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MANAGEMENT PRACTICES AND CONSTRAINTS OF SMALL-SCALE COMMERCIAL POULTRY FARMS, AND PERFORMANCE EVALUATION OF BROILERS FED DIETS CONTAINING GRADED LEVELS OF DRIED BLOOD-RUMEN CONTENT MIXTURE

PhD Dissertation

By

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Addis Ababa University, College of Veterinary Medicine and Agriculture

Department of Animal Production Studies

PhD Program in Animal Production

June 2017

Bishoftu, Ethiopia

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A Dissertation submitted to the College of Veterinary Medicine and Agriculture of Addis Ababa University in partial fulfilment of the requirements for the Degree of Doctor of Philosophy in Animal Production

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As members of the Examining Board of the final PhD open defence, we certify that we have read and evaluated the Dissertation prepared by Melkamu Bezabih Yitbarek Titled: "**MANAGEMENT PRACTICES AND CONSTRAINTS OF SMALL-SCALE COMMERCIAL POULTRY FARMS, AND PERFORMANCE EVALUATION OF BROILERS FED DIETS CONTAINING GRADED LEVELS OF DRIED BLOOD-RUMEN CONTENT MIXTURE"** and recommend that it be accepted as fulfilling the Dissertation requirement for the Degree of Philosophy in Animal Production

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STATEMENT OF THE AUTHOR

I first, declare that this dissertation is my bonafide work and that all sources of materials used for this dissertation have been duly acknowledged. This dissertation has been submitted to the requirements for PhD Degree at Addis Ababa University, College of Veterinary Medicine and Agriculture and is deposited at the University's Library to be made available to borrowers under rules of the Library. I solemnly declare that this dissertation is not submitted to any other institution anywhere for the award of any academic degree, diploma, or certificate.

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BIOGRAPHICAL SKETCH

I, the author of this dissertation was born in July 1974 in a village called Debre Mariam in Bibugn Woreda, Eastern Gojjam Zone of Amhara Region. I attended my elementary and junior secondary school at Woinwuha elementary and junior secondary school from 1982 to 1988, and then I attended my secondary school education at Motta Senior Secondary School from 1989 to 1992. After successfully passing the Ethiopian School Leaving Certificate Examination, I joined the Awassa College of Agriculture of the Addis Ababa University in 1993 and graduated with B.Sc. Degree in Animal Production and Rangeland Management in July 1996. After my graduation, I was employed by the Amhara Agricultural Bureau in Northern Shoa Zone in July 1997 and served as an Expert, Desk Officer and Team Leader in Gisherabel, Efrata and Gidem, and Antsokia Gemza Woreda Agricultural Offices for five years. In August 2002, I was employed by the Ministry of Agriculture to serve in the Wolaita Soddo ATVET College, SNNP Regional State and served for eight years as an Instructor and Senior Instructor. In 2008, I joined the Mekelle University, College of Dryland Agriculture and Natural Resources and graduated with M.Sc. Degree in Livestock Production and Pastoral Development in July 2010. In September 2010, I joined the Debre Markos University and served as Lecture and Head in the Department of Animal Science, and Vice Dean in the College of Agriculture and Natural Resources for 3 years. I published 19 articles in reputable journals and I was promoted to an Assistant Professor position in February 2015. After 3 years of experience in the Debre Markos University, I joined Addis Ababa University, College of Veterinary Medicine and Agriculture in September 2014 to pursue a PhD study in Animal Production.

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LIST OF ABBREVIATIONS

ACSI	Amhara Credit and Saving Institute
ADG	Average Daily Gain
ANOVA	Analysis of Variance
ATVET	Agriculture Technical Vocational Educational Training
BBRCM	Bovine Blood -Rumen Content Mixture
BW	Body Weight
BWG	Body Weight Gain
Ca	Calcium
CaI	Calcium Intake
CF	Crude Fibre
CFI	Crude Fibre Intake
CP	Crude Protein
CPI	Crude Protein Intake
CRD	Complete Randomized Design
CRD	Chronic Respiratory Disease
CSA	Central statistics Agency
DBRCM	Dried Blood Rumen Content Mixture
DM	Dry Matter
DMI	Dry Matter Intake
DOC	Day Old Chick
DRC	Dried Rumen Content
EE	Economic Efficiency
EE	Ether extract
FAO	Food and Agriculture Organization
FBBRD	Fermented Bovine Blood and Rumen Digesta
FCR	Feed Conversion Ratio
g	Gram
GLM	General linear Model
Gos	Governmental Organizations
HSD	Honesty Significant Difference
IBD	Infectious Bronchitis Disease

IFAD	International Feed and Agriculture Development
kg	kilo gram
ME	Metabolizable Energy
ME	Metabolizable Energy
MEI	Metabolizable Energy Intake
MJ	Mega Joule
NCD	Newcastle Disease
NFE	Nitrogen Free Extract
NGOs	Nongovernment Organizations
NRC	National research council
NVI	National Veterinary Institute
Qt	Quintal
RC	Rumen content
REE	Relative economic efficiency
RSBM	Roasted soybean meal
SAS	Statistical Analysis System
SDRBM	Sun Dried Rumen- Blood Meal
SEM	Standard Error of Mean
SNNP	Southern Nations and Nationalities People
SPSS	Statistical Package for Social Sciences
TEO	Total Edible Offal
TEVT	Technical Educational Vocational Training
TNEO	Total Nonedible Offal

DEDICATION

This dissertation is dedicated to my mother W/ro Yirefu Alimaw, my sister Yezina Meseret, and for both my grandmothers and grandfathers who passed away without seeing my success**.**

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Melkamu Bezabih Yitbarek

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ABSTRACT

Management practices and constraints of small-scale commercial poultry farms in and around Debre Markos, and performance evaluation of Sasso C44 broilers fed diets containing graded levels of dried blood-rumen content mixture. A cross-sectional study was carried out to assess management practices and constraints faced by small-scale commercial poultry farms using a structured questionnaire through interview, group discussion and spot observation. The data related to management practices were analysed using SPSS software Version 20. The constraints faced were ranked by the respondents and the factors were analysed following the procedure of Garrett's ranking technique. The effect of feeding dried blood rumen content mixtures on the performance of broiler chicks was evaluated using 225 unsexed day old broiler chicks which were randomly distributed to five dietary treatment groups in a completely randomized design (CRD). Each treatment was replicated thrice with 15 birds per replicate. The experimental diets were formulated to contain 100% roasted soybean meal (RSBM)+0% dried blood rumen content mixture (DBRCM) (T1), 80% RSBM + 20% DBRCM (T2), 60% RSBM + 40% DBRCM (T3), 40% RSBM + 60% DBRCM(T4) and 20% RSBM + 80% DBRCM (T5) during the starter phase (1-28 days) and finisher phase (29-56 days) of growth. The data were analysed using SAS software Version 9.2. The result showed that there were 49 farms and the sources of the chicks were Andassa (18.3%), Ethiochick (79.6%) and Gerado (2.1%) poultry farms. The mean flock size per farm was 844.3; among which 83.3 % were Bovans brown, 5.3% Bovans white, 7.7% Koekoek and 3.7% Sasso T44. The majority (75.5%) of the producers kept egg type chicks under intensive management system in deep litter housing. About 98% of the producers used commercial feeds and offered the feed three times per day. All poultry producers provided water

regularly and tap water represented 93.9% of the water source. All farms were accustomed to vaccinate their chicks more than once. More than half of the producers used biosecurity measures. About 77.6% and 65.3% of the farms had no access for rodents and predators, respectively. Cleaning and sanitizing of the house, the feeders, and waterers were done by the majority of the producers. Nearly 59.2% of the producers did run their farms by their own money. Almost 53.1% and 69.4% of the producers took training and got extension service respectively. About 85.7% of the producers recorded farm activities. However, the production was hindered by different constraints such as a high cost of feed, unavailability of feed and feed ingredients, unavailability of land, lack of market linkage and promotion, and high purchasing cost of day old chicks which ranked between 1 to 5. The results of the feeding trial revealed that the daily DMI ranged from 75.8 to 80.4g/bird during the entire experimental period. Birds in T5 had lower ($P<0.05$) DMI 75.8g compared with T1 (79.0g), T2 (78.9g) and T3 (80.4g). The mean daily body weight gain of birds ranged from 26.4 g to 31.6 g and no difference ($P\geq 0.05$) was detected among treatment groups. The feed conversion ratio (FCR) ranged from 2.5 to 2.9 and did not differ ($P\geq 0.05$) among treatments. The edible carcass weight and its dressing percentage ranged from 977.9 -1159.3 g and 63.1- 66.6%, respectively, with no significant differences ($P\geq 0.05$) observed among the treatments. The edible and nonedible offal components were similar ($P\geq 0.05$) among treatments. The highest ($P< 0.05$) and the lowest ($P<0.05$) total feed cost was observed for birds in T1 and T5, respectively. Birds in T4 and T5 showed the highest ($P<0.05$) economic efficiency and relative economic efficiency compared toT1. Based on the results obtained it could be concluded that alleviating the constraints faced and improving the existing management practices are the most imperative measures to improve small scale commercial poultry farms. Using DBRCM as a replacement for roasted soybean meal at 60% during the starter phase and at 80% during the finisher phase in Sasso C44 broiler production can reduce the cost of feed required to raise broilers to market age and maximizes the economic efficiency due to its local availability and cost effectiveness without affecting the total body weight gain, feed conversion ratio, performance index and carcass characteristics of birds.

Keywords: *Broilers, constraints, dried blood rumen content mixture, management practices*

1. INTRODUCTION

Food security and poverty reduction are priority policy issues in the Ethiopian government development plan due to the fact that about 23% of the population lives below the poverty line (WFP, 2014). Poor human nutrition has continued due to lack of sufficient energy and protein in the food or due to insufficient availability of food (Abedullah *et al*., 2007). According to Yusuf *et al. (*2016) the minimum intake of protein by an average person should be 65g per day; of this, 36g (that is, 55.4%) should come from animal sources. If food self-sufficiency is to be achieved and malnutrition combated in developing countries particularly in Ethiopia, there is a need to give due attention to poultry production (Melkamu, 2013). Poultry occupies a pivotal position in alleviating protein deficiency by providing eggs and meat which are important sources of edible animal protein (FAO, 2010a). Poultry production has a potential in poverty reduction by means of income generation and household food security (Abubakar *et al.*, 2007). It has also enormous potential to bring about rapid economic growth, particularly benefiting the weaker sections of society. Further, it needs low capital investment and assures quick returns (Rajendran and Samarendu, 2003).

The total poultry population in Ethiopia is estimated to be about 60.5 million, of which 94.3%, 3.2% and 2.5 % were reported to be indigenous, cross and exotic, respectively in backyard, small-scale, and large-scale commercial production systems (CSA, 2016). Despite the huge poultry population, the annual output is only 60,000 metric tonnes of meat and 40,000 metric tonnes of egg (FAO, 2013a) and the per capita egg and poultry meat consumption in Ethiopia is one of the lowest in the world: 0.4 kg eggs and 0.6 kg of chicken meat per annum (FAO, 2013a).

There are several emerging small-scale commercial poultry farms seen in Ethiopia in general and in and around Debre Markos in particular. These emerging farms have vital contribution in improving the livelihood, food security and poverty reduction as well as provide a good return in peri-urban and urban areas of the country (Robyn, 2012; Pica-Ciamarra and Otte, 2010). However, the contribution of poultry in the Ethiopian economy is only 2-3% due to different constraints (Nigusse, 1999). Among the constraints, the availability and cost of feed ingredients stand at the forefront (Melkamu, 2013). The feed cost accounts 70-75% of the total cost of production (Martinez, 1999).

The use of conventional protein sources such as peanut cake, sesame seedcake, soybean meal, and fish meal might sometimes be limited in poultry feeding due to their unavailability and costy (Etalem *et al*., 2013). For instance, about 15,824.4 tonnes of soybean was produced in Ethiopia in 2010. The demand of the oil extracting factories was 60,000 tonnes, which covered only 26.4% of their production capacity and it shares only 1% of the total oil seed production (Wijands *et al.,* 2011). Thus, under such circumstances using soybean for poultry ration is not being cost effective. The high cost of conventional protein feedstuffs has contributed to poor productivity of many poultry farms and this has led to a shortage in the availability of animal protein to the citizenry (Adeniji and Jimoh, 2007). This situation inevitably calls for animal nutritionists and other specialists to exert maximum efforts in search of cheap and locally available alternative non-conventional feed ingredients inedible to mankind for replacing the usually expensive and scarce cereal and legume grains consumed directly by humans (Onu, 2007). One of such non-conventional feedstuffs, which could be of value for poultry feeding replacing soybean meal, an expensive and scarcely available feedstuff is dried bovine blood-rumen content mixture (DBBRCM).

Bovine blood-rumen content mixture (BBRCM) is an abattoir (slaughter house) by-product that offers a tremendous potential as a cheap and locally available alternative feedstuff for poultry (Adeniji and Jimoh, 2007). The same source indicated that BBRCM has little or no cost and can be incorporated in poultry rations after appropriate processing in order to reduce production costs and help alleviate pollution problems without any reported deleterious clinical effects on the animals' health and for their performance. Abattoirs generate large amounts of solid waste and effluents such as rumen contents, blood and wash water.

According to the CSA (2013a) the cattle population in Ethiopia is 53.99 million. By considering an off-take rate of 7% for cattle (Bisrat, 2013), around 3.8 million cattle are slaughtered annually, and a recovery rate of 2.7-3.5 kg (DM basis) of ruminal contents (Dominguez *et al*., 1994) and 3-4% of its body weight blood per head of a slaughtered animal are produced (Liu, 2009), where approximately about 133,000 quintals of DM rumen content and 38 million litres of blood per annum can be produced. According to Downes *et al.* (1987), in the separation of blood into plasma and blood cell fractions, 60% plasma with a solids content of 8%, and 40% corpuscles with a solids content of 38% are obtained.

Therefore, from 100 kg of blood, 4.8 kg of plasma powder and 15.2 kg corpuscle powder would be produced. Based on this calculation from 38 million litres of blood, 76,000 quintals of blood meal can be produced in Ethiopia annually. If a quintal of dried rumen content and blood meal might be sold at 300 and 800 Ethiopian Birr, respectively, 39.9 million Birr from dried rumen content and 60.8 million Birr from blood meal can be obtained. Therefore, no use of these wastes would mean, Ethiopia would lose 100.7 million Birr annually (personal communication). Similarly in Debre Markos, around 5,000 cattle are slaughtered formally in a municipal slaughter house per annum. Accordingly, an estimated 17,500 kg DM of rumen content and 50,000 liters of blood (10,000 kg blood meal) can be produced annually (calculated by considering 250 kg body weight per slaughtered bovine).

These huge amounts of rumen content and blood are not utilized for animal feeding, but simply released into the environment and cause difficulties in disposal of such wastes. The existing system of disposing abattoir wastes results in pollution not only causing problems related to odour, flies and hygiene, but surface and ground water can also be polluted with pathogens and undesirable chemical compounds. Efforts have not been made yet in Ethiopia in general and in Debre-Markos in particular to utilize these waste products as an alternative feed ingredient in broiler rations. The need to maximize the economic benefits and minimize the disposal problems associated with rumen content and blood, led to new interests in the investigation of these by-products for a possible use in the diets of broilers as a source of protein that can replace roasted soybean meal in poultry rations.

