and some of the farms use ten birds per square meter. All the farms relied on natural ventilation which typically involves openings like windows, vents, or curtains that allow air to flow freely to maintain airflow and regulate temperature for their chickens. When it came to manure disposal, the majority cleared the manure at the end of each production cycle, while a few opted for more frequent disposal every few months. As indicated by farm owners disposing the manure at the end of production (when birds are removed from house), the poultry house is empty and this makes it easier and safer to remove all manure without disturbing the birds and to control odors pests farms implemented various measures such as keeping bedding materials dry, ensuring proper ventilation by opening windows, and regularly cleaning up spilled feed and wasted flow to prevent fermentation and unpleasant smells (Table 6).

Table 6: Housing management and lighting system of the farms

Variables	Category	Bishoftu		Ada'a		Lume		Overall	
		LF	%	LF	%	LF	%	LF	%
Housing system	Deep litter	50	56	6	6.7	28	31	84	94
	Cage	3	3.4	1	1.12	1	1	5	6
Nest box to layer ratio	1:05	15	16.85	2	2	12	13.5	29	32
	1:07	21	23.59	0	0	12	13.5	33	37
	1:10	17	19	5	5.6	5	5.6	27	31
Stocking density	6birds/m^2	13	14.6	0	0	6	6.7	19	21
	8birds/m^2	25	28	5	5.6	14	15.7	44	50
	10birds/m^2	15	17	2	2.24	9	10	26	29
ventilation	Natural	53	60	7	32	29	8	89	100
	Artificial	0	0	0	0	0	0	0	0
How to dispose manure	At end of the batch	50	56.1	6	6.7	26	29	82	92
	Daily	2	2	1	1	1	1	4	4
	Every 3 months	0	0	0	0	1	1	1	1
	Every 6 months	1	1	0	0	1	1	2	2
Measures to control odors and pests?	Yes	53	60	7	32	29	8	89	100
	No	0	0	0	0	0	0	0	0

Table 7 shows that the layer farm's photoperiod management in the study. Every layer farm owners use a combination of natural and artificial light sources for twelve to sixteen hours per day. Although all farmers reported having access to electric power, they also experienced frequent power interruption in their areas. In response to this disruption, many farmers relied on alternative sources such as solar energy, generators, or rechargeable batteries, while some reported having no back up system in place during outages and all farms noted variations in lighting due to this power issues led to observable differences in laying performance among their flock. This shows that lighting is a critical factor in the management of laying hens, as it directly influences their reproductive cycle, egg production, behavior and overall welfare.

Table 7: Lighting management

Variables	Category	Bishoftu		Ada'a		Lume		Overall	
		LF=53	%	LF=7	%	LF=29	%	LF=89	%
Photoperiod	12hr	0	0	0	0	0	0	0	0
	12-16hr	53	59.5	7	7.8	29	32.6	89	100
	16-18hr	0	0	0	0	0	0	0	0
Lighting management	NA	53	60	7	32	29	8	89	100
Electric power supply	Yes	53	60	7	32	29	8	89	100
	No	0	0	0	0	0	0	0	0
Electric power interruption	Yes	53	60	7	32	29	8	89	100
	No	0	0	0	0	0	0	0	0
Alternative Lighting source	Generator	9	10	0	0	7	7.8	16	18
	Solar	25	28	2	2.24	16	18	43	48
	Rechargeable battery	5	5.6	0	0	2	2.24	7	7.8
	Nothing	14	15.73	5	5.6	4	4.5	23	25.8
Lighting Variation	Yes	53	60	7	32	29	8	89	100
	No	0	0	0	0	0	0	0	0

NA= natural and artificial light; LF=layer farms

4.2.6 Health and Disease Management

Table 8 lists the primary health issues that layer farms in the research area faces. Majority of farm respondents of the layer farms reported occasional challenges with New Castle Diseases (NCD) and Infectious Bursal Disease (IBD). Clinical signs like coughing, nasal discharge, gasping, twisted neck, greenish diarrhea, and a noticeable decrease in egg production were used to report the presence of the diseases. Since most farms regularly check their chickens with veterinarians, they also received confirmation from animal health experts. However, it was shown that only a small number of farms had employed vaccines against Infectious Bursal Disease (IBD), whereas the majority had given NCD vaccines.

Table 8: Frequency analysis of health and disease management of farms

Variables	**Category**	**Study sites**							
		Bishoftu		**Ada'a**		**Lume**		**Overall**	
		N=53	%	N=7	%	N=29	%	N=89	%
Diseases in farms	NCD	43	48.3	2	2.24	20	22.5	65	73
	IBD	10	11.2	5	5.6	9	10	24	27
Disease outbreak	Yes	10	0	0	0	0	0	0	00
	No	53	59	7	8	29	32	89	100
Vaccinations administered	NCD	40	53.9	6	6.7	22	24.7	68	76.4
	IBD	2	2.2	0	0	4	4.5	6	6.7
	Not vaccinated	11	1.12	1	1.12	5	2.24	17	19
Regular veterinary check-ups	Yes	43	48.3	0	0	24	27	67	75.2
	No	10	11.2	7	7.86	5	5.7	22	24.7

4.3 Nutritional Evaluation of commercial layer Feeds

The nutritional quality of feed samples utilized in various layer farms was assessed by analyzing their chemical composition, as shown in table 9 below. The dry matter of commercial layer rations produced by various feed processing factories did not differ significantly (P>0.05). The analysis mean% revealed that the dry matter content ranged from 91.09 to 92.25%. This result is higher compared to the standard DM (88%) given for layer feeds. The highest dry matter content was recorded in the feed produced by MT feed processing plant which followed by S feed processing plant. Feeds with higher dry matter levels are generally more stable and less prone to mold development, making them more suitable for long-term storage. This is because lower moisture in the feed cause unfavorable environment for mold growth, thereby preserving feed quality overtime.

When comparing the dry matter contents of the different feed sources used by the farms, the variation between them was found to be minimal. Statistically the difference was not significant since p-value > 0.05 indicating that all feed sources offered relatively similar dry matter level, and by extension, comparable storage stability and nutritional consistency.

The commercial layer feed analysis revealed that noticeable variation in crude protein content among different feed processing plant sources which ranges from 14.51-19.96%. Feeds produced by some producers (MT and AB) showed significantly higher levels of crude protein, indicating better nutritional while others fell short of the required standards. However, certain producers including AM, A, J, E and MR supplied feed for layer that did not meet the minimum CP requirement (16.5%) established by the Ethiopian standard feed. This standard serves as benchmark to ensure optimal health and productivity in laying hens. The findings highlights a clear difference in feed quality among the different sources. Moreover, the statistical analysis confirmed that the differences in crude protein content across these feed processing plants were significant, since the p-value <0.05 indicating variation in nutritional standards among feed producers. This variation could potentially influence the performance and productivity of layer farms depending their feed source.

Crude fat (CF) content in commercial layers feed was analyzed, and the results showed that different layer rations' CF contents varied from 3.87 to 5.60%. . The highest levels of crude fat were recorded in the feed manufactured by OD and AM. However, the least crude fat content was reported for layer feed produced by MR feed processing plant. The variation in crude fat content among layer feed produced by different feed processing plant might be due to the variation of the ingredients and its levels of in ration formulation. Despite this variation, all feed samples taken from different feed processing plant met the minimum crude fat (2%) requirements established by the Ethiopian standard for layer feed. The statistical analysis revealed that the differences in crude fat content among the feed sources were significant suggesting inconsistency in formulation practices across the layer feed manufactures. Such variability may affect the energy balance and overall productivity in layer farms depending on the feed brand.