In general, information on management practices and major constraints of small-scale commercial poultry farms in and around Debre-Markos is scanty. However, relevant information on management practices of the farms is very vital to take remedial measures for maximum output with minimum input to assure food security in a sustainable way. Therefore, this study was conducted to assess management practices and constraints of small-scale commercial poultry farms in and around Debre Markos, and performance evaluation of Sasso C44 broilers fed diets containing graded levels of dried blood-rumen content mixture as replacement for roasted soybean meal with the following specific objectives

- To assess the management practices in small-scale commercial poultry farms in and around Debre Markos,

- To identify and rank the major constraints faced by small-scale commercial poultry farms,
- To determine effects of feeding graded levels of dried blood-rumen content mixture (DBBRCM) at a 1:1 ratio as a replacement for roasted soybean meal on feed intake, body weight gain and carcass characteristics of Sasso C44 broilers, and
- To analyze the economic efficiency of feeding Sasso C44 broilers with rations containing graded levels of dried blood-rumen content mixture.

2. LITERATURE REVIEW

2.1. Poultry Production

Poultry production is an important and diverse component of global agriculture. Poultry is the largest livestock species which accounts for 20.35 billion worldwide (Rosegrant *et al*., 2009). Poultry are kept in most areas of the world and provide an acceptable form of animal protein (meat and egg) to most people throughout the world. They provide a source of high-quality protein and a source of income. The poultry sector supports the livelihoods and food security of millions of people. Currently the demand for poultry meat and eggs has increased, due to population growth, increased income and urbanization, (FAO, 2011).

The world poultry meat production in 2012 was 103.5 million tonnes, which contributes 34.3 % of global meat production (excluding fish) of which Africa's share is only 4.9 million tonnes (FAO, 2012). The global egg production was estimated around 65 million tonnes in 2012, from which Africa shares 3.0 million tonnes (FAO, 2012).

Poultry production is an important economic activity in Ethiopia. It plays a significant role in family nutrition beside its social and cultural benefits. According to the CSA (2016), the total poultry population in Ethiopia is estimated to be about 60.5 million. Annual output is very low despite the large population (FAO, 2013a).

2.2. Poultry Production Systems

In the classification of world livestock production system, poultry systems are described under landless monogastric systems, where feeds are introduced from outside the farm (FAO, 1996). The most important poultry production systems identified globally is the extensive system, the semi-intensive system and the intensive system (FAO, 1996). The choice of the system is determined largely by the availability of resources and inputs; such as housing, cages, feed, drugs, time/attention and vaccination (Guéye, 2004). Four poultry production systems can be described in developing countries. These are the free-range system or traditional village system; the backyard or subsistence system; the semi intensive system and the small-scale intensive system (Sonaiya *et al*., 1999). Also Branckaert and Guéye (2000) and Guéye (2004) reported that in developing countries typically four management systems have been recognized: the free range or unimproved backyard, the

improved backyard, the semi-intensive and the intensive systems.

2.3. Poultry Production Systems in Ethiopia

Poultry production in Ethiopia is an indigenous and integral part of the farming system that ranges from low input traditional free ranges to modern production system using relatively advanced technology (Alemu, 1995). The poultry sector in the country can be characterized into three major production systems based on some selected parameters such as breed, flock size, housing, feed, health, technology, and bio-security (Alemu and Tadelle, 1997; Bush, 2006). The production systems are the traditional poultry production system, small-scale market oriented poultry production system and commercial poultry production system (Emebet and Kidane, 2016).

2.3.1. Traditional poultry production system

Traditional poultry is the predominant system in Ethiopia and accounts for nearly 98% of the poultry population (CSA, 2013c). The breeds are mostly indigenous chickens and although some hybrids and exotic breeds (< 50 birds) may be kept under this system and managed by individual farm household management with minimum labor inputs (Dawit *et al.*, 2008). When birds are kept under a scavenging system; little or no inputs for housing, feeding or health care are provided. The system is not business oriented and is rather intended to satisfy the various needs of farm households. The traditional system of poultry production, which has come to be known as "balanced farming" is characterized by its low input and a corresponding low output (Tadelle *et al.*, 2000).

2.3.2. Small-scale market oriented poultry production system

The small-scale market oriented poultry production system is characterized by medium level of feed, water and veterinary service inputs and minimal to low bio-security (Alemu and Tadelle, 1997). Most small-scale poultry farms obtain their feed and foundation stock from large-scale commercial farms (Nzietchueng, 2008). Modest flock sizes usually ranging from 50 to 1000 cross or exotic breeds are kept for more commercial objectives. It is common in the urban and peri-urban areas of Addis Ababa and East Shoa.

2.3.3. Commercial poultry production system

The large-scale commercial production system is a highly intensive production system that involves from 2,500 to 50,000 birds kept under indoor conditions with a moderate to high bio-security levels (FAO, 2007). This system heavily depends on imported exotic breeds that require intensive inputs such as feed, housing, health, and modern management systems. It is estimated that this sector accounts for nearly 2% of the national poultry population (Alemu and Tadelle, 1997). This system is characterized by higher level of productivity where poultry production is entirely market oriented to meet the large poultry demand in major cities. The existence of better biosecurity practices has reduced chick mortality rates to merely 5% (Bush, 2006). A few companies that are situated mostly in East Shoa in and around Debre Zeit areas (ELFORA, Alema, Almaz, Tseday. Kalehiwot etc) and few public poultry multiplication and distribution centers (PMDC) located in different regions operating with the major objective of distributing improved exotic breeds to smallholder farmers. In commercial system, the profit from poultry production can be increased by minimizing feed cost which accounts for more than half of the total cost of production. Large scale poultry producers mostly make their own feed (Lawrence *et al.*, 2015).

Table 1. Characteristics of the poultry production system in Ethiopia

Characteristics	**Intensive commercial**	**Small scale market oriented**	**Traditional**
Breed and flock size	Specialized breeds: 2,500–50, 000	Specialized and dual-purpose breeds: 50–1000	Local indigenous type: <50
Housing	Modern housing, generally with concrete walls and regulated internal environment	Varies from modern houses to simple housing made from locally available materials	Specific poultry houses are rare
Feed resource	Commercially compounded feeds	Commercially compounded, homemade mixtures and scavenging	Scavenging and occasional feeding with home grains and refuse
Health programme	Standard and regular animal health program	Disease control and health program at varying levels	No regular health program of disease control measures
Markets	Cold chain system for input-output distribution	Input and output distribution is based on existing trading canters	No formal marketing channels

Source: FAO, 2007

2.4. Classification of Poultry Farms in Different Countries

Poultry farms can be classified into two main types: egg production farms and meat production farms (Lawrence *et al.*, 2015). In egg-producing farms, day-old chicks and/or chicks are purchased from specialized hatcheries that produce egg- producing pullets. They are either raised by the egg producer or a pullet grower up to start of lay (Beutler, 2007). On meat production farms, broiler breeders are raised mainly in environmentally controlled poultry houses. Fertile eggs are collected and transported to the hatchery and after hatching, broiler chicks are distributed to producers who grow out the birds, and send them for slaughtering and processing after 42 days (Beutler, 2007). The private commercial sector which operates using advanced technology and specialized genetic material plays a key role in supplying poultry meat and egg to urban market (FAO, 2008). The commercial poultry farms are further categorized based on the flock size in different countries.

Table 2. Classifications of commercial poultry farms by flock size

Country	**Classification**	**Flock size**	**Source**
Ethiopia	Small-scale	50-1000	
	Large-scale	2,500-50,000	FAO,2007
	Industrial and integrated	>50,000	
Botswana	Small-scale	100-20,000	Moreki, 2010
	Medium-scale	20,001-50,000	
	Large-scale	>50,000	
Vietnam	Small-scale	51-2,000	Burgos *et al.*, 2007.
	Large-scale	2,000-100,000	
Kenya	Small-scale	1-1000	https://en.wikipedia.org/wi
	Medium-scale	1001-10,100	ki/ Poultry farming
	Large-scale	>10,000	
Ghana	Small-scale	50-5,000	
	Medium-scale	5,000-10,000	Lawrence *et al.*, 2015
	Large-scale	>10,000	
Nigeria	Small-scale	<1000	Omotosho and Oladele,
	Medium-scale	1,000-3,000	1988 ;Subhash *et al.*,
	Large-scale	>3,000	1999; Ojo, 2003

2.5. Small-scale Commercial Poultry Farms in Ethiopia

It is a newly emerging system in urban and peri-urban areas of Ethiopia, where either broilers or egg type exotic breeds of chicken are produced along commercial lines using relatively modern management methods (Alemu and Tadelle, 1997). In small-scale poultry farms, modest flock sizes usually ranging from 50 to 500 exotic breeds are kept for operating on a more commercial basis (Mekonnen, 2007). However, Solomon (2007) reported under this system of production, a small number of exotic breeds of chickens (50-1,000) are produced along commercial lines using relatively modern management methods. This activity is being undertaken as a source of income in and around major cities and towns with relatively improved feeding, housing and health care (Mekonnen, 2007; Simeamelak *et al*., 2011). Most small-scale poultry farms are located around Debre-Zeit town in Oromia region and Addis Ababa (Solomon, 2007). This production system is characterized by medium level of feed, water and veterinary service inputs and minimal to low bio-security. Most small-scale poultry farms obtain their feed and foundation stock from large-scale commercial farms and occasionally from nearby government owned breeding and multiplication centers (Solomon, 2007). This system is involved in the supply of table eggs to various supermarkets, kiosks and hotels through middlemen (Nzietcheung 2008).

2.5.1. Poultry management practices in small-scale commercial poultry farms

Poultry management usually refers to the husbandry practices or production techniques that help to maximize the efficiency of production. Poultry management involves monitoring poultry health; ensuring that the poultry house is maintained with appropriate brooding, rearing, growing and laying conditions; and ensuring that recommended vaccinations are given and appropriate feeding programming are used (FAO, 2013b). The aim of management is to provide the conditions that ensure optimum performance of the birds (Bell and Weaver, 2001). This is accomplished by controlling diseases, maintaining feed efficiency, proper handling of wastes, and proper sanitation of the poultry house (Hamra, 2010)

Suitable housing plays a vital role in raising all types of birds. The requirements for housing of poultry vary according to the way poultry is raised. The poultry house should keep birds' dry, clean and comfortable at all times and needs to be secure enough to keep poultry in and

birds out (Breedt and Uitenweerde, 2000). The house must protect the poultry from cold winds and rain. It also needs to have good air circulation to remove smells and moisture. Under the intensive system, battery (cage system) and deep litter housing are most common. Some birds grow and live happily on the floor of poultry house and some in cages. The deep litter house is most suitable for chicks and should be convenient and easy to clean (Breedt and Uitenweerde, 2000). Although deep litter is easy to manage and is suitable for flocks of different types and sizes, the system generates more waste than the battery cage system (Ogunjumo, 2001). The deep litter system is relatively convenient, with fewer injuries to chickens and encourages production (May *et al.,* 1982).

The most commonly observed housing systems in small-scale intensive poultry farms were the half-zinc half-wire mesh open-sided buildings and the half block–half wire mesh open-sided buildings (Akidarju *et al.,* 2010). The floor is covered with a deep litter (5 to 10 cm deep) layer of grain husks (maize or rice), straw, wood shavings or a similarly absorbent (but non-toxic) material (Primefact, 2007). The fully enclosed system protects the birds from thieves and predators and is suitable for specially selected commercial breeds of egg or meat-producing poultry (layers, breeder flocks and broilers). For sustainable commercial poultry production, planned and properly designed deep litter poultry housing is essential to keep the birds healthy and productive. Deep litter housing system was the most practiced management system in small-scale farms closely followed by battery cage in Nigeria (Akidarju *et al.,* 2010; Nusirat *et al*., 2012; Uduak *et al*., 2014).

Poultry farming is a lucrative and popular business, but it can be risky if the producers are not concerned about poultry feed management. Success in poultry farming mostly depends on feeding quality feed and appropriate feed formulation system. Feeding high quality, fresh and nutritious feed ensure good health, proper growth and high production. It is necessary to provide adequate quality feed and fresh water to birds. When managing of small-scale commercial poultry farms, the sources of such feed and water must be available close to the farm to maximize the profit with minimum production cost. The feed is obtained either from poultry feed manufacturing (commercial feed) or formulating the feed on the farm by purchasing different available ingredients. The performance of the farm depends largely on how the producers are managing the feeding and watering practices on their farm (Rahman, 2015). In small-scale commercial poultry farms, commercial feed was the most widely used and few number of producers used self-compounded feed (Nusirat *et*

al., 2012; Uduak *et al.*, 2014). The source of water in small-scale commercial farms were pipe water, bore-hole water, well water (Uduak *et al.*, 2014)

Various types of poultry diseases can cause serious loss in the poultry farming business. Diseases occur due to lack of proper care and management, inadequate nutritious feeding and some other factors. Almost all types of animal can be affected by different types of disease in their lifetime. Poultry are no exception. In small-scale commercial farms coccidiosis was identified as the most common disease, followed by IBD and NCD (Safari *et al.*, 2004; Akidarju *et al*., 2010). However, infectious bronchitis, Marek'sdisease, fowl cholera, fowl pox, avian encephalomyelitis are also the major poultry diseases which affects the flock in the farm (Jacob *et al.*, 1998; Ahmed *et al.*, 2011; Hailu, 2012).

Controlling diseases from the beginning is important for the success of poultry operation (Mobley and Kahan, 2007). Vaccination is an effective way to reduce the negative effects of diseases that can cause losses in a poultry operation. Viruses are the number one cause of poultry disease and are considered to be the largest threat to poultry farms. Viral diseases can be reduced by proper sanitation on the farm, biosecurity measures, and vaccination (Hamra, 2012). Administering all the recommended vaccinations against Newcastle Disease (NCD), Infectious Bursal Disease (IBD), Fowl Cholera, and Fowl pox are very crucial (Akidarju *et al.* 2010 and Nusirat *et al.*, 2012).

After poultry are removed from the poultry house, it must be cleaned and sanitized. The sanitation process differs depending on the floor type and type of poultry house. Several disinfectants can be used to clean and sanitize the poultry house. However, the disinfectant must be chosen carefully to avoid problems with newly introduced flocks (Smith, 1999). During cleaning and sanitation, taking of biosecurity measures in poultry farms like wearing of protective cloths and gloves are very crucial (Uduak *et al.*, 2014). Cleaning of houses, feeders, drinkers and changing poultry litter are routine practices in small-scale commercial poultry farms (Uduak *et al.*, 2014). Poultry wastes must be disposed by burying, burning and/ or use as a manure (Nusirat *et al.*, 2012).

Records are other management practices in small-scale intensive poultry farms. Record are kept to provide information based on which the poultry business may be analyzed so that the operator can develop more effective plans to improve the enterprise, to provide profit and

loss accounts, to provide net worth statement showing financial progress throughout the year, to keep production records on birds and to keep a complete historical record of financial transactions for future reference (Ensminger, 1992). Omoruyi *et al.* (1999) and Poggio (2006) classified farm records under four basic types; they are the resource inventories, production records, financial records and supplementary records. Resource inventories include assets and liabilities of the farm whiles production records include mortality, breeding, bird performance, feed information, laying and labour. Financial records include income from sale of eggs and birds and expenditure from feed, vaccines, labour and maintenance of farm equipment. Supplementary records include survey map, the farm layout (map) and the legal documents of the farm. Issues recorded by most farmers include; total number of birds housed, the cost of birds or the cost of rearing birds if it's done by the owner, eggs collected daily, sales made, feed consumption, mortality and labour costs (Sainabury, 1993). Records should not be elaborated otherwise they may not be kept properly by workers (Smith, 1993).

2.5.2. Constraints of small-scale commercial poultry farms

In spite of the contribution of the poultry industry to the economy, the subsector is facing challenges for fastest growth. Poultry feed and nutrition is one of the most critical constraints to poultry production under both the rural small holder and large-scale systems in Ethiopia (Tadelle *et al.,* 2003). The problem is mainly associated with lack of processing facilities, inconsistent availability and distribution, and substandard quality of processed feeds when available (Tadelle *et al,* 2003). According to Solomon (1996) availability, quality and cost of feed are the major constraints to poultry production in Ethiopia which is not self-sufficient in cereal grains that form the bulk of concentrate feeds for poultry. There are shortages of protein supplements and micronutrients (vitamins and minerals) in the country which are needed for the preparation of balanced rations.

Constraints in small-scale commercial poultry farms were poor husbandry practices such as poor feeding and health, unavailability of inputs, lack of information and credit in Ghana (Lawrence *et al.,* 2015). Small-scale poultry farmers also encountered problems in marketing produce (Okantah *et al.,* 2003). Aromolaran *at al*. (2013) reported that in small-scale commercial poultry farm; lack of quality ingredient for feed formulation and high cost of feed were a major constraint encountered which prevented the farm from increasing

layers production in Ibadan Oyo State Nigeria. Okoli *et al. (*2005) illustrated that high cost of production inputs, lack of adequate finance and disease were the leading constraints to run the small-scale commercial poultry farms in Nigeria. According to Adejoro (1991) the poor availability and the supply of quality chicks were main constraints in small-scale commercial poultry farms in the tropics. The financial problems especially, difficulty in getting bank loans was a big challenge to the poultry farms in Ghana (Lawrence *et al.*, 2015)

Bishop *et al.*, (2009) explained that the constraints faced by the intensive poultry producers were transportation difficulties, feather pecking/cannibalism, mortality of adult birds, lack of feeds, lack of finance and difficulties in sourcing for day-old chicks in Delta State Nigeria. Rajendran and Samarendu, (2003) shown that high cost of feed, high cost of medicine and vaccine, and poor quality of feed and feed ingredients were the principal constraints in intensive poultry production in India. Adegbola *et al.*, (1986) reported that the intensive commercial poultry farm was capital intensive in terms of buildings, cages, inside materials and labor costs. Gueye (2003) as cited by Alabi and Osifo (2004) stated that the conditions influencing small-scale commercial poultry production were lack of inputs, which included poultry drugs, improved birds, feeds, vaccines equipment, lack of skilled man-power and incidence of diseases.

The findings of a study by Kazooba (2006) revealed that poor record keeping and inadequate basic business management skills are major contributors to small business failure in Africa. Insufficient management experience often makes it difficult for business owners to succeed. Researchers have also identified other factors hindering the success of small businesses as poor bookkeeping, inexperience in the field of business and poor technical knowledge, poor managerial skills, lack of planning, and lack of market research (Lussier, 1996; Murphy, 1996). The high cost of production, resulting from the cost of drugs and feed, inefficient production methods have contributed to the terrible situation of the poultry industry (Lawrence *et al.,* 2015). Sources of economic losses in poultry business include lack of technical know-how, poor quality feed, poor housing, mismanagement and disease outbreaks (Torimiro *et al.*, 2002).

The overall constraints in small-scale commercial poultry farms were noted by the report of Adejoro (1991), Reddy (1991), Adeyemo (2009) and Ghasura *et al.(*2013), stated that high cost of feed, high cost of the birds, unavailability of land/space, lack of finance,

difficulty in getting loan, high price of medicine, lack of market for birds, non-availability of prompt veterinary aids, non-availability of equipment nearby, losses due to change in environmental conditions and inadequate poultry extension service were the constraints to hinder the profitability and sustainability of the farm. Bishop *et al.* (2009) reported that, there were more constraints under the intensive poultry production system followed by the semi-intensive and extensive poultry production systems. Grain (2006) has shown that intensive poultry rearing represents a higher risk than the rearing of scavenging poultry.

Table 3. Summary of constraints faced in small-scale commercial poultry farms

Constraints	**Country**	**Source**
Poultry feed and nutrition	Ethiopia	Tadelle *et al*., 2003
Availability, quality and cost of feed	Ethiopia	Solomon, 1996
poor quality of processed feed, diseases	Ethiopia	Emebet & Kidane,2016
Less biosecurity measures	Ethiopia	Birhanu *et al*., 2015
Disease, shortage of feed, inadequate sanitation, lack of veterinary service	Ethiopia	Mohamed *et al*., 2016
Price of feed, shortage of land, unavailability of pullets in time, high cost of pullets, feed quality	Ethiopia	Nebiyu *et al*.,2016a
Poor feeding and health, unavailability of inputs, financial problems especially difficulty in getting bank loans	Ghana	Lawrence *et al.*, 2015
Lack of quality ingredient for feed formulation and high cost of feed	Nigeria	Aromolaran *at al.*, 2013
High cost of production inputs, lack of adequate finance and disease	Nigeria	Okoli *et al*., 2005, Apantaku, 2006
Transportation difficulties, feather pecking, mortality of adult birds, lack of feeds, lack of finance and difficulties in sourcing for day-old chicks	Nigeria	Bishop *et al.*, (2009)
High cost of feed, high cost of medicine and vaccine, and poor quality of feed and feed ingredients	India	Rajendran and Samarendu, 2003

2.6. Broiler Production

Broiler production represents one of the most economic and easiest means of bridging the supply demand gap of animal protein, due to their rapid growth rate and superior feed conversion ratio. More so, compared to other livestock species, broilers enjoy a relative advantage of easy management, quick returns to capital investments and wide acceptance of its meat for human consumption (Joni, 2009). Broilers today have emerged as the fastest growing segment for poultry industry with the increased acceptance of chicken meat in city, town and villages. The demand for broiler is growing fast. Broiler chickens are mainly bred for fast growth and slaughtered when they weigh about 1.8 to 2.2 kg body weight, usually between 6 and 8 weeks of age (Musa *et al.*, 2006).

2.7. Sasso C44 Broiler Chicken

Sasso is a company name established before 33 years ago by the leading French "Label Rouge" poultry producers. Sasso C44 broiler chicks are one of the most rapidly growing broiler breeds which have been produced by Sasso. The breeds of birds came from a long and strict selection based on the performance. It has come from the cross breeding of a Sasso rooster and a recessive Sasso hen. Sasso C44 is a colored chicken that alternatively grow red feathers, yellow skin, shanks and feet. They are extremely resistant chicken in a wide range of tropical environments with excellent livability, easy to manage with a high rusticity, good carcass uniformity and provide top quality meat with excellent flavor. The birds are ideal for certified and farmer style productions. They are cost-effective for producers, in the best sanitary conditions.

The overall average body weight ranges from 2200 to 2700 g and the mean body weight of male and female were 2785 and 2279 g, respectively in 56 days of age. The average daily gain of the bird is greater than 40 g (SASSO C44 broiler breeds http://www.sasso.fr/best-chicken-breeds-alternative-growth-for-free-range-poultry breeding, retrieved on 20/03/ 2016). According to Hann *et al.* (2014) the average live weight of SASSO C44 broilers was 2123.5 g and the mean weight of male and female was 2315 and 1932 g, respectively at 49 days of age. The same author noted that the daily body weight gain was 46.4 g for males and 38.6 g for females in 49 days of growth period.

2.8. Broiler Nutrition

The science of nutrition involves providing a balance of nutrients that best meets the need of broilers optimum growth, maintenance, finishing, work, reproduction, and production. Successful broiler production is dependent upon supplying the birds with feed of the highest achievable quality, in terms of ingredients used, processing procedures applied as well as the form in which the diet is presented to broilers (Arbor, 2009). NRC (1994) reported that poultry diets are composed primarily of a mixture of several feedstuffs such as cereal grains, soybean meal, animal by-product meals, fats, vitamin and mineral premixes. These feedstuffs together with water provide nutrients that are essential for birds. Broiler rations should be formulated to supply the correct balance of energy, protein and amino acids, minerals, vitamins and essential fatty acids to allow optimum growth and performance. When formulating broiler diets, the main emphasis is placed on the crude protein (CP), because protein is the critical constituent of poultry diets, and together with the other main nutrients such as carbohydrates, fat, water, vitamins and minerals are essential for life (Cheeke, 2005).

2.9. Nutrient Rrequirements of Broilers

Chinrasri (2004) defined nutrient requirement as the amount of nutrients needed by broilers to maintain their activities, maximize growth, feed utilization efficiency, and optimize fat accumulation. For economic reasons, the supply of nutrients should be at least cost. Therefore, only enough must be supplied to meet requirement without any major excess (Ranjhan, 2001). Formulate rations that will fulfil all the nutrient requirements of poultry especially protein and energy for growth.

While formulating a broilers' diet, the main emphasis is placed on the crude protein (CP), because it is one of the major cost components of poultry diets (Kamran *et al.,* 2004). Meeting the protein requirements of broilers is more difficult compared to other nutrients. The ingredients used primarily for protein supply during feed formulation are most expensive ingredients (Ojano-Dirain and Waldroup, 2002). High cost of conventional protein feedstuffs has contributed to the poor performance or productivity of many poultry farms and this has led to a shortage in the availability of animal protein to the citizenry (Adeniji and Jimoh, 2007). Thus, broiler production in many countries is affected by

scarcity and high cost of conventional protein feed ingredients (Onu and Okongwu, 2006; Atawodi *et al.,* 2008; EL-Deek *et al.,* 2008).

Broiler chickens have high protein requirements to meet the needs for rapid growth, carcass composition and overall cost of the finished products (Sklan and Noy, 2003). NRC (1994) recommended 23%, 20% and 18 % dietary protein levels for the broiler chickens during the starter (0-3weeks), grower (3-5weeks) and finisher phases (6-8weeks), respectively for optimal growth and maximum productivity. Horton *et al.* (2002) reported that protein deficiency in a feed reduced growth in broiler chickens as a consequence of depressed appetite and, thus, intake of nutrients.

Birds usually consume just enough feed to meet their energy requirements (Nahashon *et al.,* 2006). NRC (1994) reported that broilers should get 3200 kcalME/kg DM from 0-8 weeks of age. Leeson *et al.* (1996) showed that broiler chickens fed up to 25 days and 49 days of age were able to adjust their feed intake to a constant energy intake over a range of dietary Metabolizable energy levels from 11.29 to 13.80 MJ ME/kg DM. Increasing the dietary energy concentration leads to a decrease in feed intake and vice versa (Veldkamp *et al.*, 2005), thus affecting growth. Nahashon *et al.* (2006) have shown that as dietary energy level increases, birds satisfy their energy needs by decreasing feed intake. However, Araujo *et al.* (2004) did not find differences in feed intake between two groups of broiler chickens fed ad-libitum diets containing two energy levels of 13.38 and 15 MJ ME/kg DM. Smith (1990) suggested that if the diet is adequate enough in all other essential nutrients, and that nutrient density, accessibility and palatability do not limit feed intake. In general feeding animals below their energy or protein requirements thus reduces growth and efficiency of nutrient utilization.

2.10. Non-conventional Feedstuffs

In developing countries, feed cost is the most important component accounting for 55 to 75% (Ensminger *et al.,* 1990), 70-85% (Opara, 1996) and 70-75% (Martinez, 1999) of total production cost of poultry. Rising feed cost and competition in consumption between human and animals for food items strongly suggest that, alternative energy and protein sources should be used partially or wholly to replace conventional energy and protein source feeds in poultry diet to reduce cost of meat production and to make available the major cereals for

human consumption. The bulk of the feed cost arises from protein concentrates such as groundnut cake, fishmeal and soybean meal. The prices of such conventional protein sources of feed have increased time to time and they are becoming uneconomical to use them in poultry feeds (Opara, 1996; Esonu *et al.*, 2001).

Most experiments on poultry nutrition have been conducted to substitute one ingredient by another to reduce feed cost. Poultry production should be supported with efficient techniques of incorporating locally available agricultural by-products. The use of agricultural by-products in poultry nutrition represents valuable means of the indirect production of food from waste (El Boushy and Vanderpoel, 2000). There is a need therefore to look for locally available and cheap sources of feed ingredients particularly those that do not attract competition in consumption between humans and livestock. One of the most alternative feed resources that could be used for poultry nutrition is non-conventional feed stuffs. Non-conventional feeds refer to all those feeds that have not been traditionally used in poultry feeding and are not normally used in commercially produced rations for poultry. Thus, non-conventional feeds could partly fill the gap in the feed supply, decrease competition for food between humans and animals, reduce feed cost, and contribute to self-sufficiency in nutrients from locally available feed sources (Esonu *et al.*, 2001). Among the nonconventional feed staffs, blood rumen content mixture is one of the cheapest sources of protein obtained from backyard slaughtering system, slaughtering slabs, slaughtering house and abattoirs.

2.10.1. Blood meal

Blood is a highly specialized body fluid that delivers necessary substances to the body cells such as nutrients and oxygen, and transport waste products away from the cells (Wikipedia, 2010). Blood consists of several types of cells suspended in a fluid medium called plasma. The cellular constituents consist of red blood cells (erythrocytes) which carries respiratory gases, white blood cells (leucocytes) which fight against diseases, and platelets and cell fragments which play an important role in blood clotting (Roberts, 1976). So far, blood has a varied structure and performs a wide range of functions. Blood is usually sterile in a healthy animal (Liu, 2009). It has high protein content with reasonably good balance of amino acids. Blood is a significant part of the animal's body mass (2.4% – 8.0% of animals live weight). Liu (2009) further revealed that the average percentage of blood that can be

recovered from pigs, cattle and sheep is 3.0–4.0%, 3.0–4.0% and 3.5–4.0% of their live weight, respectively. Blood is then processed and dried to produce blood meal. Blood is a source of high quality protein as blood meal (80-90% CP) (NRC, 1994). Blood meal contains 89% DM, 76% CP, 1.1% EE, 1.2% CF, 5.96% NFE, 4% Ash, 0.5% Ca, 0.4% P (FAO, 2010b). It is one of the richest sources of lysine, arginine, methionine, cystine, and leucine but very poor in isoleucine and contains less glycine than fish meal (NRC, 1994). The nutritional value of blood meal increases when fed in combination with other protein sources for poultry (Dafwang *et al.,* 1986).