The analysis of the crude fiber content of the various feed sources showed that D feed (3.72%) had the lowest crude fiber content and AB feed (5.26) had the greatest. The layer feed crude fiber result was ranged between 3.72-5.26% which is somewhat far from the standard 9%. This could be due to an indigestible component of fiber, most feed manufacturers use less fiber content in the layer feed. The crude fiber content observed for all evaluated layer feed sources were below the maximum limit (9%) which set by the standard requirement of layer feeds by Ethiopian layer feed standards. Furthermore, the fiber content showed significant variation among the different feed sources indicating statistically meaningful difference.

The layer feed has an ash content of 11.0-17.76% compared to the recommended values of 5.39% for layers mash (NAP, 1994). There is non-significant effect of feed sources on egg broken among different feed sources ($p>0.05$) However, the ML and FP feed processing plants had the lowest and highest levels of ash content, respectively. Figure 4 shows that even though the ash content of different feed sources are above the standard, the minimum and maximum percentage mean of egg broken were observed in the farms utilized the feed sources of S and D, respectively. This differences might be due to imbalanced calcium absorption, poor feed digestibility, environmental stress and age of layers (Quirino, 2023).

The amount of insoluble ash, minerals, and trace elements in the feed can be estimated from the crude ash content. Therefore, it was suggested that birds given the FP had the highest ash content, which would improve their access to trace minerals that could increase the body's enzymatic processes. Although there were notable variations among the feed processing plants ($P<0.0001$), the ash content of every layer ration available on the market is higher than the amount of ash advised for layer chickens. This suggested that feed processing plants were able to incorporate high levels of minerals into their formulations due to the market's ample supply and affordable prices.

The varied layer diets produced by different feed processing plants have a considerable variation in the amount of metabolizable energy (ME). The layer ration ME assessed in this study falls between 2742.50 to 2914.07 kcal/kg, which is within the range suggested by the NRC (1994), which states that the average ME for broilers at all growth stages should be 3200 kcal/kg and for layers, 2900 kcal/kg. Based on the analysis of the feed samples, the feed produced by OD and ML feed processing plant demonstrated the highest availability of ME, indicating its potential to support better performance in layer hens. However, the feed produced by Friendship Company was found to have the lowest ME content, suggesting it may be less efficient in meeting the energy demands of the birds since its ME was lower than the minimum recommended level. The difference in ME values among the various feed sources used in layer farms could be related to level of energy source feed in their formulation. This highlights the importance of carefully selection of feed sources to ensure optimal energy supply for layers.

Nitrogen free extract refers to the portion of feed that consists of easily digestible carbohydrates, including sugars and starch. As indicated in table below, the calculated NFE values across the different feed sources revealed noticeable variations. The highest level of NFE recorded for the feed produced by ML Feed processing plant. This is suggesting a greater concentration of energy rich and non- fiber carbohydrates of the diet. However, feed source from MT, FP, RT and AB recorded below the requirement since layer requirement of NFE is 50-70 % (Hussain *et al.*, 2021). Feed processing plant showed the lowest NFE content indicating a comparatively lower contribution to the bird's immediate energy supply. The feeds that contain low percent of NFE may affect energy supply, energy supply, egg production, feed efficiency and overall healthy. The differences in NFE values among the various feed types were statistically significant this could be linked to the level of energy sources of feed used in their formulation.

Table 9 Nutritional Evaluation of layer feeds produced by different feed processing plants

Feed sources	DM (%)	CP (%)	C.Fat (%)	C.Fiber (%)	ASH (%)	ME (%)	NFE (%)
MT	92.25 ±0.00	19.96 ± 0.00 ^{a}	5.10 ± 0.00 ^{ab}	4.40±0.00 ^{bcd}	16.40±0.00 ^{ab}	2802.55±0.00^{abcd}	46.39 ±0.00 ^{c}
S	91.95±0.105	17.07 ± 0.30^{cde}	4.80 ± 0.08 ^{bc}	3.95 ± 0.05 ^{cd}	14.37 ±0.23 ^{abc}	2861.54± 15.88^{abc}	51.74 ± 0.23^{ab}
D	91.88 ±0.00	17.93± 0.49^{bc}	5.14 ± 0.17 ^{ab}	3.78± 0.08 ^{d}	13.86 ± 0.59 ^{bc}	2900.40 ± 17.84 ^{ab}	51.160 ±1.06 ^{ab}
V	91.82±0.29	16.97±1.30^{cdef}	4.73 ± 0.08 ^{bc}	3.83 ± 0.53 ^{d}	13.80 ± 0.45 ^{bc}	2878.36± 32.96 ^{abc}	52.43 ± 0.73 ^{ab}
ML	91.81± 0.12	16.41 ± 0.22 ^{cdef}	4.34± 0.10^{cd}	4.88± 0.27 ^{bcd}	11± 0.56^{c}	2914.07 ± 21.90^{a}	54.97± 10.63^{a}
O	91.7 ± 0.74	16.81 ± 0.46 ^{cdef}	5.10±0.20^{ab}	4.65 ± 0.65 ^{abcd}	13.80± 0.30 ^{bc}	2861.73 ± 69.95 ^{abc}	51.33 ± 1.02 ^{ab}
A	91.58 ± 0.06	15.90 ± 0.08 ^{defg}	4.70± 0.03 ^{bc}	4.30 ± 0.04 ^{bcd}	13.16± 0.20 ^{bc}	2872.93± 7.56 ^{abc}	53.52±0.24 ^{a}
FP	91.55± 0.00	17.44 ± 0.48^{cd}	4.56 ± 0.06 ^{bc}	4. 66 ± 0.33^{abcd}	17.76 ± 2.03^{a}	2691.48 ± 86.26 ^{cd}	47.11 ± 2.77 ^{c}
T	91.53 ± 0.45	17.21 ± 0.09^{cde}	4.49± 0.07 bc	4.30 ± 0.30 ^{bcd}	14.05± 0.92^{bc}	2841.41 ± 30.42 ^{abc}	51.260 ± 0.43 ^{ab}
E	91.52 ± 0.08	15.78 ± 0.29^{efg}	4.49 ± 0.07 ^{bc}	3.72± 0.12^{d}	14.90± 0.47 ^{abc}	2819.32±16.411 ^{abcd}	52.61±0.44 ^{ab}
OD	91.50 ± 0.25	17.25 ± 0.69^{ced}	5.60± 0.06^{a}	4.50 ±0.28 ^{abcd}	12.80± 1.69 ^{bc}	2919.31 ± 62.50^{a}	51.32 ± 1.75 ^{ab}
RT	91.48 ± 0.08	16.92 ± 0.26 ^{cdef}	4.84± 0.07 ^{bc}	4.29 ± 0.29^{a}	15.71± 1.11^{ab}	2742.50 ± 43.98 ^{cd}	49.06 ± 1.60^{bc}
J	91.45 ± 0.16	15.40 ± 0.12f^{g}	4.67± 0.19 ^{bc}	4.29± 0.29^{bcd}	13.41± 0.66 ^{bc}	2857.58 ± 17.33 ^{abc}	53.67 ± 0.89 ^{a}
AM	91.28 ± 0.04	14.51 ± 0.31^{g}	5.46± 0.15^{a}	4.88± 0.27^{abc}	12.95± 0.40 ^{bc}	2885.27±28.22 ^{ab}	53.16±0.42 ^{ab}
MR	91.22 ± 0.22	16.07 ± 0.07^{def}	3.87± 0.07^{d}	4.17 ± 0.07^{cd}	15.47± 0.07^{abc}	2744.56 ± 9.477^{cd}	51.63 ± 0.35 ^{ab}
AB	91.09 ± 1.09	19.10 ± 0.56^{ab}	5.10±0.69^{ab}	5.26± 1.12^{ab}	15.20± 1.72 ^{abc}	2772.16±46.56 ^{bcd}	46.42±0.03^{c}
P-value	**0.2977**	**0.0001**	**0.001**	**0.0001**	**0.001**	**0.001**	**0.001**