2.10.2. Rumen content

Rumen content (RC) is an abattoir waste which accounts for about 80% of the capacity of the adult ruminant stomach (Adeniji and Oyeleke, 2008). This paunch or rumen content consists of partially digested feed materials, natural or prepared recently eaten by the animal before slaughter, together with digestive juices and millions of bacteria, most of which normally live in the rumen and perform an essential role in the digestive process of cattle (McDonald *et al.,* 2002). The average amount of this material contained in the paunch of slaughtered cattle weighs approximately 25.85 kg (Stahler, 1970). Approximately 2.7-3.5 kg per head (DM basis) of ruminal contents are removed from cattle during slaughter (Dominguez *et al.,* 1994). Abattoirs generate large amounts of solid waste and effluents such as rumen contents, blood and wash water. An abattoir that slaughters up to 15 head of cattle per day generates up to 1 tonne of wet rumen contents and blood (WRC, 1990). Rumen content varies in composition with the feed and feeding practices given to animals prior to slaughter and with the types of processing method used. Adeniji, (2001) reported that DRC contains 92.83 % DM, 17.13% CP, 7.49% Ash, 2.81% EE, 24.88% CF, 40.82% NFE and 2278.5 kcal ME/kg of DM. It has been used as a feed for poultry without affecting their growth and feed conversion ratio (Emmanuel, 1978).

2.10. 3. Bovine blood rumen content mixtures (BBRCM)

Bovine blood rumen content mixture (BBRCM) is an abattoir by product that offers a tremendous potential as a cheap and locally available alternative feedstuffs for livestock. It is a novel feedstuff, processed from the mixture of blood and rumen content (Adenui and Balogun, 2003). The BBRCM is a potential viable alternative protein supplement, and of

economic importance in reducing the cost of poultry feed (Adeniji, 1996). The blood and rumen content are considered as wastes which cause disposal problems in abattoirs. They are easy to process and are nontoxic when fed to poultry (Adeniji, 1996). It has been used to feeding poultry (Adeniji and Balogun, 2001; Odunsi, 2003; Adeniji and Jimoh, 2007) rabbits (Dairo *et al.,* 2005; Togun *et al*., 2009) and ruminants (Salinas-Charina *et al.*, 2007; Rios Rincon *et al.,* 2010) as a cheap untraditional feedstuff to reduce feeding costs and alleviate pollution problems without any reported deleterious clinical effect on animal health and performance. Different methods have been used to process bovine blood and rumen digesta mixture: application of heat (Adeniyi and Balogun, 2002), sun-drying, oven drying and open air drying (Tukur *et al.,* 2001).

2.10.3.1. Nutrient composition of blood-rumen content mixture

The blood and rumen content, which are readily available in any abattoirs and slaughter houses, could be good sources of protein in poultry diets if properly processed and harnessed. Adeniji (2001) and Mohammed *et al.* (2011) recommended blood-rumen content mixtures (BRCM) as replacement for some of the conventional protein source feeds in livestock diets. According to Mann (1984), Adeniji and Balogun (2002) and Dairo (2005) the composition and potentials of rumen content and blood rumen content mixture qualifies them as good sources of protein for monogastric animals. Blood rumen content mixture has been reported to have potentials as source of protein in poultry diets (Mohammed *et al.*, 2005; Adeniji, 2008).

The proximate composition of BBRCM at 1:1 ratio mixture showed that it contains 92.86 %DM, 45.35 % CP, 8.81% CF, 4.10 EE, 15.42% Ash, 26.32% NFE (nitrogen free extract) and 2599.49 kcal/kg ME (Onu *et al.*,2011). The crude protein content of BBRCM was 46.1% and 33.81% reported by Odunsi (2003) and Dairo *et al.* (2005), respectively. The nutrient quality of the feed ingredient is one of the major prerequisite apart from availability (which sometimes is a function of cost and season) for production of good quality feeds. The basic nutrient that cannot be compromised in the choice of ingredients for feed formulation and preparation is protein (Zeitler *et al.,* 1984). The disparity in crude protein composition may be due the type of pasture and/or diet consumed by the animals and the proportion of the constituent mixtures. This could also be influenced by the period of fasting prior to slaughter and stage of digesta degradation in the rumen. The high crude protein

value of BBRCM suggests its utilization as a protein supplement in diets for finishing broilers. The crude protein and energy values of the diets increase with increase in the level of BBRCM inclusion in the diets. The crude fibre values of the diets also increased progressively as dietary inclusion of BBRCM increased (Onu *et al.,* 2011).

According to Olukayode *et al.* (2008), the CP content of sundried blood–rumen content meal at 1:1 ratio mixture is 47% and the total essential amino acid content more than adequate compared with NRC (1994) amino acid requirements for broiler. The CF content is 9.6% which is much lower than that given by Jurgens (1978). The chemical composition of blood rumen digesta meal (BRDM) is reported to be 94% DM, 46.1% CP, 2.13%EE, 6.38% CF, 23.4% Ash and 16% NFE (Odunsi, 2003). The nutrient composition values of BBRCM indicate a good potential for use as protein supplement in chicken diets. The BBRCM mixed at 1:3 ratio of rumen content had CP value of 31.42%, EE 0.88%, CF of 18.71%, and calculated metabolizable energy value of 2686 kcal/kg (Adenui and Balogun, 2003).

Ojebiyi and Saliu (2014) reported the chemical composition of BBRCM at equal (1:1) mixtures to be 90.0% DM; 51.0% CP; 2.26% CF; 2.2% EE; 11.78% Ash and 22.7% NFE. The crude protein, fat, fiber and ash contents of sun-dried blood rumen content meal were 47.06, 6.55, 9.59 and 11.6, respectively (Olukayode *et al.,* 2008). It was adequate in all essential amino acids. It has been reported that rumen content contains no anti-physiological factors (Adeniji and Balogun, 2002). The blood and rumen content are considered as wastes which cause disposal problems in abattoirs. They are easy to process and are nontoxic when fed to poultry (Adeniji, 1996). Blood rumen content mixture as an alternative feed resource must have a comparative cost advantage over the conventional feedstuffs and must not contain anti-nutritional factors or toxic substances (Ojebiyi *et al.,* 2010).

2.10.3.2. Feed intake of birds fed blood-rumen content mixture

Broilers fed at 15% sun dried rumen blood meal (SDRBM) had shown the lowest feed intake in both the finisher phase and the entire period, however at 10% the higher feed intake was observed (Olukayode *et al.,* 2008). This is probably due to increasing fibrousness of the diets as the inclusion level of SDRBM was increased since fiber limits feed utilization in poultry production (Bolarinwa, 1998). Esonu *et al.* (2011) reported that broilers fed 10%

fermented bovine blood and rumen digesta (FBBRD) during finisher phases showed higher feed intake than birds fed the control diet. The improved performance of birds fed FBBRD could be attributed to the higher protein content of the test material (Esonu *et al.,* 2011) and the adequate dietary crude fibre level, since FBBRD is high in fiber. Crude fibre activates the intestine and more occurrences of peristaltic movement and enzyme production resulting in efficient digestion of nutrients (Esonu *et al.,* 2005). Adult birds utilize high fibre materials than chicks (Esonu *et al.,* 2004). This suggests that the finisher birds could tolerate FBBRD diets better than the chicks, because at this stage, they have a more developed gastro intestinal tract to handle the fiber contents of the diets (Adeniji and Balogun, 2002; Esonu *et al.,* 2004).

A study conducted by Adenui and Balogun (2003) to determine the effects of feeding graded levels of BBRCM on the laying performance of test pullets indicated that feed intake by birds was increased with increasing levels of BBRCM inclusion in their diets. A higher feed intake was observed by birds fed a diet containing 20% BBRCM. There was no significantly different from the intakes by pullets on the 10% BBRCM diet. Shim *et al.* (1989) and Pond (1989) reported that feed intake is high on fibrous diets. This could have caused the higher feed intake by the pullets on 20% BBRCM diet.

Onu *et al,* (2011) reported that the broilers fed on the control diet had significantly higher feed intake than birds fed higher inclusion levels of BBRCM at finisher phases. The reduced intake of the birds on BBRCM diets could be attributed to depressed appetite resulting from the unpleasant smell of the diets (Onu *et al.,* 2011). Odunsi (2003) reported that the inclusion of blood meal and / or rumen content imparted obnoxious odour to the final diet and made it less palatable to birds causing a depression in feed consumption.

2.10.3.3. Body weight gain of birds fed blood-rumen content mixture

According to Onu *et al.* (2011), body weight gain increased linearly with increasing the level of bovine blood rumen content meal of broilers while the feed intake decreased with increase in the level in BBRCM. The improved weight gain of birds fed BBRCM diets could be attributed to higher protein content of the diets which were efficiently metabolized for growth. Esonu *et al.* (2004) reported that crude fibre activates the intestine and more

occurrence of peristaltic movement, more enzyme production resulting in efficient digestion of nutrients.

The starter dietary treatments did not have significant impact on average final body weights, body weight gain and feed conversion efficiency when birds fed different levels of sun dried rumen blood meal (SDRBM). However, birds fed SDRBM at 10% had higher feed intake than birds fed 15% SDRBM (Olukayode *et al.,* 2008). Final body weight, body weight gain, feed conversion efficiency and feed cost per unit weight gain were superior for birds fed 10% SDRBM compared with all other diets in both the finisher phase and the entire period (Olukayode *et al.,* 2008). Broilers fed a diet containing up to 20% fermented bovine blood and rumen digesta (FBBRD) was higher weight gain than the group on the control diet (0% FBBRD) (Esonu *et al.,* 2011).

Growth rates were higher in pullets as the BBRCM level of their diet increased (Adenui and Balogun, 2003). The better growth rate observed in birds fed on the high fibre diets shows that grower birds can tolerate such diets and still have good weight gain. Hassan *et al.* (1993) reported that egg-type chicks can tolerate a high fibre diet when such diets are introduced after the 5^{th} week of age. The birds on the BBRCM-based diets (except the 5% BBRCM fed birds) had better initial body weight, resulting in good body conformation and development for egg production (Adenui and Balogun, 2003).

2.10.3.4. Feed conversion ratio of broilers fed blood-rumen content mixture

Feed conversion ratio is the relation between feed intake and product (weight gain or eggs). Lower FCR can be interpreted as a bird being more efficient in converting feed into weigh gain and/ or egg. Reduced FCR yields can have huge financial benefits for the poultry producers (Pollock, 1999). There was a significant improvement in the feed conversion ratio of the birds as the level of BBRCM inclusion in the diets increased in finisher phases (Onu *et al.,* 2011).

The broilers on the control diet recorded the best feed conversion ratio of 2.79 while the group on 20% fermented bovine blood and rumen digesta (FBBRD) gave the poorest feed conversion ratio of 3.13(Esonu *et al.* (2011). The same author illustrated that there was no significant difference in FCR among the groups fed a diet containing different levels of

FBBRD. Pullets on the 15% BBRCM diet had the best feed to gain ratio however birds fed at 20%BBRCM had the lowest FCR (Adenui and Balogun, 2003). Pond *et al.* (1989) reported that an average high feed conversion ratio was recorded in control group and at 6% BBRCM diets. High fiber diets reduce feed/gain ratio probably because it is the grower phase where growth rate tends to be reduced.

2.10.3.5. Carcass characteristics of broilers fed blood-rumen content mixture

Carcass yield is an indication of the amount of edible, saleable meat generated by meat animals and it is usually expressed as a percentage of the live body weight (Pollock, 1997). Therefore, higher carcass yield means higher profit for the poultry industry. Onu *et al. (*2011) reported that there was no significant difference in the carcass characteristics of birds on increasing level of BBRCM, indicating that BBRCM had no adverse effect on carcass yield and organ weights of the birds. Carcass yields were higher for all SDRBM diets than the 0% SDRBM diet (Olukayode *et al.,* 2008). According to Esonu *et al.* (2011), there were no significant differences in the live weight, dressing percentage and organ weight of birds fed on different levels of FBBRD. The intensity of yellow coloration of the shank, skin and beak of the birds increased with increasing levels of FBBRD in the diet.

2.10.3.6. Economics of production of birds fed blood-rumen content mixture

Onu *et al.* (2011) reported the cost of feed intake of broilers significantly reduced with increase in the level of BBRCM in the diets. Similarly, cost of producing a kilogram of broiler meat decreased significantly with high rate of BBRCM inclusion in the diets. The reduction in the cost of diets containing higher levels of BBRCM is because the cost per kg of processed BBRCM was by far cheaper than soybean (Onu *et al.,* 2011). It is more profitable and economical to partially replace soybean meal in broiler finisher diets with bovine blood rumen content mixture

Feed cost per unit weight gain was lower for all SDRBM diets than the SDRBM-free diet (Olukayode *et al.,* 2008). These results indicated that no advantage was gained by fishmeal over SDRBM diets. Esonu *et al.* (2011) noted that the dietary inclusion of FBBRD reduced cost of producing one kilogram of feed and this reflected in the cost of a kg of meat produced. Based on the economy of producing a kilogram of body weight, the 15% and

20% FBBRD diets were the cheapest feed while the 0% FBBRD diet was most expensive. Feed cost declined with increasing dietary level of FBBRD.

Pullets fed different levels of BBRCM, a reduction in the price of feed was observed with an increased level of BBRCM in the test diets. The 20% BBRCM diet was better than the control diet for the total cost of raising the pullets from day-old to point-of-lay (Adenui and Balogun, 2003). The reduction in the price of feed with increase in the level of BBRCM in the diet was a result of the lower price per kg of the BBRCM feedstuff.

3. MATERIALS AND METHODS

For this study, survey and feeding trial were carried out. Hence, the materials and methods followed during the study are presented as follows

3.1. Survey

3.1.1. Description of the study area

This study was conducted in and around Debre-Markos, East Gojjam Zone which is located at 300 km from Addis Ababa in northwest of the country and 265 km southeast of Bahir Dar town, capital of Amhara Region. The geographical coordinates of the town is $10^{0}21^{1}$ latitude North and $37^{0}43^{1}$ longitudes East. The total area of the town is about 60 km^{2} (6160 hectares) and located at 2420 meters above sea level. The weather condition of the town is Woynadega and the mean annual rainfall and temperature is 1308 mm and 16^{0}C, respectively. The town consists of 7 Keble's and the population is estimated to be 107,684 of which 57,791 are females and 49,893 are males (CSA, 2013b)

Debre Markos is the capital city of East Gojjam Zone, Amhara Region. The Zone borders with Oromia Region in the South, West Gojjam Zone in the West, South Gondar Zone in the North, and with South Wollo Zone in the East. The total area coverage of the Zone is 1,400,975 hectares. It is situated in the range of 500-4154 meter above sea level. The landscape of the area is 67.5% plateau, 7.8% mountainous and 24.9% valley. It has different agro ecological zones (2.1% frost land, 11.9% highland, 80.55% midland and 5.45% lowland). The annual rainfall ranges from 900-1800 mm and a minimum and maximum temperature of the area is 7.5^{O}C and 25^{O}C, respectively. The Zone has a total population of 2,572,154, of whom 1, 271,161 are men and 1,300,993 women (CSA, 2013b). The average rural household has 1.1 hectare of land (compared to the national average of 1.01 hectare of land and an average of 0.75 for the Amhara Region) and the equivalent of 0.6 heads of livestock unit (Deininger and Jin, 2006). The agricultural system practiced is mainly mixed crop-livestock production system, even smallholder traditional poultry production is practiced in each village and house hold level. According to CSA (2016), the estimated livestock population in East Gojjam Zone is 2.0 million cattle, 1.4 million sheep, 0.51

million goats, 0.1 million horses, 0.02 million mules, 0.42 million donkeys, 1.6 million poultry and 0.15 million beehives.

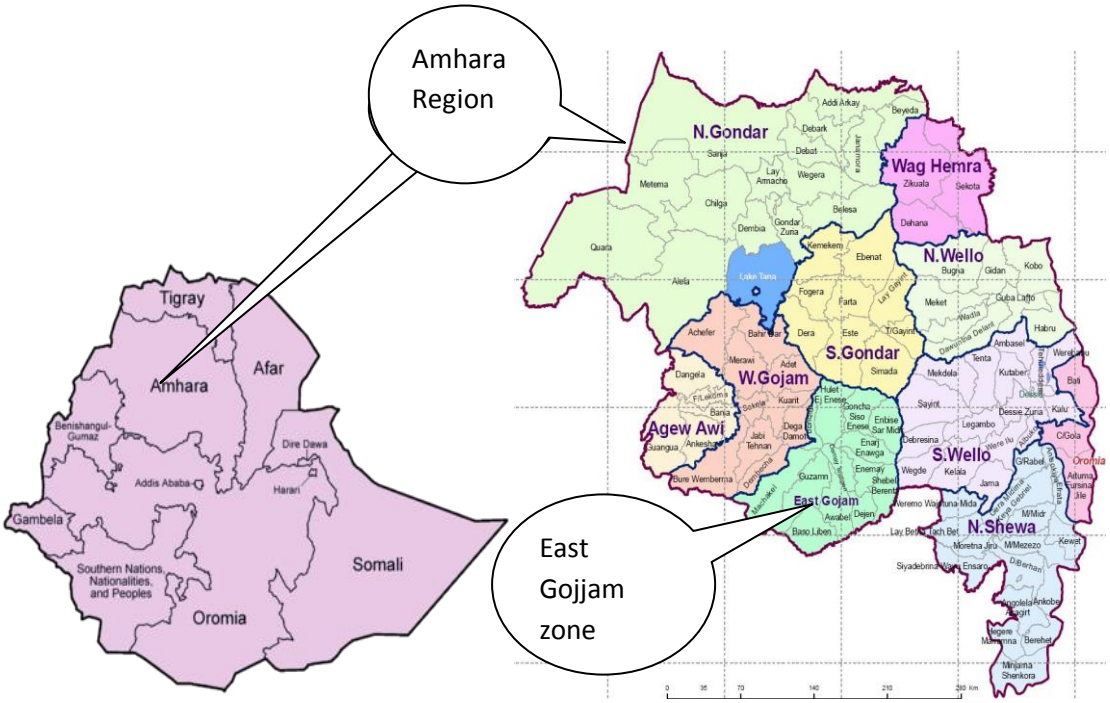

Figure 1. Map of Ethiopia and Amhara Region

3.1.2. Study population

For the survey, all small-scale poultry farm owners who started poultry production on their own initiation and those organized by small and micro enterprise in and around Debre Markos were considered to be the study population.

3.1.3. Sample Size determination and sampling method

Prior to undertaking any sampling, it was planned to collect background information on small-scale poultry farms in and around Debre Markos through rapid exploratory farm visits together with focus group discussions and reviewing available secondary information. A list of all small-scale poultry farms was obtained from the Agricultural Office of Debre Markos town, East Gojjam Zone Agriculture Department and Ethiochicks chicken distributer. From the list, producers who kept more than 50 chicks in small scale commercial farms were

considered for this study. Accordingly, all small-scale commercial poultry farms (49) in the area were considered for the assessment of the general husbandry practices and constraints of small-scale commercial poultry farms.

3.1.4. Research design

A cross-sectional study was carried out to assess small-scale poultry farms with emphasis on household characteristics and poultry management practices such as source of birds, flock sizes, housing and housing materials, feed resources and feeding strategies, sanitation and hygiene of houses and equipment, marketing, source of money, poultry health management practices, availability of support services and constraints faced in poultry production.

3.1.5. Methods of data collection

3.1.5.1. Primary data

The primary data were collected by using a structured questionnaire, with open-ended and close-ended questions. The questionnaire was prepared and pre-tested before administration. Based on the outcome of the questionnaire pretest, some modifications, reframing and corrections in accordance with respondents' perception were made. The questionnaire was administered to purposively selected household heads (owners of the farms) and leaders of the farm (organized by small and micro enterprises) to generate information on household characteristics, management practices and constraints of small-scale poultry farms through interviews. One purposively trained enumerator /extension worker/ and the researcher himself administered the questionnaire in each farm. Prior to the administration of the questionnaire explanations were made to the interviewees about the purpose of the interview and the way it should be handled. Additionally, focus group discussions were made with well-educated and experienced heads and leaders of the farm about the management practices, challenges faced, the issues required for government interventions. To enrich the data, direct observation was made in each small-scale commercial poultry farm about the management practices undertaken and the constraints faced. For additional information, the key informant interview was also done using pretested structured questionnaire from government offices (town, kebelle, woreda and zone agriculture offices and small and micro

enterprise offices) about the technical and extension supports, the challenges faced to small-scale poultry producers and opportunities of the production for further expansion.

3.1.5.2. Secondary data

Previous studies, guidelines, manuals, policies and regulations, literatures and documented data were reviewed to describe small-scale poultry farms, feed resources, management practices and production constraints. The secondary data pertaining to the investigation were collected from small-scale poultry farms and governmental organizations like number of small-scale commercial poultry farms, selling prices of chicks at 45 days of age which was fixed by the government and the vaccination schedule.

3.1.6. Chemical analysis of commercial and farm produced rations

Representative samples from commercial ration which was sourced from commercial feed sellers and farm produced rations which was prepared by them were collected and a composite sample were taken to animal nutrition laboratory of National Veterinary Institute (NVI) at Bishofitu, Ethiopia for chemical analysis. All samples were analyzed for dry matter (DM), ether extract (EE), crude fiber (CF) and ash contents (A.O.A.C., 2000). Nitrogen was determined by Kjeldhal procedure and crude protein (CP) was calculated by multiplying N content by 6.25. The calcium content was determined by atomic absorption spectrometer after dry ashing. The metabolizable energy (ME) levels of feed ingredients was calculated using the formula,

ME (kcal/kg DM) = 3951 + 54.4 EE - 88.7 CF - 40.8 Ash (Wiseman, 1987).

3.1.7. Statistical analysis

Data generated during the survey were entered into Statistical Package for Social Science software (SPSS, 2012) Version 20 and analyzed using descriptive statistics with emphasis on frequency, mean and percentages. Chi-square (χ^2) for association values was computed to determine the relationships between the categorical variables such as the feed source with type of feed. Analysis of variance (ANOVA) was computed to know the significant difference of variables.

The data related to constraints faced by small-scale commercial poultry producers were analyzed by using Garrett's ranking technique with six steps to interpret the results as follows

Step one: The ranking given by producers for each factor was analysed

Step two: The assigned ranks by the individual producers were counted into percent position value by using the formula.

Percentage position = 100 (Rij-0.50)/Nj

Where, Rij - Rank given for the i^{th} factor by the j^{th} individual

Nj - Number of factor ranked by the j^{th} individual.

Step three: For each percent position scores were obtained with reference to Garrett's Ranking Conversion Table and each percent position value was converted into scores by reference to Garrett's Table (Garrett and Woodworth, 1969)

Step four: The summation of the scores for each factor were worked out for the number of respondents who gave ranking for each factor

Step five: The mean score was calculated by dividing the total score by the number of respondents

Step six: The mean scores for all the factors were arranged in descending order and the most influencing factors were identified through the ranks assigned.

3.2. Feeding Trial

3.2.1. Description of the study area

This study was done in Debre-Markos town, East Gojjam Zone which is located at 300 km from Addis Ababa in northwest of the country and 265 km southeast of Bahir Dar town, capital of Amhara Region. The geographical coordinates of the town is $10^{0}21^{1}$ latitude North and $37^{0}43^{1}$ longitudes East. The total area of the town is about 60 km^2 (6160 hectares) and located at 2420 meters above sea level. The weather condition of the town is Woynadega and the mean annual rainfall and temperature is 1308 mm and 16^{0}C,

respectively. The population is estimated to be 107,684 of which 49,893 are males and 57,791 are females (CSA, 2013b)

3.2.2. Collecting and processing of blood

For the feeding trial, fresh blood was collected in plastic containers from slaughter house immediately after cattle were slaughtered. The blood was then transferred into a barrel and boiled to $100^{O}C$ for 45 minutes, in order to let water evaporate and destroy potential pathogenic organisms (Tabinda *et al.,* 2007). After boiling the coagulant was spread on a clean plastic sheet over the spreading table to avoid any contamination on the ground. The drying time was from 08:00 A.M to 05:00 P.M. While drying, it was stirred and turned four times daily so as to facilitate even drying. Then the material was put indoors at night to protect it from re-absorbing moisture. The drying period lasted from three to five days depending on weather condition, the amount of the materials spread and frequency of turning. The particle size of the dried blood was reduced by hand crushing. Oversized dried blood was ground using a hand mortar to pass through 3 mm sieve size, which was similar to the size of the commercial broiler ration (Addo *et al.,* 2012).

3.2.3. Collecting and processing of rumen content

Fresh rumen content obtained from freshly eviscerated cattle was collected into clean containers from the Debre-Markos municipality slaughter house. The rumen was split with the aid of a sharp knife and the contents emptied into a big metal vat. The metal vat containing the rumen content was placed on burning firewood and boiled for 2 hours with intermittent stirring to prevent burning until the mixture was almost free of steam (Adeniji and Jimoh, 2007). This was done to reduce the microbial load of the rumen content. The boiled rumen content was then spread on a clean plastic sheet for sun drying. The drying time was from 08:00 A.M to 05:00 P.M. While drying, it was stirred and turned four times daily so as to facilitate even drying. The material was put indoors at night to protect it from re-absorbing moisture. The drying period lasted from three to four days, depending on weather condition, the amount of the materials spread and frequency of turning. The particle size of rumen content was reduced by beating using stick and hand crushing. To uniform the particle size, oversized dried rumen content was ground using a hand mortar to pass through

3 mm sieve size, which was similar to the size of commercial broiler ration (Addo *et al*., 2012)

3.2.4. Mixing of dried blood and rumen content

The dried blood and dried rumen contents were mixed at 1:1 ratio to produce dried blood-rumen content mixture that was used to replace roasted soybean meal at varied levels in rations of starter and finisher phases of growth.

3.2.5. Preparation of roasted soybean meal

Sufficient amount of full fat soybean was purchased from the local market in Debre Markos. All impurities were purified by hand picking and shaking in wind. It was rinsed in water to clean up. The full fat soybean was roasted using metal plate for 15 minutes by continuous stirring until it turned in to golden brownish colour to destroy the anti-nutritional components (trypsin inhibitor) (Dave, 2007). A great precaution was given to avoid under and overheating. Under-heated beans will have a characteristic 'nutty' taste, while over-heated beans will have a much darker colour and a burnt taste (Dave, 2007). Under-heating will fail to eliminate heat-labile anti-nutritional factors, whilst overheating may destroy or lower the availability of essential amino acids such as lysine and cysteine (Catootjie, 2009). The roasted soybean was ground by milling machine which passed a 3mm sieve size and the meal was then used for feed formulation

3.2.6. Experimental birds and their management

According to the observations made during the exploratory farm visits, it was seen that most of the small scale commercial poultry producers kept Bovans Brown chicks which are egg type breeds and very few kept dual purpose breeds like Koekoek and Sasso T44. Producing broiler chicks in the area was unusual. Thus introducing broiler production in the area using the available broiler breeds with locally available feed resources was understood to be very crucial, because the broiler chicks reach a market age at 42-56 days of age. Sasso C44 broiler breeds were the available broiler chicks and preferred to use for this experiment. Therefore, two hundred and twenty five day old unsexed SASSO C44 broiler chicks were

purchased from Ethiochick PLC. All broiler chicks were individually weighed and randomly allocated to the pens, using a Completely Randomized Design (CRD) experiment.

The experimental house was divided into fifteen separate pens of 1.8m^2 (with 0.12m^2/bird) using timber and mesh wire. Before placing the experimental birds into the pens, the whole unit was cleaned, disinfected with 37% formalin two weeks prior to the introduction of chicks, allowed to dry and littered with properly dried teff *(Eragrostis teff)* straw at a depth of about 8 cm before the arrival of the chicks. Subsequently, the necessary sanitary precautions were observed. The house was electrically heated using 200 watt bulbs per pen. The brooder temperature was maintained at about 35-32°C for the first 7 days of age. After 7 days the temperatures was gradually reduced by 2 °C every week up to the end of the experiment. The temperature was frequently monitored for about 3 times/d i.e. in the morning, during the day, and at night. Sufficient air exchange was also allowed. Windows were opened adequately to provide natural ventilation.

Cleaned and disinfected feeders and waterers were provided in each pen. The feeders were filled with the measured amounts of feed and offered twice a day at 7:30-8:30 AM in the morning and 5:30-6:30 PM in the afternoon. The waterers were washed every day and filled with fresh and clean tap water provided *ad libitum.* Strict sanitary measures were followed during the experimental period. Experimental chickens were vaccinated for NCD; using HB1 at 7th day and Lasota at 21 and 45 days with drinking water and for Gumboro at day 14, 28 and 42 with drinking water. At 49 days the birds were vaccinated against fowl thyphoid. Amprolium was used as a prophylactic treatment for coccidiosis for three times (at a time 30 g/100 litters of water for 5 days) during the experimental period.

3.2.7. Treatments and experimental rations

The feed ingredients used in the formulation of different experimental rations for the study were maize (*Zea mays*), wheat middling, noug (*Guizotia abyssinica*) seedcake, roasted soybean (*Glysine max*), a 1:1 ratio of dried blood rumen content mixture (DBRCM), vitamin premix, lysine, methionine, salt and limestone. The ingredients were milled to a sieve size of 3 mm and stored until required for the formulation of experimental rations.

The test diets for the starter phase (1-28 days) were formulated to be isocaloric and isonitrogenous containing 3000 kcal ME /kg DM and 23% CP and the finisher phase (29-56 days) contain 3200 kcal ME/kg and 20 % CP to meet the requirements of starter and finisher phases of broiler (NRC,1994). Rations were formulated based on the results of the chemical analysis of the feed ingredients, and the control diet was formulated to contain about 30% roasted soybean meals from the total ration. Therefore, based on 30% roasted soybean meal, the treatments contained in T1 (100% RSBM+0%DBRCM), T2 (80% RSBM+20% DBRCM), T3 (60% RSBM+40% DBRCM), T4 (40% RSBM+60% DBRCM) and T5 (20% RSBM+80% DBRCM). The experimental ration, containing dried blood rumen content mixture as replacement of roasted soybean meal was formulated and fed for 56 days of experimental period.