^{abcdef} indicate statistical grouping. Means that share at least one letter are not significantly different from one another at the given significant level (P < 0.5, DM=dry matter; CP=crude protein; C.Fat= crude fat; C.Fiber=crude fiber; ME= metabolizable energy; NFE=nitrogen free extract

4.4. Effects of Commercial Layer Feeds on Egg production, Egg Weight, Feed Intake and Feed Conversion Ratio

Key performance metrics such as hen-day egg production (HDEP), egg weight, feed conversion ratio and feed intake were used to assess the effects of various commercial layer diets that originated from various feed processing plants (table 10). The findings revealed notable differences among the origin of feed sources used by different layer farms. The majority of commercial layer farms (61.3%) use “A” processed feeds. This might be due to the company's current brand name. The majority of layer farms also frequently used feed, which originated from ML and E chicken feed producing plants, respectively. A, ML, and E layer feeds were thought to increase egg weight and production by layer farm owners. This study disproved the notion that layer farms that used feed from those feed processing plants produced less in hen-day egg production than those who used feed from other sources. These feeds' nutritional parameters also demonstrated that they were lower in key nutrients including metabolizable energy and crude protein (table 9) which contrast to the layer farmer’s perception.

The study found that layer feeds from various sources did not significantly affect HDEP, egg weight and feed intake ($P>0.05$). Nonetheless, farmers that used layer feeds processed at the “S” feed processing plant produced noticeably more HDEP. This might be related to the feed's high protein content, as seen in table 9. Comparing layer farms that used “S” feed to those that processed it at other feed processing plant, the higher HDEP for “S” feed suggested that the nutrients were more balanced. Different feed processing factories were the source of the layer ration, which had a substantial ($P<0.05$) impact on the FCR.The variation in breed of layers, age, production stage, management practices, health status, feed composition, ingredient source, temperature, feed intake and egg weight may be linked to the variation in this FCR. There is no significant effect of feed source on feed intake of layers since p-value> 0.05, however, the lowest and highest feed intake of layers were observed on farms where birds fed were fed diets of E and S, and RT respectively. This variation may be attributed to the difference in energy levels, with E having a higher energy content that typically reduces feed intake, while RT, with its lower energy level, leads to increased consumption.

Table 10: Effects of feed sources on egg production, egg weight and FCR (Mean ± SE)

Feed sources	Farm frequency	Mean of HDEP (%)	Fgg weight(g)	FCR	FI (g)
A	46	69 ± 2.8	59 ±0.4	2.9± 0.14[a]	112± 1.8
ML	9	74 ±3.3	58 ±0.7	2.7 ± 0.02 [ab]	112±2.2
E	5	60 ± 7	58 ±1	1.1±0.12 [c]	107±5.6
D	3	82± 6.8	57 ±1.89	1.6± 0.11 [abc]	111±2.9
AM	3	63± 7.3	60. 6 ± 0.3	1.2 ± 0.16 [bc]	116±3.8
RT	3	58 ±2	59 ± 1.7	1.2 ±0.05 [bc]	122± 0.0
FP	2	79 ± 0.9	59 ±4	1.6 ±0.05[abc]	119±2.4
J	2	79 ±6.9	58 ±1.25	1.5 ± 0.03[abc]	113± 4.9
S	2	94 ±1.9	60±1.25	1.9 ±0.08[abc]	122±0.07
p- value		0.1895	0.9304	0.001	0.7605

[a, b, c], indicate means grouping. Means that share at least same letter are not significantly different from one another at the given significant level (P< 0.05), HDEP = Hen day egg production; FCR=Feed; Conversion ratio; FI= Feed Intake

Figure 4 shows that even though the ash content of different feed sources are above the standard, the minimum and maximum percentage mean of egg broken were observed in the farms utilized the feed sources of S and D, respectively. This differences might be due to imbalanced calcium absorption, poor feed digestibility, environmental stress and age of layers (Quirino, 2023).

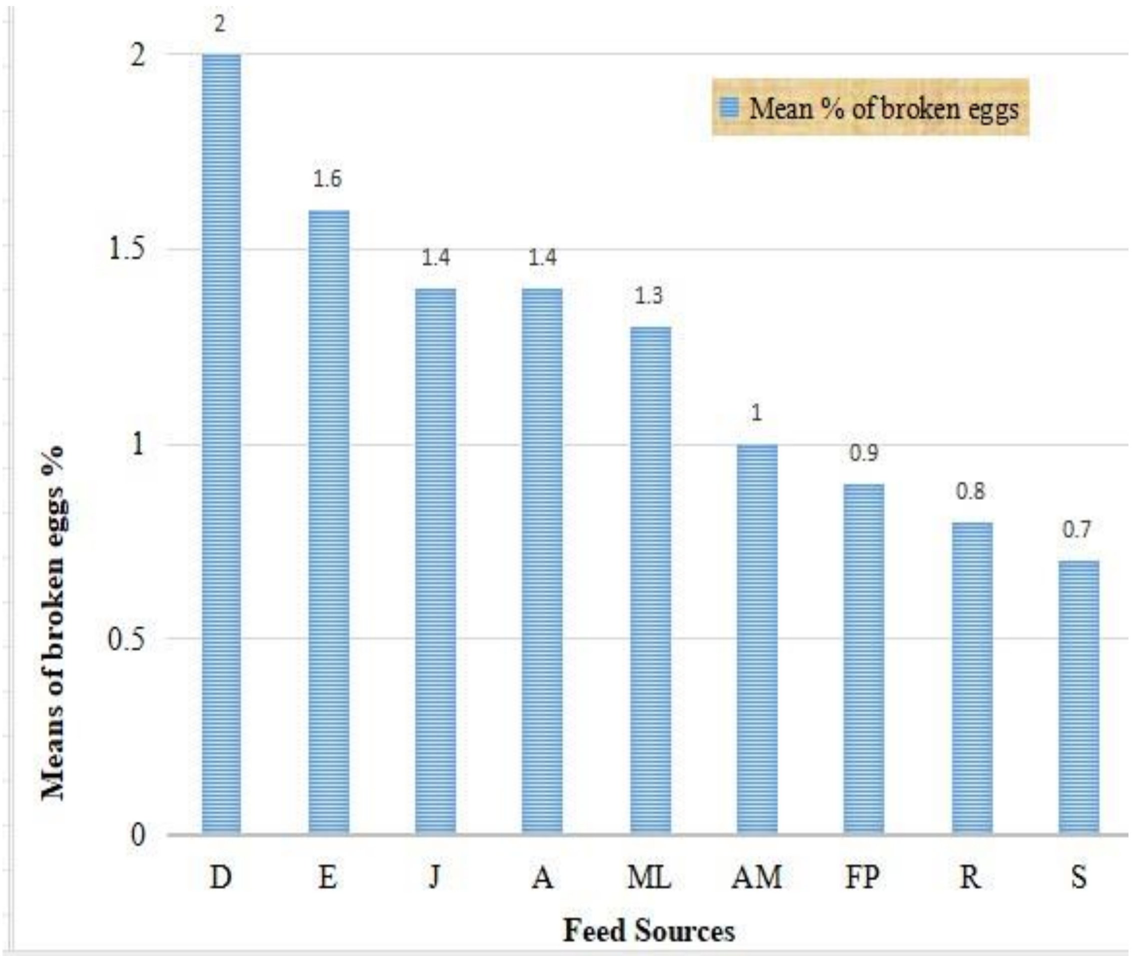

Figure 3: Feed sources and egg breakage

5. DISCUSSION

The sociodemographic profile of layer farm respondents in Bishoftu, Ada'a, and Lume is presented in Table 2. This study finding highlights the limited involvement of the government in poultry production of the area. The layer farms in study area were owned by private either individual or groups conforms to the findings of Ibrahim and Goshu, (2020), who reported that, individual-owned and group-owned poultry farms are extremely common. This high participation of private in poultry farm could be due to the very modest initial expenditure needed to launch a business. Educational level of the respondents shows more of primary to tertiary levels with the majority having less experience (1-5 years) in poultry rearing. According to Ukoha *et al.* (2010), education, experiences, technical know-how, and skill shaped technology adoption and management effectiveness. But, comparatively lower percentage of degree holders suggests that higher education is not necessarily essential to partake in layer farming, perhaps due to the nature of the business being practical and experiential.

The farming experience difference across the three study areas reflects the understanding of poultry business profitability and its development. The respondents of Bishoftu had higher levels of education, greater farming experience, and greater percentages of privately owned farms, consistent with available literature of Gure *et al.* (2024) who indicates Bishoftu as a well-established poultry hub with greater exposure to training, inputs, and market. On the contrary, respondents in Ada'a were less experienced and educationally lower and therefore a relatively new entry into poultry farming, consistent with Hailemichael *et al.*(2017), whose results indicated slower poultry sector development in peripheral districts. The relatively higher intensity of cooperatives in Ada'a and Lume contrasts with the increasingly dominant role of private ownership in Bishoftu, reflecting different levels of access to resources and support structures in locations. These findings emphasize the need for place-based interventions of educational and training in poultry farming and business.

The differences in farm characterization and husbandry practices across Bishoftu, Ada’a, and Lume reflect disparities in commercial poultry development and infrastructure.

Bishoftu exhibited a wider range of farm scales, including medium and large operations, showing more advanced commercialization, consistent with findings by Gure *et al*. (2024), who identified Bishoftu as a poultry investment hotspot. In contrast, the predominance of small-scale farms in Ada'a and Lume reflects earlier stages of sector development that needed technical support for scaling. This shows that more of the participants were involved in small-scale poultry production. This might be because of level of understanding about the poultry business, low capital investment, availability of labor resources. This study was supported by Tadesse *et al.* (2017), Kshash. (2019), and Waktole *et al*.(2023) who reported that most of the poultry farming were small-scale farming in central part of Ethiopia with intensive farming system particularly in Bishoftu, Mojo, and Adama. As indicated in Table 3, most of layer farms included in this study were small and medium farm-scale dominated with Bovans brown chicken breed which were kept as intensive farming system. Likewise, many scholars stated that Bovans Brown was the chicken breed which dominated the chicken production in different parts of Ethiopia. Study Aman *et al.,* 2017b; Solomon *et al.,* 2018; Litigebew *et al.* 2021). This could be associated with outstanding performance and livability of the breed which is consistent with study report of Abera *et al.* (2021).

Feeding practices in this study show that there was high reliance on commercial feed across all study sites. This is consistent with report of Tadesse *et al.* (2017), who documented 96.08% of study farms used commercial feed from company in Tigrai region. Similarly, Litigebew *et al.* (2021) reported that the majority (69.7%) of chicken producers use commercial feed in Amhara region. However, the complete absence of home-formulated feed in this study is different from previous research that Ebro *et al.* (2016) noted the use of a mixture of commercial and home-formulated rations, particularly in rural settings. The disparity may be attributed to the relatively more urbanized setting of study sites, where commercial feeds and markets are more accessible.

The layer farmers in the study offered a volume of diet which ranges between 110-125 g/hen (Table 4). This feeding quantities are likely to fall within the optimal level range for layer performance, as noted by Alemayehu *et al. (*2015), who recorded optimal daily feed intake of 110–125 grams per bird for semi-intensive system layers. But according to Wang *et al*. (2024), feed intake for layers in intensive commercial farming is based on age, breed, and environmental conditions and typically layers consume 100-130g/bird /day. The breed of layer hens plays a significant role in feed intake since high producing breeds such as Hy-line and Lohmans tend to have higher feed intake to support their high egg output (Jiang *et al.,* 2023). In the current study the maximum daily feed intake is higher than the standard daily feed intake of Lohmann Browns and Bovans Brown which indicate 110-120 and 114-116 respectively (Lohmann Brown Classic and Bovans brown management guide 071021).The present finding is less than Alemayehu *et al.* (2021) who indicated the daily feed intake of Lohmans breed was 117.26-127.14g. So, the Feed quantity uniformity between sites shows a growing awareness in standardized feeding by poultry producers.

With regard to frequency of feeding, it is important to feed two or three times a day for energy supply, better digestion and absorption, reduces feed wastage and minimizes stress and competition. The predominance of three times a day in feeding agrees with Soltanmoradi *et al.* (2013), who determined that frequent feeding is beneficial in ensuring enhanced feed intake and egg laying. The current study is agree with Wang *et al*. (2024), who recommended the two to three times a day of feeding frequency was essential since more frequent ensures stable blood glucose levels reducing stress and long feeding interval can lead to causing metabolic fluctuations. Researchers recommended. This method of managing feeding schedules helps regulating laying cycles and improving egg quality.

Vitamin supplementation practice in this study is considerably more pronounced than in earlier findings by Merhun (2018), who recorded patchy or nonexistent supplementation in traditional systems. Vitamin supplementation practice in the study areas were majorly conditional in most farms which may indicate higher awareness of nutritional health management. Discrepancy in the vitamin supplementation, however, is contrary to practice advocated by FAO (2013) of consistent micronutrient intake for guaranteed flock productivity and health. Controlled feeding method in current study is in line with best practices in maximizing feed efficiency and minimizing stress in layers. Likewise, Soltanmoradi *et al.* (2013) encouraged controlled feeding system for its benefit towards egg-laying performance. In the study sites, all participants working on layer farming uses commercial layer feed in the form of mash (Table 4). Pellet form of feed is slightly more expensive, this could be due to less economic feasibility of mash diet. The feed producers' company produce mash form of feed frequently due to manufacturing of pellet form needs process. Consistently Zohair *et al*. (20120 noted that mash form of layer diet is more economical as compared to pellet feed.