3.2.8. Measurements

Average dry matter intake (ADMI), body weight gain, feed conversion ratio and mortality percentage were recorded to evaluate the difference between the treatment rations. Feed offered and refusals were weighed and recorded every day throughout the experimental period to estimate the feed intake for each replicate and treatment. Feed intake was determined by difference from the quantity offered and refused daily. Dry matter and nutrient intakes were calculated by difference between offered and refusals on dry matter basis. The body weight of birds was weighed individually from each replicate at the beginning of the experiment and weekly till the end of the experiment. The total body weight gain was calculated by subtracting the initial body weight from the final weight of birds, and average daily weight gain (ADG) was calculated as body weight change divided by the number of experimental days. Feed conversion ratio was calculated as unit weight of feed consumed per unit body weight change. Nutrient conversion ratio (crude protein, metabolizable energy, crude fibre and calcium) was also calculated by dividing the nutrient intake to body weight gain. The performance index in each phase of growth during the experimental period was computed by dividing the mean body weight of broiler chicks to feed conversion ratio and multiplied by 100 (North, 1981). Daily mortality was recorded for each replicate and treatment, and then weekly mortality rate was calculated by subtracting the number of dead chicks from the number of live chicks at each interval.

3.2.9. Evaluation of carcass characteristics

At the end of the experiment; 60 birds (12 birds per treatment: 2 male and 2 female birds per replicate) were slaughtered to determine dressing percentage. The birds were starved for twelve hours before slaughter. Then, each bird was weighed, killed and bled for 180 seconds. The slaughtered birds were immersed in a bucket of hot water (63°C) for approximately 120 seconds, and de-feathered by hand plucking. The carcass was then eviscerated (removing of, head, heart, crop, pancreas, kidney, lungs, proventriculus, small intestine, large intestine, caeca, urogenital tracts and lower leg) and suspended over the evisceration line and allowed to drain for 15 minutes prior to weighing. The back, the two thighs, two drumsticks, two wings and breast were used to evaluate the commercial carcass yield. The dressing percentage was calculated as the proportion of carcass weight to slaughter weight multiplied by 100. Gizzard, skin and liver are edible in most places in Ethiopia and included in the edible component (Asrat, 2007; Melesse *et al.,* 2013). They were added to the carcass weight and another version of dressing percentage was calculated. The eviscerated carcass such as the back, thighs, drumsticks, wings and breast were separated and weighed, and then their weights were divided by slaughter weight and multiplied by 100 to determine percentage weights of each component. The fat around the proventriculus, gizzard, abdominal wall and cloacae was collected and weighed. Fat percentage was calculated as the proportion of the slaughter weight (Etalem *et al.*, 2013). The giblets which included the heart, gizzard and liver were weighed and their percentage was calculated as the proportion of the slaughter weight. The total edible offal (TEO) component which includes skin, gizzard and liver were weighted and its percentage was calculated as the proportion of slaughter weight (Melesse *et al*., 2013). Under Ethiopian context the total nonedible offal (TNEO) component includes blood, shank & claws, feather, head, crop, esophagus, proventriculus, spleen, pancreas, kidney, heart, lung, small intestine, large intestines and abdominal fat were weighed and its percentage was calculated as the proportion of slaughter weight (Asrat, 2007).

3.2.10. Chemical analysis of feed ingredients

Representative samples of feeds were collected from each feed ingredient used in the experiment and taken to animal nutrition laboratory of the National Veterinary Institute

(NVI) at Bishofitu, Ethiopia for chemical analysis before formulating the actual dietary treatments. In the same way, samples were taken from each treatment diet at each mixing and from refusals every day during the experiment and kept in paper bags until analyzed. The refusal from each pen was collected each morning before fresh feed is given, cleaned from external contaminants using a 5 mm mesh size sieve and by hand picking, weighed and pooled by treatment and a sample was taken while the rest was discarded. All samples were analyzed for dry matter (DM), ether extract (EE), crude fiber (CF) and ash contents (A.O.A.C., 2000). Nitrogen was determined by Kjeldhal procedure and crude protein (CP) was calculated by multiplying N content by 6.25. The calcium content was determined by atomic absorption spectrometer after dry ashing. The metabolizable energy (ME) levels of feed ingredients was calculated using the formula,

ME (kcal/kg DM) = 3951 + 54.4 EE - 88.7 CF - 40.8 Ash (Wiseman, 1987).

3.2.11. Economic efficiency analysis

Feed cost per unit gain was computed using the cost of feed consumed to attain a kilogram (kg) of body weight gain. The feed cost was calculated based on the cost of one kg commercial ration and DBRCM on the market. The cost of the control diet was calculated by the cost of one kg commercial ration in the available market by the total feed consumed. The cost of other treatments was calculated using cost proportions of a commercial ration and DBRCM percentage in the diet and multiplied by the total feed consumed during the experimental period. The feed cost per unit gain was considered in order to evaluate the effect of a new feed inclusion on net revenue of chicken sales.

In order to examine the economic advantage of replacing roasted soybean meal with dried blood rumen content mixture, economic efficiency (EE) was calculated as the ratio between income (price of weight gain) and the cost of feed consumed (Waheed and Eltaieb, 2005). The data were calculated that the price of one kg body weight of bird on selling time and the cost of feed used according to the prices available in local markets during the experimental period. The economic efficiency was calculated based on Waheed and Eltaieb (2005) formula as follows,

Price of total feed consumption (Birr) = Total feed consumption (kg) per bird X price/kg feed

Total revenue (Birr) = Total gain (kg) X price of one kg body weight on selling (Birr)

Net revenue (NR) (Birr) = Total revenue (Birr) from this gain–total feed cost for this gain

Economic efficiency (EE) =Net revenue /total feed cost

EE %= (Net revenue / total feed cost)*100

Relative economic efficiency (REE) = Economic efficiency /control economic efficiency

REE % = (EE/Control EE)*100

3.2.12. Statistical analysis

All collected data during the feeding trial were subjected to analysis of variance (ANOVA) using the general linear model (GLM) procedure by Statistical Analysis Systems software (SAS, 2008) Version 9.2. When treatment effects were found to be significant ($P<0.05$), mean separation was undertaken using Tukey HSD test. All values were calculated on a pen average basis. The following statistical model was used for data analysis,

$$Yij = \mu + Ti + eij$$

Where Yij = Response variable

μ = Overall means

Ti = Treatment effect (i=1-5)

eij = Random error term

4. RESULTS

4.1. Survey

4.1.1. Household characteristics

The household characteristics of small-scale commercial poultry producers are presented in Table 4. About 49 small-scale poultry farms were found of which 75.5% run by private producers who initiated by themselves and the remaining 24.5% of the farms were organized by the small and micro enterprise office. Sex had a significant effect ($P< 0.05$) on operating of small-scale poultry farms. The majority (83.7%) of the farms were run by males and the rest (16.3%) by females. Age had a significant ($P<0.05$) effect in running of small-scale poultry farms. Among the poultry producers, 85.7% of the age profile ranged between 15-30 years. There was no any significant ($P\geq0.05$) difference between married and unmarried in operating of small-scale poultry farms. The unmarried poultry producers were 55.1% and the married were 44.9%. The educational level had highly significant ($P<0.05$) effect in poultry farming. One third (36.7%) of small-scale poultry farming was run by first degree poultry producers. More than half (57.1%) of the producers had no experience while the rest (42.9%) of the producers had previous experience. Family size had a significant effect ($P<0.05$) on small-scale poultry production. The majority (79.6%) of the producers had a family size between 1-3. Nearly 79.6% of the poultry producers were engaged fully in poultry production while the rest (20.4%) of the producers, poultry production was a secondary occupation. About 81.6% of the producers had 1-3 members, and the rest 16.3% and 2.1% of the producers had 4-6 and >6 members, respectively. Most (81.6%) of the farm activities were done by members of the farm, the rest by family labors (16.3%) and hired labor (2.1%). Male producers (59.2%) were highly involved in the farm activities than females (28.6%), and the rest (12.2%) were equally involved. All producers spent at least 17 hours per day in performing routine activities in the farm.

Table 4. Household characteristics of small-scale commercial poultry farms in and around Debre Markos, Ethiopia

Variables	Category	N	%	χ^2	P-Value
Sex	M	41	83.7	10.69	< 0.001*
	F	8	16.3		
Age	<15	1	2.0		
	15-30	42	85.7	97.20	< 0.001*
	31-45	5	10.2		
	46-60	1	2.0		
Marital status	Married	22	44.9	0.51	0.475
	Unmarried	27	55.1		
Occupation	Poultry production	39	79.6	17.16	<0.001*
	Others	10	20.4		
Family size	1-3	39	79.6	49.14	<0.001*
	4-6	9	18.4		
	7-9	1	2.0		
Experiences	Yes	21	42.9	1.00	0.317
	No	28	57.1		
Years of experience	New	28	57.1	23.55	<0.001*
	1-3	20	40.8		
	4-6	1	2.0		
Educational level	5-8 grade	4	8.2		
	9-10 grade	8	16.3		
	11-12 grade	9	18.4		
	Diploma	10	20.4		
	Degree	18	36.7	10.69	0.030*

*Note: N-Number of respondents; % - Percent; *Shows a significant effect at P<0.05*

4.1.2. Sources of day old chicks and flock size

The sources of day old chicks in the study area were both private (81.7%) and government (18.3%) poultry farms. From private poultry farms, Ethiochick PLC was the major sources of chicks (79.6%) and Gerado contributed only 2.1%. The Andassa poultry farm is one of the government poultry farms and supplied about 18.3% of the day old chicks. The average flock size of chicks in a farm was 844.3 (Table 5). Flock size was significantly (P<0.05) affected by sex of birds. Female chicks were kept in all farms and the mean flock size was 774.7 which was greater (P<0.05) than the male chicks, however, the male chicks were kept in 13 farms (26.5%) and the mean flock size was 261.7. There was no statistical significant difference (P>0.05) among breeds in the average flock size. However, 71.4%, 4.1%, 18.4%

and 6.1% of the producers kept Bovans Brown, Bovans White, Koekoek and Sasso T44 birds, respectively. From the total population of chicks (41, 371) kept in the farms during the study period; 83.3%, 5.3%, 7.7% and 3.7% of the chicks were Bovans brown, Bovans white, Koekoek, and SASSO T44, respectively.

Table 5. Flock size and breeds of chicks in small-scale poultry farms in and around Debre Markos, Ethiopia

Variables	**N (%)**	**Mean ±SEM**
Flock size	49 (100)	844.3± 98.257
Sex		
Female chicks	49 (100)	774.7±98.257[a]
Male chicks	13 (26.5)	261.7±104.890[b]
Breed		
Bovans brown (egg type)	35 (71.4)	982.0 ±121.952[a]
Bovans white (egg type)	2 (4.1)	1105.0± 605.000[a]
Koekoek (dual)	9 (18.4)	354.4± 82.481[a]
Sasso T44 (dual)	3 (6.1)	503.3± 115.518[a]

Note: N (%) describes number or percent of producers; SEM-standard error of mean, means with the different letter of superscript in the same column did differ significantly (P<0.05)

4.1.3. Housing of chicks

Housing of chicks in small-scale poultry farms is presented in Table 6. About 75.5% of the producers started their business using egg type day old chicks and the rest 24.5% used dual purpose day old chicks in intensive management system with deep litter housing. Nearly 71.4% of the producers reared up the chicks in dwelling houses by separating one room, the rest of the producers produced in shades built with the support of the small and micro enterprise office (24.5%) and in the rented houses (4.1%). There was a significant effect (P<0.05) on small-scale commercial poultry house buildings. About 85.7% of the deep litter houses were made from mud and the mean area of the floor was 61.5m^2. Around 77.6% of the houses were soiled floor and the rest were concrete floor. More than half of the farms house orientation was east to west direction (57.1%) and the rest 42.9% was north to south direction. Houses had three windows on average for ventilation. Nearly half (49%) of the

houses had good ventilation and only 14.3% of the houses had bad ventilation. The average heater (200 watt) in the house were 10.7 per farm and chicks got heat for 23.8 hours for almost 21 days and then gradually were minimized the heat to 12 hours until they were sold. The mean flock density was 13.7 chicks /m^2 floor space. The average production period of chicks was 78 days for 2.7 rounds per year. Almost 95.9% of the producers used all-in and all-out management system and the rest 4.1% introduced at any time.

Table 6. Housing in small-scale poultry farms in and around Debre Markos, Ethiopia

Variables	**Category**	**N**	**%**	**χ^2**	**P-Value**
Deep litter floor type	Concert floor	11	22.4		
	Soiled floor	38	77.6	14.88	<0.001*
House orientation	East -West	28	57.1	1	0.373
	North- South	21	42.9		
Houses made from	Totally concrete block	3	6.1		
	Totally mud	42	85.7	96.39	<0.001*
	Partly concrete and partly mud	2	4.1		
	Totally metal sheet	2	4.1		
House ventilation	Bad	7	14.3		
	Good	24	49.0	21.12	<0.001*
	Very good	15	30.6		
	Excellent	3	6.1		

*Note: N-Number of respondents; % - Percent; * depicts a significant effect (P<0.05) in the same column in chi square test*

4.1.4. Feeds and feeding of chicks

Feeds and feeding in small-scale commercial poultry farms are presented in Table 7. There was a significant (P<0.05) difference in offering of commercial and farm produced feed for their chicks. About 98% of the producers offered commercial feed to chicks of which 63.3% offered commercial feed only and 34.7% offered both commercial and farm produced feed. Only 2% of the producers offered farm produced feed only. All the farm produced feeds

were prepared from maize (63%), wheat (5%), barley (8%), soybean meal (roasted) (6%) and noug seed Cake (18%).

The sources of the commercial feed were commercial poultry farms and government poultry farms. The commercial poultry farms were higher ($P<0.05$) feed sources than the government poultry farm which represent 83.3 % of the feed source. Half (50%) of the poultry producers sourced their feeds from Mekelle Ethiochick PLC, 22.9% from Alema (Bishoftu) poultry farm and 16.7% from Andassa poultry farm (Bahr Dar, government farm). Almost 98% of the producers purchased the commercial ration and the purchasing price of the feed was higher ($P<0.05$) than the farm produced ration.

All of the producers didn't know the nutritional content of the feed purchased from private and government poultry farms. About 93.9 % of the producers didn't know the amount of feed offered per day for their chicks, conversely, only 6.1% of the producers knew the amount of feed offered and gave 28 grams of feed per day per chick. Almost 49% of the producers offered three times per day during morning, afternoon and evening. The other 44.9% of the producers offered feed four times per day during morning, at noon, evening and at mid night. About 73.5% of the producers had a feed store and stored their feeds for 1-4 months.