Result showed that farmers predominantly sourced their layer feed from private companies majorily a feed processing plant (Table 5). This reflecting a preference for commercial feed suppliers. This is consistent with the findings of Zegeye *et al.* (2023), who reported that urban and peri-urban poultry producers in Ethiopia increasingly rely on private feed suppliers due to accessibility and consistent availability. In the present study feed processing plant of 'A' is more accessible compared with others since the majority of the farms utilized it frequently. The preference for feed brands based on availability rather than quality or cost indicates while quality and costs are important, availability ensures business continuity and reduces operational risks. A study by Negash (2020) noted that although availability often drives feed choice, quality control remains a significant challenge in Ethiopia's commercial animal feed market, which is largely unregulated. The absence of formal feed quality assessments in this study aligns with this concern, highlighting a systemic issue in ensuring feed standards.

The study revealed that the majority of poultry farms in Bishoftu, Ada'a, and Lume utilized the deep litter housing system, with only a small percentage employing cage systems. This finding is consistent with the research conducted by Tsegaye *et al.* (2023), Abah *et al.* (2017), Akidarju *et al*. (2010), and Keutchatang *et al.* (2021), who reported the deep litter housing system as the predominant poultry housing type, with prevalence rates of 95.5%, 83.3%, 82.7%, and 77.8%, respectively. The choices between two types of housing system depends on farm size, budget and management since both types have their own advantages and disadvantages. In cage system, while higher egg production produced, higher initial investment is needed, birds may experience stress and legs problems because of movement is restricted which can affect welfare. This more preference to the deep litter housing system may be because of its affordability, simplicity, and minimal technical requirements.eventhough it needs land more than cage syetm, it is preferred more than cages. This finding also supported by Kogoor *et al*.(2021) who concluded that deep litter system provide a good managerial system and then cage system in open sided houses.

Majority of layer farmers in the study area uses one to seven nest to layer ratio. The current study is lower than Shi *et al.* (2019) who recommended 3-6 nest box to layer for reducing egg brakage and dirtness and supported by Engel *et al.* (2019) who reported that high ratio of nest box to layer can negatively impact the behavior of layers and this causes the large number of eggs breakage.Wegner *et al.* (2022) also indicated that hens prefer well lines of nests which can reduce cracked or dirty eggs. Therefore, an adequate number of nest box is essential to minimize egg damage and those layer farmers needs training to improve their husbandry practices of nest to layer ratio. The difference may be due to cost constraints, flock size variability, hen behavior and housing system

Result revealed that 100% of the layer farmers were implementing odor and pest control measures, indicating a level of awareness and proactive management. The farmers in study area control odors by improve ventilation by opening the windows and curtains for entering fresh air, updating the dirty part of litter material immediately. This finding aligns with the study reported by Ali *et al. (*2014), who noted that a majority of farms controlled the entry of wild birds, rodents, or insects into poultry sheds or enforced strict measures to keep other poultry and domestic animals away from their flocks. Conversely, this report contrasts with the findings of Ismael *et al.* (2021), who indicated that only a few farms implemented permanent pest control measures.

Concerning stocking density, which is crucial factor in poultry farming as it directly impacts the welfare, healthy and productivity of laying hens (Roy *et al*,.2021), half of the farms reported maintaining 8 birds/m², which contradicts the findings of Badubi and

Ravindran (2004), who documented densities of 10 birds/m² in Botswana. This increased stocking density may contribute to higher incidences of heat stress, aggression, and respiratory issues, particularly in structures with inadequate ventilation. However, housing system and economic constraints can limit the stocking density among the farmers since farmers balance the stocking density with profitability.

The current findings indicate that manure disposal practices were predominantly performed at the end of the production cycle (92%), which is largely consistent with the report by Nebiyu (2016), who noted that farmers removed manure/litter once annually in Addis Ababa and Zhang *et al*. (2022) who reported that manure is collected in belts beneath cage and removed periodicaly in the farms which used cage housing system but in deep litter, it is disposed at the end of the production cycle. The present study also agree with Bryant *et al*. (2022) who reported that the frequency of manure disposal depends on the housing system. Muhammad *et al. (*20200 reported that frequently disposal of manure in layer farms cause's respiratory problems, contamination of feed and water and stress on chickens.

Electricity is essential in poultry farms supporting various oppressions such as lighting, ventilation, heating and automated feeding system. If so, electric access is very important for poultry farmers. All farms in the present study had access to electricity, which supported by Sierocka *et al.* (2023) who reported 100% of poultry farms utilized electric power for different purposes in Poland, and is inconsistent with earlier findings reported by Tadesse *et al.* (2012), who stated that electricity was available in poultry houses for only 26.7% and 13.3% of respondents in the Ada'a and Lume districts respectively. The diffirences in electric access between the present study and the previous could be attributed to infrastructure development and data collection diffirences.

The study revealed that Newcastle Disease (NCD) was the most commonly reported disease at different times, affecting 73% of the surveyed farms, followed by Infectious Bursal Disease (IBD) at 27%. This may be due to absence of enough biosecurity measures application for instance majority of the farmers have no updated footbath at the entry of their farm This finding is in agreement with Tsegaye *et al.* (2023), who reported that the most prevalent poultry diseases were NCD (79.5%) and IBD (54.7%) in their studied farms. However, this result is inconsistent with earlier research reported by Elelu *et al.* (2012), which noted IBD at 24.2% and NCD at 21.2% in Ilorin, Kwara State, Nigeria. Regarding disease outbreaks, this study is consistent with the report by Yitbarek *et al.* (2016), who found that 91.8% of producers did not experience disease outbreaks during the study period. In contrast, this report disagrees with the previous findings of Akpabio *et al.* (2014), who indicated a 26% incidence of disease outbreaks in Kaduna State, Nigeria. This discrepancy emphasizes the significance of biosecurity as a primary defense against the entry and spread of diseases.

The majority of farms reported conducting vaccinations which is consistent with the findings of Tsegaye *et al.* (2023), who noted that 86.4% of commercial farms in selected districts of Arsi and East Showa zones practiced chicken vaccination. However, this report is inconsistent with previous report by Tadesse *et al.* (2012) who reported that the majority of the respondents (78.8%) in Ada'a district, East Shewa did not vaccinate their chicken. This variation might be due to farmers' educational level and distance from vaccine production center. Furthermore, 75.2% of the farms reported regular veterinary check-ups, representing an improvement over the previous report by Elelu et *al.* (2012), who indicated that only 42.1% of respondents routinely consulted veterinarians. This increase in veterinary support likely reflects the growing commercialization and enhanced extension services in Bishoftu and its surrounding districts.

The majority of layer feed nutrients composition have significant variation ($P< 0.05$) except DM% (Table 9). The analysis revealed that the dry matter content ranged from 91.09 to 92.25% which is higher compared to the standard DM (88%) given for layer feeds. Feeds with higher dry matter levels are more stable and less prone to mold development, making them more suitable for long-term storage. This is because lower moisture in the feed create unfavorable environment for mold growth, thereby preserving feed quality overtime. The study identified that the DM% of the different sources of feed were higher according to Ethiopian commercial layer standard. This study is agree with Ofori *et al*. (2019) who reported the minimum and maximum of DM % of 88.2 and

92.16%, respectively in Ghana, Akinola. Moreover, Ekine (2018) reported 91.3-94.1% DM for commercial layer feeds contain in Nigeria and Singh *et al.* (2019) reported the 88-90% DM for layer feed. These variations could be due to feed ingredient variation related to cost effeteness. This study is agree with the reports of Negash *et al.* (2022).