Table 7. Feeds and feeding of chicks in small-scale poultry farms in and around Debre Markos, Ethiopia

Variables	Category	N	%	$\chi 2$	P-value
Offer commercial feed	Yes	48	98.0	45.08	<0.001*
	No	1	2.0		
Type of feed	Commercial feed only	31	63.3	3.45	0.063
	Commercial and farm produced only	17	34.7		
	Farm produced only	1	2.0		
Poultry feed sources	Commercial poultry farms	40	83.3	34.31	<0.001*
	Government poultry farms	8	16.7		
Commercial feed sources' name	Debrezeit - Alema farm	11	22.9		
	Bahir Dar - Andasa farm	8	16.7		
	Mekelle - Ethiochick PLC.	24	50	51.53	<0.001*
	AA - Friendship farms	3	6.3		
	AA - Seble & Woinshet farms	1	2.1		
	Dessie- Gerado farm	1	2.1		
Daily feed offered /bird	Known	3	6.1		
	Not known	46	93.9	37.74	<0.001*
Frequency of offering	Once	2	4.1		
	Twice	1	2.0		
	Thrice	24	49.0	37.94	<0.001*
	Fourth	22	44.9		
Time of offering	Morning	2	4.1		
	Morning and afternoon	1	2.0		
	Morning, afternoon & evening	24	49.0	37.94	<0.001*
	**All time	22	44.9		

Variables	N	Mean± SEM
Average feed utilized (Qt) per farm	49	18±1.062
Price of commercial feed (Birr) /Qt	48	1031.00±22.200 [a]
Price of farm produced feed (Birr) /Qt	18	795.00±27.106 [b]

Note: N-Number of respondents; % - Percent; AA- Addis Ababa; PLC- Private limited company; Qt- quintal; ** *All time (*morning , afternoon ,evening *and mid night); * depicts a significant effect (P<0.05) in the same column in chi square test; SEM- Standard Error of Mean; Different superscript letters depicts significant difference at P<0.05 within the same column; 1 Birr=0.045USD*

4.1.5. Chemical composition of starter chick rations in small-scale commercial poultry farms

The chemical composition of commercial starter chick rations obtained from different sources and farm produced ration are presented in Table 8. Numerically, commercial rations had higher percentage of Ash, CF, CP, EE and Ca than farm produced feeds; however, ME (kcal/kg DM) was lower in commercial ration.

Table 8. Chemical compositions of commercial and farm produced chick starter rations obtained from different sources

Chemical Composition	**Commercial starter chick's ration seller farms**								**Nutrient Requirement for starter chicks in %**
	A	**B**	**C**	**D**	**E**	**F**	**ACR**	**FPR**	
DM (%)	90.8	91.7	91.7	90	90.9	90.8	91.0	90.7	>=90
Ash (%DM)	6.1	11.7	7.5	5.8	6.2	7.9	7.5	3.4	=
CF (%DM)	3.3	10.8	2.2	7.9	5.2	6.7	6.0	2.8	5.0
CP (%DM)	20.7	15.4	17.2	23	22.8	18	19.5	14.5	20.0
EE (%DM)	1.9	5.1	6.4	5.2	5	4.6	4.7	3.7	6.0
Ca (%DM)	2.1	3.5	2	1.8	1.9	3.2	2.4	1.2	1.0
ME(kcal/kgDM)	3514.8	2795.4	3796.9	3293.7	3507.4	3290.2	3366.4	3766.6	2850.0

Note: ACR-Average commercial ration; FPR-Farm produced ration; DM- Dry matter; CF-Crude fibre; CP-Crude protein; EE-Ether extract; Ca-Calcium; ME-Metabolizable Energy.

4.1.6. Sources of water and watering frequency

Sources of water and watering frequency of small-scale poultry farms in and around Debre Markos is presented in Table 9. All poultry producers in and around Debre Markos had provided water regularly. The source of water was tap water, well water and bore water. Tap water had significantly higher ($P<0.05$) than the other sources which represents 93.9% of the water source. Approximately, 79.6 % of the producers didn't know the amount of water provided for chicks a day; however the rest 20.4% of the producers knew the amount of water to be given and gave 86.3 millilitres per day. The frequency of water provision varied significantly ($P<0.05$), however, about 63.3% of the producers provided water four times a day at morning, afternoon, evening, and mid night.

Table 9. Source of water and watering frequency of small-scale poultry farms in and around Debre Markos, Ethiopia

Variables	Category	N	%	χ^2	P-value
Water provision	Yes	49	100		
Amount of water given per bird	Known	10	20.4		
	Not known	39	79.6	17.16	<0.001 *
Watering frequency	Once	5	10.2		
	Thrice	13	26.5		
	More than thrice	31	63.3	21.71	<0.001 *
Time of offering	Morning	5	10.2		
	Morning, afternoon ,evening	13	26.5		
	**All times	31	63.3	21.71	<0.001 *
Source of water	Well water	2	4.1		
	Tap water	46	93.9	80.86	<0.001 *
	Bore hole	1	2.0		

*Note: N-Number of respondents; % - Percent; **all time (morning,* afternoon, evening *and mid night); * depicts a significant effect (P<0.05) in the same column in chi square test*

4.1.7. Poultry diseases and prevention systems

Poultry diseases and prevention systems in small-scale commercial poultry farms is presented in Table 10. Only 38.8% of the producers suspected the frequently occurring disease in the farm to be coccidiosis and the other 61.2% of the producers didn't know which type of disease occurred in their farms. Producers are not accustomed to record disease occurrence. Some producers (30.6%) associated the predisposing factors of the diseases to environmental problems, 24.5% management problem and 12.2% both environment and management problems. The other 24.5% of the respondents didn't know the cause of the diseases in their farms. Culling of sick birds and calling for assistance of veterinarians when disease is observed was very common in all farms.

There was a significant (P<0.05) difference in the experiences of disease outbreak. About 91.8% of the producers didn't have an exposure of disease outbreak and reporting of the disease outbreak for the concerned body. However, prevention and treatment were the major systems for controlling of diseases. The immediate measures against sick birds were

isolation and treating them until recovery. More than half of the producers could treat their chicks by their own by purchasing amprollium and oxytetracycline from vet pharmacies. If a disease was severe, all the producers did call veterinarian for treatment of chicks for suspected birds. About 79.6% of the producers had close relation with veterinarians.

Table 10. Poultry diseases in small-scale poultry farms in and around Debre Markos, Ethiopia

Variables	**Category**	**N**	**%**	χ^2	**P-value**
Frequently occurred disease	Known (Coccidiosis)	19	38.8		
	Not known	30	61.2	2.47	0.116
Predisposing factors of disease	Management problem	12	24.5		
	Environment problem	15	30.6	8.65	0.070
	Both	6	12.2		
	Didn't know clearly	12	24.5		
	No disease occurred	4	8.2		
Accustomed to treat chicks by own	Yes	27	55.1	0.51	0.475
	No	22	44.9		
Time of recovery after treatment	1-3 days	30	61.2	17.18	<0.001*
	4-6 days	9	18.4		
	No recovery	10	20.4		
Experiences to disease outbreak	Yes	4	8.2		
	No	45	91.8	34.31	<0.001*
Reporting of disease out break	Yes	4	8.2		
	No	45	91.8	34.31	<0.001*
Close relation with veterinarians	Yes	39	79.6	17.16	<0.001*
	No	10	20.4		

*Note: N-Number of respondents; % - Percent; * depicts a significant effect (P<0.05) in the same column in chi square test*

The major symptoms of diseases in small-scale commercial poultry farms are presented in Fig. 2. The most leading symptoms of diseases reported were ruffled feather (15.5%), loss of appetite (15.1%), depression (12.6%), diarrhoea (9.7%), and others.

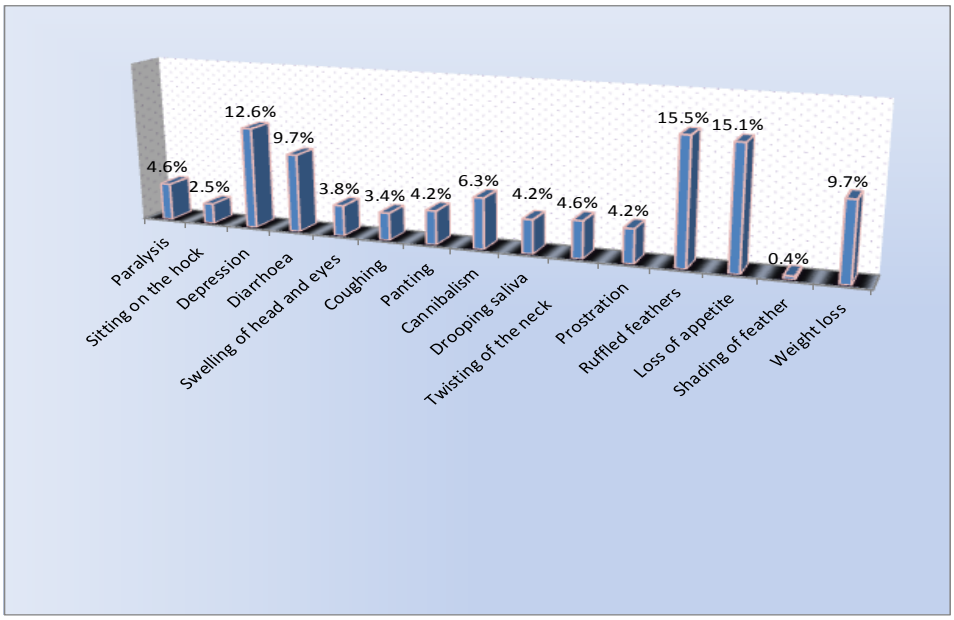

Figure 2. Symptoms observed in chicks under small-scale poultry farms in and around Debre Markos

Vaccination of birds in small-scale commercial poultry farms is presented in Table 11. All producers vaccinated their chicks either twice, thrice, four times and more than four times. The majority of the producers (46.9%) vaccinated their chicks more than fourth. Nearly half of (49%) of the producers vaccinated their chicks against Newcastle disease and Gumboro.

Table 11. Vaccinations in small-scale commercial poultry farms in and around Debre Markos, Ethiopia

Variables	**Category**	**N**	**%**	**χ^2**	**P-value**
Chicks vaccination	Yes	49	100		
Vaccination for	NCD	6	12.2		
	NCD[1]	24	49.0	19.00	<0.001*
	NCD[2]	14	28.6		
	NCD[3]	5	10.2		
Frequency of vaccination	Twice	10	20.4	12.96	0.005*
	Thrice	7	14.3		
	Four times	9	18.4		
	> Four times	23	46.9		

*Note: N-Number of respondents; % - Percent; NCD- Newcastle disease; [1]Gumboro; [2]Gumboro, Fowl typhoid; [3]Gumboro, Fowl typhoid, Fowl pox; * depicts a significant effect (P<0.05) in the same column in chi square test*

The mortality percentage of chicks in small-scale commercial poultry farms was 4.7% at 1-3 weeks of age (Table 12). According to the producers reply, the highest (P<0.05) mortality was recorded during the long rainy season and the mortality was sporadic. The reason for mortality could be transportation stress (51%) and overcrowding (32.7%) due to light disturbance in the house

Table 12. Mortality of chicks in small scale commercial poultry farms in and around Debre Markos, Ethiopia

Variables	**Category**	**N**	**%**	**χ^2**	**P-value**
Highest mortality age	Starter (1-3 weeks)	49	100		
Season of mortality	Long dry season (October to January)	3	6.1		
	Long rainy season (June to September)	46	93.9	37.74	<0.001*
Perceived reasons of mortality	Transportation stress	25	51.0	26.18	<0.001*
	Overcrowding due to light	16	32.7		
	Cannibalism	2	4.1		
	Unclear	6	12.2		
Type of mortality	Sudden	14	28.6		
	Sporadic	35	71.4	9.00	0.003*
Mortality %			4.7		

*Note: N-Number of respondents; % - Percent; * depicts a significant effect (P<0.05) in the same column in chi square test*

4.1.8. Rodents and predators

Rodents and predators occurrence in small-scale poultry farms are presented in Table 13. Rodent problem was reported in 22.4% of the farms and rat was the most difficult rodent in the farms. Around 34.7% of the farms were affected by predators. Especially cats (64.7%) played a significant (P<0.05) role in attacking of chicks in those farms than weasels (35.3%).

Table 13. Rodents and predators of small-scale poultry farms in and around Debre Markos, Ethiopia

Variables	Category	N	%	χ^2	P-value
Presence of rodents	Yes	11	22.4		
	No	38	77.6	14.88	<0.001*
Name of the rodents	Rat	11	100		
Presence of predators	Yes	17	34.7		
	No	32	65.3	4.59	<0.032*
Name of the predator	Cat	11	64.7	1.47	0.225
	Weasel	6	35.3		

*Note: N-Number of respondents; % - Percent; * depicts a significant effect (P<0.05) in the same column in chi square test*

4.1.9. Source of finance and credit services

Source of finance and credit service to small-scale poultry farms in and around Debre Markos is presented in Table 14. The majority (59.2%) of producers run their farms using their own finance which was higher (P<0.05) than other sources. Generally the money was used to purchase day old chicks, feed and medicaments.

Table 14. Source of money and credit service to small-scale poultry farms in and around Debre Markos, Ethiopia

Variables	Category	N	%	χ^2	P-value
Source of finance	Own	29	59.2	51.10	<0.001*
	ACSI	11	22.5		
	Women affairs microfinance	1	2.0		
	Credit from private lenders	3	6.1		
	Credit from family	5	10.2		
Presence of credit	Yes	12	24.5		
institution	No	37	75.5	12.76	<0.001*
Interest rate of the	High	4	8.2		
credit	Medium	8	16.3		
	Not known because not taken	37	75.5	39.71	<0.001*

*Note: N-Number of respondents; % - Percent;*depicts significant effect at P<0.05*

4.1.10. Marketing of chicks

Marketing of small-scale poultry farms is presented in Table 15. Koekoek chicks were purchased from the government poultry farm known as Andassa and their purchasing price was significantly lower (P<0.05) than the other breeds of chicks which were purchased from private sources. The selling of chicks was influenced (p<0.05) by colour, breed, weight and age. However, weight of chicks was playing a great role in selling of chicks. Nearly 51% of the producers sold their chicks to other farmers through agriculture office. The money was collected by the development agents from the farmers and the agriculture office purchased the chicks from the producers (farms) and distributed to farmers according to their need. About 46.9% of the producers sold their chicks to farmers and/ or town dwellers directly. Nearly 73.5% of the producers sold at farm gate and the rest at farm gate and local markets. Chicks were sold the earliest at 45 days of age with 50.00 Ethiopian Birr (which means age in days plus 5.00 Birr) that was fixed by the government. If all chicks were not sold at 45 days of age, the same calculation would be employed beyond 45 days of chick's age.