Crude protein is a crucial component of layer feed as it directly impacts egg production. From the result, in present study it was found that the minimum and maximum CP percentage were recorded for different feed sources which ranges from 14.51-19.96% (table 8). The minimum percentage of CP in this study was higher than the report by Niguse *et al*. (2022) who reported the minimum of 9.80% CP in Tigray region but according to Igwemmar *et al.* (2022) lower crude protein content of feed can affect egg production. The current study is supported by Akinola and Ekine (2018) in Nigeria. Moreover, Ofori *et al.* (2019) reported the minimum (16.56%) and maximum (19.68%) CP for layer ration.

Crude fat is an essential component of layer feed providing energy and aiding in the absorption of fat soluble vitamins like A, D, E and K. As a result indicated (table 9) the mean percentage of crude fat (3.87 to 5.60%) was above the minimum crude fat percentage (layer requirement) according to Ethiopian commercial layer feed standard (ES1032-1) which was 2%. The current study is lower than Niguse *et al.* (2022) who reported the maximum percentage of crude fat 8.69. However, Ekeocha *et al.* (2021) reported the analyzed crude fat content of feeds that ranges from 6.5-6.8%. On contrary, Oyedeji et *al*. (2013) reported 5.96-9.45% crude fat for layer feed respectively, in Nigeria. The lower crude fat in present study may be due to less added fat or oil in the diet which can affect feed palatability, nutrient absorption and feed palatability, potentially affecting layer performance and feed intake (Han *et al.*, 2023.

Crude fiber play crucial role in feed contributing to gut health, digestion, and overall behavior so the right type and amount (moderate) of fiber in layer diets is essential for optimizing their health and productivity since excess fiber reduces nutrient absorption, while too little may lead to digestive issues (Jha and Mishra, 2021). The layer feed crude fiber result was ranged between 3.72-5.26%. This study result identified that the minimum and maximum percentage of crude fiber was found in the feed produced by E and AB layers feed processing plants, respectively (Table 9). This result is below the maximum percentage of crude fiber (9%) according to Ethiopian layer commercial feed standard (ES1032-1). This study result disagree with Ekeocha *et al.* (2021) who reported the minimum and maximum percentage of crude fiber 5.5 and 5.9, respectively. The total crude fiber content of feeds were significantly varied among different layers feed sources (P <0.05). The total crude fiber variability among different feed sources may be due to fiber content in poultry diet varies significantly due to the intrinsic chemical and structural organization of feed ingredients as well as differences in grain type, cultivar and environmental conditions (Tejeda and Kim, 2021).

Among the different sources of layers feed, the minimum and maximum mean percentage of analyzed ash content recorded in ML and FP feed sources (table 9). The total ash content vary between different sources of feeds that layer farms used (P< 0.05). The current study was supported by Akinola and Ekine (2018) and disagree with Niguse et *al.* (2022) who reported the minimum and maximum percentage of analyzed ash content of feeds from different sources were 5.45 and 15.59.This agree with Swiatkiewicz *et al*. (2018) who have done on the effect of feed additives on egg performances and egg shell quality in Poland.

Metabolizable energy (ME) is crucial in layers nutrition as it directly affects the birds' productivity. Metabolizable energy is the amount of energy available to the birds from its feed after digestion and metabolism. As a result shows from the table 9, feed produced by OD feed processing plant produces layer feeds, which consist the highest ME whereas Mule feed processing plant consist the lowest ME. This result was higher than the base mark of Ethiopian Standard Agency (ESA), 2019 which was 2600kcal/kg for layer feed. The layer ration ME assessed in this study falls between 2742.50 to 2914.07 kcal/kg, which is within the range suggested by the NRC (1994). There was variation in ME among different feed processing plants (P<0.05). The minimum and maximum mean percentage of ME in this study was not similar with Akinola and Ekine (2018) who reported the analyzed ME content of layers feed was 1820 and 2044kcal/kg for minimum and maximum among different feed sources, respectively. Lower ME for layer feed was also noted by Negash *et al*. (2022) who reported 2451kcal/kg ME content in the layers feed.

NFE primarily represents digestible carbohydrates like starch and sugars. The result of calculated NFE percentage in the different source of feeds showed that the highest and the lowest of NFE were recorded which ranges from 46.39-53.67%. There was statistically significant difference in NFE among feed sources. The present study is higher than 39.06-48.95% reported by many scholars (Cherian, 2020; Igwemmar *et al*. 2022; Pesti, 2024) in Australia. ($P<0.05$). The differences may be due to ingredient composition since grains such as maize and barely have high NFE and others such as wheat bran and cassava leaf meal reduce NFE due to their low starch content (Beck *et al.*, 2024). Generally, this study revealed variations in chemical composition among layer feeds produced by different feed processing plants (Table 9). This could be associated with variation in the use of feed ingredients during formulation (different raw materials such as grains, oilseeds, and byproducts), processing method (heat treatment, grinding and pelleting), geographical differences in which agricultural practices occurred and storage condition can affect the nutritional composition (Pascual *et al.,* 2024). The findings of this study supported the idea that there was no quality control system in place to check the quality of layer feed produced by various plants for the same breed or at different stages of production.

One of the factors that affect chicken egg production rate is feed quality (Rakonjac *et al.*, 2021). The availability of high quality feed is critical for production performances. Poultry have different nutritional requirement at various stages of their life cycle (Zegeye *et al.,* 2023). Assessed farms those used different feed sources had different mean production performances. The minimum and maximum HDEP% was recorded for layer farms using S and R feeds, respectively. S feed generally offers a better-balanced composition, particularly in terms of ME, CP and NFE which are crucial for maintaining egg production. The present study was higher than the study reported by Fekadu (2021) who indicated 49.58% HDEP when chickens fed diets with MEkcal/kg of 2750 and CP% 15.5 and the lowest 41.17% HDEP % was recorded when chicken fed diets with MEkcal/kg of 2650 and CP%16.5. Niguse *et al.* (2023) reported the minimum and maximum HDEP percentage of 29.96-62.26%. Farms those used RT feed sources had the lowest HDEP%. This suggesting that variations in nutrient availability and energy levels might have influenced their laying performance.

The minimum egg weight (57.75g) was noted for farms which relied on “D” feed processing plant while the maximum (60.583g) egg weight was recorded for farms which depend on Amen feed processing plants (table 10). This might be because of the impact of chemical composition such as NFE and crude fat since the layer feed from AM feed processing plant had slightly higher in content of NFE and crude fat. Additionally, it might be the factors such as age and breed can affect egg weight. Ekeocha *et al.* (2021) had reported the highest mean of egg weight (56.40g) when the hens fed diets with CP%21.7, MEkcal/kg 2700, crude fat% 6.8, crude fiber% 5.9, while the lowest egg weight (54.4g) was reported when the hens fed diets with CP%18.2, MEkcal/kg 2650, C.fat% 6.8 and C. Fiber%5.5. However, Fikadu *et al*. (2021) reported the minimum egg weight of 51.32g when chicken fed with CP%14.5 and MEkcal/kg 2650. The difference might be breed, stage of production, and general management. The study was supported with Niguse *et al*. (2023) who reported the minimum and maximum egg weight of 54.41-58.47g in Tigray region.

Significant difference ($P<0.05$) was noted for FCR among different feed sources (Table 10). The highest FCR was recorded for the farms relied on layer feeds produced by A and ML. However, lower FCR was recorded in the farms which used Ethiochicken feed for layer chickens. The FCR is crucial metric for poultry farmers, as a lower FCR indicates better efficiency meaning hens require less feed to produce more eggs. The present study was lower FCR (better feed efficiency) than the study reported by Akinola and Ekine (2018) who indicated the minimum (2.57) FCR was recorded when hens fed diets with CP percentage of 20.3, Crude fat percentage of 6.5, Crude fiber percentage of 5.5 and MEkcal/kg 2700; and maximum (5.26) FCR was recorded when hens fed diets with CP percentage of 17.85, Crude Fat percentage of 6.8, Crude Fiber percentage of 5.5 and MEkcal/kg of 2500 in Nigeria. The difference might be because of breed, the balance of chemical composition of feeds, environment and management practices (Clark *et al*. (2019).

There was significance difference in feed intake of layer chickens fed on different layer diet produced by different feed processing plants. This study result is contrary to Ekeocha *et al.* (2021) who reported as the feed intake among different feed sources were significantly different in Zimbabwe.   In this study higher FI was noted as compared to the result reported by Singh *et al.* (2019) who recorded 106- 112 when hens fed with different feed sources. The difference might be breed of layers, housing system, nutritional composition and other management practices as confirmed by Wang *et al.* (2024).

6. CONCLUSION AND RECOMMENDATIONS

The study found that most commercial layer farms (95%) use deep litter housing systems. While the majority (92%) clean manure at the end of each production cycle, a small portion (8%) dispose of it more frequently. The assessment found that 73% of farms faced occasional challenges with Newcastle Disease, while 27% encountered issues with Infectious Bursal Disease. Although most farms (76.4%) administered vaccines for Newcastle Disease, only a small fraction (6.7%) vaccinated against Infectious Bursal Disease. All assessed farms (100%) implemented controlled feeding practices. The majority (37%) provided a diet of 110–115 g per hen, while 82% conducted feeding three times daily. Most farms (52%) depended on a single feed source, labeled "A," prioritizing availability over quality. The analysis of commercial layer feed revealed statistically significant variations ($p < 0.05$) in nutrient composition among different feed processing plants. The crude protein content ranged from 14.51% to 19.96%, crude fat from 3.87% to 5.6%, crude fiber from 3.72% to 5.26%, ash from 11% to 17.76%, energy levels from 2691.48 to 2919.31 kcal/kg, and nitrogen-free extract from 46.39% to 54.97%.The difference in dry matter content among various factories was not statistically significant ($p > 0.05$), with values ranging from 91.09% to 92.25%. The findings showed no statistically significant effect ($p > 0.05$) of feed source origin on hen-day egg production, egg weight, or feed intake. However, a significant impact was observed on the feed conversion ratio. Based on the above conclusion the following recommendations are forwarded:-

- There should be regular training for poultry farm owners on the layers farm husbandry practices and biosecurity of the farms.
- The study findings highlighted the absence of a quality control system to assess the consistency of layer feed across different plants, breeds, and production stages. Therefore, strict regulations should be implemented for layer feed producers, ensuring proper feed composition and regular evaluations.
- There should be regular vaccination schedule for endemic diseases such as Newcastle and infectious bursal diseases and monitoring of the program.
- Further research should be conducted to fully evaluate feed nutrient composition, aiming to minimize farmers' reliance on continuous vitamin supplementation

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8. APPENDICES

Appendix 1: Assessment of Layer Husbandry Practices, Evaluation of Available Commercial Feed and Its Effect on Production Performance and Quality in Ada'a and Lume Woredas, Ethiopia

Section 1: General Information

1.1 Demographics:

Name of the farm/owner ____________________: *Location of the farm Region* ___________ Woreda_______________ Kebele_____________ GPS location Latitude________________ Longtude_________________

Year of establishment____________: *Ownership type* -Individual ☐ Group ☐ Company ☐

Educational status of farm manager: A. Primary B. Secondary C. Diploma D. Any_____

*Education level of farm manager/owner*_______________________

Years of experience in poultry farming? A. 1-5 B. 5-10 C. >10 years

1.2 Farm Characteristics:

1.2.1. Total number of layers a. 100-1000 b 1001-5000 c. 5000-10,000 d. >10,000

1.2.2. Farm caretaker to flock size ratio:_________________________

1.2.3. Farming system: a. Intensive b. Semi-intensive c. Extensive

1.2.4. Date of chickens introduced in to the farm_____________________

1.2.5. Average Age of the chikens (day/week)__________

1.2.6. Breed(s) of layers used a. Bovans Brown b. Lohmann brown C. Other, specify if any_____________

1.2.7. Average egg production per farm per day_________ per layer per day _____

1.2.8. Production stage of layers: a. Phase I (20 – 42 weeks of age) b. Phase II (43-62 weeks of age) c. Phase III (63-72 weeks of age)

1.2.9. Type of housing system used - A. Deep litter system B. cages system C. Other__________________________

1.2.10. Type of bedding material used: A. Teff straw B. Wood shaving C. Other_____

Section 2: Husbandry Practices

2.1. Health and Disease Management:

2.1.1. Was there a disease outbreak in your farm A Yes B No ___________ How Frequent ___________ What was the common Disease in you farm ____________

2.1.2. What are the Common Poultry Diseases in the Area ____________

2.1.3. What vaccinations are administered, and how frequently?_______

2.1.4. Are there regular veterinary check-ups? If yes, how frequently?

2.2 Feeding Practices:

2.2.1. What type (s) of feed do you provide: commercial feed□, homemade □ a combination □ other ____________

2.2.2 How much gram you provide per day per chicken ________ is that fit to the breed standard ____________

2.2.3. Feeding frequency: a. once a day b. twice a day c. thrice a day d. Four times a day

2.2.4. Are chikens satisfied with the given amount or do they need more_________

2.2.5. Do you provide vitamin supplement A Yes B No, If yes, how frequent _________ for how many days at a time __________

2.2.6. Feeding method: A. Ad libtum B. Controlled C. Other__________

2.2.7. Daily feed offer for a flock (kg/day):__________________

2.2.8. Feeding type: a. Mash type b. Pelleted type c. crumbled d. combined (Mash/Pell/crumble)

2.3 Housing Management:

2.3.1. Total area allocated for poultry production (Compound dedicated for poultry farming) _______________

2.3.2. What is the area of the poultry house _________ stocking density (number of birds per square meter) _________ _________

2.1.5. Nest box to layer ratio: A. 1:5 B. 1:7 C. 1:10 D. Other_______

2.1.6. Photoperiod (light duration/day in hrs): A. 12 B. 12- 16 C. 16-18 D.

2.1.7. How is temperature regulated in the poultry house_________________

2.1.8. How is poultry manure managed or disposed of? ____________________________

2.1.9. What is the type of ventilation a Natural, b Artificial

2.1.10. How is hygienic condition of the house a excellent b very good c good d bad

2.1.11. Are there any measures in place to control odors or pests related to waste?

2.2. Lighting and Production Management:

2.2.1. What lighting management system is used A Only natural B artificial C natural and artificial

2.2.2. Photoperiod (light duration/day in hrs): A. 12 B. 12- 16 C. 16-18 D. Other_____

2.2.3. Is there any electric power in the areas? A Yes B No; if yes, is there power interruption? A Yes B No , if yes what lighting alternative you use to fulfil the lighting requirement _____________________

2.2.4. Is there any variation in laying percentage due to the lighting problem you observed? A Yes B No

Section 3: Feed Quality and Efficiency

3.1. Commercial Feed Evaluation:

3.1.1. Frequent feed utilized by your farm originated from:

A. Alema Koujds

B .Jaglish

C. Friendship

D .Dina

E. Gumara

F. Mule

g. ethiochicken

H. maranata

I elfora

J top

K ok

L others _____

3.1.2. Reason for frequent use of feed from the same source: A. cheap Price B. high quality C. Availability E. Other, if any:________________________

3.1.3. Have you discussed or gotten information from other farmers on feed quality? A Yes B No

3.1.4. Have you had experience using a different feed previously? A Yes B No , if yes, why did you change to the new one (price, availability, quality, productivity, etc)________________________

3.1.5. Are there variations in feed quality between suppliers? _______________________

3.1.6. Have you conducted any feed quality assessments or laboratory tests for the feed you use to check the nutrient composition of the feed (e.g., protein, energy levels)?

A Yes B No

If yes, how frequently are analyses conducted?

If not, what was the reason? _________________

3.1.7. Have you observed any egg production or quality variations when switching feeds? A Yes B No other___________

3.1.8. How does feed quality impact your production efficiency (feed conversion ratio, productivity palatability etc)? ___________________________________

Section 4: Challenges and Recommendations

4.1. **Challenges**:

4.1.1. What are the key challenges in husbandry practices A housing, B disease control, C labor, etc.)?

4.1.2. What are the main issues faced with feed quality and access?

4.2. Farm productivity and marketing

4.2.1. Egg weight:____

4.2.2. Egg price at farm gate:_____________________________

4.3. **Recommendations**:

4.3.1. What recommendations do you have for improving husbandry practices and feed quality?

Husbandry ________________________________

Feed Quality __ ________________________________

4.3.2. What support do you need from government or private stakeholders?

____

4.3.3. What changes have you implemented in your farm management practices over the last few years, and how have they impacted productivity?

4.3.4. What is your opinion on controlling the feed quality at the market, and who needs to be responsible for that? What will be the role of each stakeholder (farmers, government, producers associations, etc?)

Appendix 2*:* Record format for collecting data

Date:__________________________

No.	Age	Beginning flock balance	Mortality	Culled	Ending flock balance	Feed				Egg production						
						Initial	Add	Consumed	Left over	Normal	Broken	Total	Egg weight (g)	Prod %	Transferred to store	Ending balance
1																
2																
3																
4																
5																
6																
7																
8																
9																
10																
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28																
29																
30																
Av.																

Data Recorder: ________________________________ Responsible Unit manager: __________________________ Signature:

Appendix 3: Photo gallery of Poultry Layers Farm

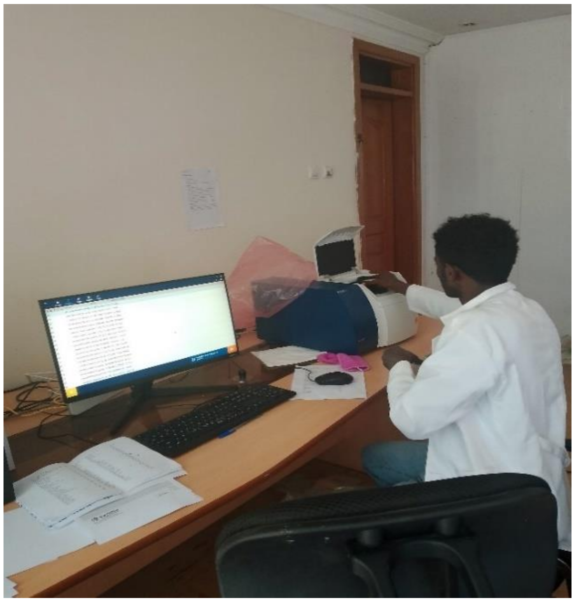
Poultry farm in cage system

Poultry farm in deep litter system

Pictures showing Measuring of egg weight

Collecting of feed samples

Grinding the feed sample



Scanning of feed amples

FOSS machin*e*

Appendix 4 : Lists of guidance as reference

Ethiopian commercial layer feed standard (ES1032-1)

Lohmann Brown Classic and Bovans brown management guide 071021)

Appendix 5 : Different poultry feed sources

S. no	Code of feed sources	Name
1	A	Alema
2	ML	Mule
3	E	Ethiochicken
4	D	Dina
5	AM	Amen
6	RT	Rifenti
7	FP	Friendship
8	J	Jagdish
9	S	Sale
10	OT	Other
11	MR	Maranatha
12	V	Vision
13	OD	Oda
14	MT	Mati
15	H	HY
16	EN	Etina

Appendix 6 : Ethical clearance

ADDIS ABABA UNIVERSITY
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Animal Research Ethical Review Committee

Ethical clearance certificate

Certificate Ref. No: VM/ERC/04/65/17/2025

Name of Applicant: **Haweni Asfewu** (BSc in Animal Science, MSc student)

Address: Department of Microbiology, Parasitology and Poultry Health, College of Veterinary Medicine and Agriculture, Addis Ababa University

Title of the project: *Assessment of layer husbandry practices, nutrient evaluation of layer commercial feeds and their effects on production performances and egg weight in Bishoftu town, Ada'a and Lume Woredas, Ethiopia*

Date of application:	**December, 2024**
Nature of the project:	**Farm investigation**
Target animal species:	**Chicken**
Number of animals involved:	**89 layer farms**
Study area:	**Central Oromia, Ethiopia**

Minutes No. and date of review: **VM/ERC/04/17/025, 25/02/2025**

The Institutional Animal Care and Use Committee of the College of Veterinary Medicine and Agriculture of the Addis Ababa University has reviewed the above research project and unanimously approved the application of Haweni Asfewu.

Professor Getachew Terefe (DVM, PhD)
Chairman

Signature

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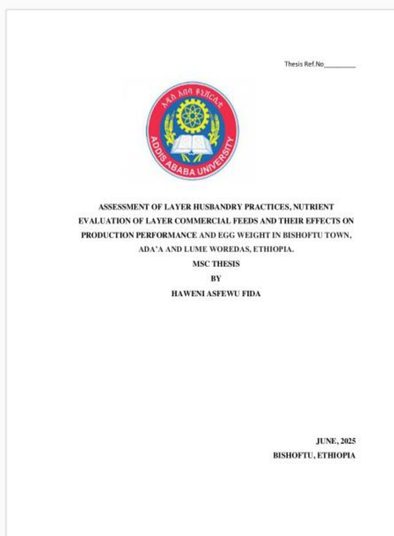
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ASSESSMENT OF LAYER HUSBANDRY PRACTICES, NUTRIENT EVALUATION OF LAYER COMMERCIAL FEEDS AND THEIR EFFECTS ON PRODUCTION PERFORMANCE AND EGG WEIGHT IN BISHOFTU TOWN, ADA'A AND LUME WOREDAS, ETHIOPIA.

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