Table 15. Marketing of chicks in small-scale poultry farms in and around Debre Markos

Variables	**Category**	**N**	**%**	χ^2	**P-Value**
Buyers of birds	Farmers through agriculture office	25	51.0	21.71	<0.001*
	Town dwellers	1	2.0		
	Farmers and town dwellers	23	46.9		
Selling place of birds	At farm gate	36	73.5	10.80	<0.001*
	At farm gate & local market	13	26.5		
Factors affecting selling of birds	Colour	11	22.4		
	Breed	8	16.3		
	Weight	21	42.9	8.71	0.033*
	Age	9	18.4		

Variables	**N**	**Mean±SEM**
Purchasing price of Bovans Brown (Birr) per chick	35	25.46±0.042[a]
Purchasing price of Bovans White (Birr) per chick	2	25.50±0.000[a]
Purchasing price of Koekoek (Birr) per chick	9	11.89±0.389[b]
Purchasing price of Sasso T44 (Birr) per chick	3	20.67±1.333[a]

Note: *N-Number of respondents; % - Percent; *depicts significant effect at P<0.05 in chi square test; SEM- Standard Error of Mean;*
Different superscript letters represent a significant difference (P<0.05) within the same column; 1 Birr=0.045USD

4.1.11. Training and extension services

Training and extension services of small-scale commercial poultry farmers are presented in Table 16. Almost 53.1% of the producers took training for 10.4 days. About 92.3% of the training was given by the government (agriculture office and TVET College). Approximately 28.6% of the respondents took training once and 20.4% of the respondents were trained twice during their production period. About 36.7% of the producers said, the given training was both theoretical and practical, and it was useful to run their farms. About 69.4% of the respondents replied that there was an extension service given by animal resources experts from agriculture office for once (26.5%) and twice (26.5%) per production cycle about technical advice (30.6%), provision of day old chicks (6.1%) and complete package (32.7%).

Table 16.Training and extension services of small-scale commercial poultry farms

Variables	**Category**	**N**	**%**	χ^2	**P-Value**
Training taken	Yes	26	53.1	0.18	0.668
	No	23	46.9		
Training given by	Government	24	92.3	18.62	<0.001*
	Nongovernment	2	7.7		
Frequency of training	Once	14	28.6		
	Twice	10	20.4		
	Thrice	2	4.1		
	No training	23	46.9	18.67	0.001*
Type of training	Theoretical	6	12.2		
	Practical	2	4.1		
	Both	18	36.7		
	No training	23	46.9	23.90	<0.001*
Presence of extension services	Yes	34	69.4	7.37	<0.007*
	No	15	30.6		
Type of extension service	Technical advise	15	30.6		
	Provision of DOC	3	6.1		
	Complete package	16	32.7	9.37	0.025*
	No extension service	15	30.6		
Frequency of extension service	Once	13	26.5		
	Twice	13	26.5		
	Thrice	3	6.1		
	Four times	4	8.2		
	>Four times	1	2.0		
	No extension service	15	30.6	23.12	0.001*

*Note: N-Number of respondents; % - Percent; *depicts significant effect at P<0.05*

4.1.12. Biosecurity measures

Biosecurity in small-scale poultry farms in and around Debre Markos is presented in Table 17. There was significantly higher (P<0.05) using of the foot bath to protect the entrance of microorganisms in the farm. About 77.6% of the producers used the foot path in front of their farm entrance like formalin and bleach /berekina/. There was no significant (P≥0.05) effect on wearing of overall. Only 63.3% of the producers dressed protective cloth (overall). Using of shoes /boots/ and hand gloves were significantly lower (P<0.05). Only 26.5% wore shoes (boots), however, 91.8% of the producers didn't use hand gloves.

Table 17. Biosecurity measures of small-scale poultry farms in and around Debre Markos, Ethiopia

Variables	**Category**	**N**	**%**	χ^2	**P-Value**
Presence of foot bath	Yes	38	77.6	14.878	<0.001*
	No	11	22.4		
Wearing of overall	Yes	31	63.3	3.449	0.063
	No	18	36.7		
Wearing of shoes (boots)	Yes	13	26.5		
	No	36	73.5	10.80	<0.001*
Using of hand gloves	Yes	4	8.2		
	No	45	91.8	34.306	<0.001*

*Note: N-Number of respondents; % - Percent; * depicts a significant effect (P<0.05) in the same column in chi square test*

4.1.13. Sanitation and hygiene

Sanitation and hygiene of small-scale poultry farms in and around Debre Markos are presented in Table 18. About 98% of the producers were using teff straw as a litter material up to the depth of 6.2 cm, because it has a good potential for warming of chicks and protect from severe cold. Approximately 30.6% of the respondents were changing the litter material once per week, however, around 46.9% of the respondents were spreading only few litter materials when the earlier litter were spoiled by faeces and removed it at the end of the production cycle. The farm waste was removed by burning (36.7%), burying (38.8%) and spreading on the ground (24.5%). About 91.1% of the producers disposed off the dead birds

by burying and the rest by throwing on the earth surface. Nearly 67.3% of the producers cleaned the floor of the house once at the end of production cycle and 34.7% of the producers washed the feeders once per week, Almost 83.7% of the producers had washed the waterer daily and the rest washed once and more than once per week.

Table 18. Sanitation and Hygiene of small-scale poultry farms in and around Debre Markos, Ethiopia

Variables	**Category**	**N**	**%**	**χ 2**	**P-value**
Washing feeders	Once per week	17	34.7	18.71	0.002*
	Twice per week	9	18.4		
	Thrice per week	7	14.3		
	>thrice per week	2	4.1		
	No wash but rubbing	3	6.1		
	No washed till the end of production cycle	11	22.4		
Washing waterers	Daily	41	83.7	124.57	<0.001*
	Once per week	1	2.0		
	Twice per week	1	2.0		
	Thrice per week	3	6.1		
	>Thrice per week	3	6.1		
Cleaning of the room	Daily	1	2.0		
	Once per week	11	22.4		
	Twice per week	3	6.1		
	Thrice per week	1	2.0		
	Once per production cycle	33	67.3	75.59	<0.001*
Type of litter material	Teff straw	48	98	45.08	<0.001*
	Saw dust	1	2		
Frequency of r changing litter material	Once per month	15	30.6		
	Twice per month	8	16.3		
	Thrice per month	3	6.1		
	Addition and change at the end	23	46.9	18.51	<0.001*
Waste disposal	Burning	18	36.7		
	Burying	19	38.8	1.76	0.416
	Spread on the earth	12	24.5		
Disposal of dead birds	Burying	45	91.9	34.31	<0.001*
	Throwing on the earth surface	4	8.1		

*Note: N-Number of respondents; % - Percent; * depicts significant effect at P<0.05*

4.1.14. Culling of chicks

Culling of birds in small-scale poultry farms in and around Debre Markos is presented in Table 19. About 63.3% of the producers culled their birds purposively for management reasons. There was a significant difference (P<0.05) in the reasons of culling birds. Almost 51.6% of the producers culled significantly their birds due to small size, 6.5% due to deformed shape and 41.9% due to both small size and deformed shape. The culled birds were fed separately and finally sold.

Table 19. Culling of chicks in small-scale poultry farms in and around Debre Markos, Ethiopia

Variables	**Category**	**N**	**%**	**χ 2**	**P-value**
Culling of birds purposely	Yes	31	63.3	3.449	0.063
	No	18	36.7		
Uses of culled birds	Sale	31	100		
Reason of culling	Small size	16	51.6	10.516	0.005*
	Deformed shape	2	6.5		
	Both	13	41.9		

*Note: N-Number of respondents; % - Percent; * depicts a significant effect at P<0.05*

4.1.15. Record keeping

The system of record keeping in small-scale poultry farms in and around Debre Markos is presented in Table 20. About 85.7% of the producers had a good system to record the farms activity. However, most of them (83.3%) recorded only production cost, feed offered and mortality.

Table 20. Record keeping in small-scale poultry farms in and around Debre Markos

Variables	**Category**	**N**	**%**	**χ 2**	**P-value**
Custom of record keeping	Yes	42	85.7	25.000	<0.001*
	No	7	14.3		
Parameters recorded	Production cost	7	16.7		
	Production cost, feed offered and mortality	35	83.3	25.000	<0.001*

*Note: N-Number of respondents; % - Percent; * depicts a significant effect at P<0.05*

4.1.16. Constraints of small-scale commercial poultry farms

The constraints faced to hinder sustainability of small-scale poultry farms are presented by their rank in Table 21. The most important constraints were like high cost of feed, unavailability of feed and feed ingredients, unavailability of land/space, lack of market linkage and promotion, high cost of birds, lack of finance etc.

Table 21. Rank of constraints faced in small-scale poultry farms in and around Debre Markos, Ethiopia

Constraints	**Total score**	**Mean score**	**Garrett's rank**
High cost of feed	3080	62.86	I
Unavailability of feed and feed ingredients	2867	58.51	II
Unavailability of land/space	2579	52.63	III
Lack of market linkage and promotion	2326	47.47	IV
High cost of day old chicks	2177	44.43	V
Lack of finance	1974	40.29	VI
Lack of extension service	1746	35.63	VII
Lack of training	1734	35.39	VIII
Poor credit facilities	1725	35.20	IX
High cost of medicaments	1477	30.14	X
Unavailability of improved birds near the farm	1339	27.33	XI
Electric disturbance	1301	26.55	XII
Lack of technical know-how in handling poultry	1291	26.35	XIII
Mortality of day-old/young chicks	1282	26.16	XIV
Losses due to environmental change	1277	26.06	XV
High initial investment	1227	25.04	XVI
Cannibalism	1084	22.12	XVII
Lack of veterinary service	1063	21.69	XVIII
Inability to diagnose sick birds	1005	20.51	XIX
High rate of interest on loans	956	19.51	XX
Unavailability of desired breed	897	18.31	XXI
Lack of equipment	798	16.29	XXII
Unavailability of waste disposal	779	15.90	XXIII
Difficulty for water	634	12.94	XXIV
Labour problem	552	11.27	XXV
Disease outbreak	542	11.06	XXVI
Loss of birds due to predators	538	10.98	XXVII
High rate of morbidity of birds	496	10.12	XXVIII
Inability to pay constant attention	395	8.06	XXIX

According to the agriculture, and small and micro enterprise office experts, the constraints faced by small-scale commercial poultry producers were grouped in to two namely the producers' related and the experts' related. The constraints related to the producers' side were the producers started the farm without adequate training, refusing the advice given by the experts (professionals), inability to save the loan prerequisite for credit institution (20%) and unable to sustain for long production period due to market problems. The constraints faced due to the experts' (professionals) side were inability to do and show profit maximization analysis before starting the farm, no consistency in professional support, inadequate training and extension service given, insufficient market promotion and linkage, insufficient transportation facilities and lack of adequate budget for per diem, and knowledge limitation to give adequate support related to poultry production

4.1.17. Opportunities for further expansion

According to the agriculture, and small and micro enterprise offices, there are opportunities for further expansion of poultry farming in the area. Presence of large number of educated youth in the area, high population, urbanization and increasing income, great emphasis given by the government, a plan to construct a number of shades for production and marketing purposes are the opportunities for further expansion of the small-scale commercial farms.

4.2. Feeding Trial

4.2.1. Chemical composition of dried Blood, rumen content and their mixtures

The chemical composition of dried blood (DB), dried rumen content (DRC) and dried blood and rumen content mixture (DBRCM) is presented in Table 22.

Table 22. Chemical composition of dried blood, dried rumen content and dried blood-rumen content mixtures collected and processed in Debre Markos on DM basis.

Feed type	DM%	Ash	CF	CP	EE	Ca	NFE	kcal ME/kg DM
		% DM						
DB	94	4.36	2.87	83.5	0.64	1.42	2.63	3553.36
DRC	93.1	11.28	31.79	16.2	2.02	1.79	31.81	780.89
DBRCM	93.3	7.5	15.75	36.93	1.48	1.43	31.64	2328.49

NOTE: DB-dried Blood; DRC- Dried Rumen Content; DBRCM- Dried Blood Rumen Content Mixture; DM -Dry Matter; CP-Crude Protein; ME-Metabolizable Energy; CF-Crude Fiber; EE-Ether Extract; NFE-Nitrogen Free Extract; Ca-Calcium.

The chemical composition of feed ingredients used for the experimental diets is presented in Table 23. The feed ingredients were dried blood rumen content mixture (DBRCM), noug seed cake (NSC), white maize, roasted soybean meal and wheat middling.

Table 23. Chemical composition of feed ingredients used for preparing experimental diets on DM basis

Feed type	DM%	Ash	CF	CP	EE	Ca	NFE	kcal ME/kg DM
		% DM						
DBRCM	93.3	7.5	15.75	36.93	1.48	1.43	31.64	2328.49
NSC	94.6	8.88	23.35	38.46	7.27	2.47	16.64	1913.04
Maize (white)	90.7	0.63	1.65	7.45	4.98	1.29	75.99	4049.85
RSBM	96.8	5.65	14.77	32.17	13.29	2.07	30.92	3133.36
Wheat middling	90.3	3.06	6.53	17.72	4.21	1.66	58.78	3475.97

Note: DBRCM- Dried Blood Rumen Content Mixture; NSC- Noug Seed Cake; RSBM-Roasted Soybean Meal; *DM -Dry Matter; CP-Crude Protein; ME-Metabolizable Energy; CF-Crude Fiber; EE-Ether Extract; NFE-Nitrogen Free Extract*

4.2.2. Feed ingredients of starter and finisher ration

The feed ingredients and chemical composition of the five dietary treatment groups of starter and finisher rations are present in Table 24

Table 24. Proportion of ingredients used in formulating broiler starter and finisher rations and chemical composition of the treatment feeds on dry matter basis

Ingredients %	**Starter ration**					**Finisher ration**				
	T1	**T2**	**T3**	**T4**	**T5**	**T1**	**T2**	**T3**	**T4**	**T5**
RSBM	30	24	18	12	6	30	24	18	12	6
DBRCM	0	6	12	18	24	0	6	12	18	24
Maize(white)	34.2	36.6	35.2	36.1	36.2	40.7	42.2	43.2	45.5	46.0
NSC	24.4	24.7	21.8	21.5	20.6	13.8	12.5	12.4	11.7	9.9
Wheat middling	8.8	6.1	10.4	9.8	10.6	12.7	12.7	11.8	10.2	11.5
Limestone	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
Vitamin premix	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Salt	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Lysine	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Methionine	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Total	100	100	100	100	100	100	100	100	100	100

Table 24. *Continued…*

	Starter ration					Finisher ration				
	T1	**T2**	**T3**	**T4**	**T5**	**T1**	**T2**	**T3**	**T4**	**T5**
CP (% DM)	23.1	23.2	23.1	23.2	23.3	20.2	20.1	20.3	20.2	20.1
ME(kcal/kg DM)	3097.7	3058.5	3047.5	3009.1	2975.4	3293.7	3281.3	3240.3	3216.2	3198.9
CF (% DM)	5.2	5.1	5.4	5.3	5.1	6.4	6.2	6.1	6.3	6.2
Ash (% DM)	8.5	8.6	8.4	8.3	8.5	9.3	9.6	9.5	9.3	9.4
EE (% DM)	5.4	5.2	5.3	5.1	5.4	5.6	5.5	5.4	5.3	5.2
NFE (% DM)	57.8	57.9	57.8	58.1	57.7	58.5	58.6	58.7	58.9	59.1
Ca (% DM)	1.2	1.1	1.3	1.4	1.2	0.84	0.82	0.86	0.85	0.81

Note:RSBM=Roasted Soybean Meal; DBRCM=Dried Blood Rumen Content Mixture;NSC= Noug SeedCake; *T1=0%DBRCM +100%RSBM, T 2=20%DBRCM +80%RSBM; T3=40%DBRCM+60%RSBM;T4=60%DBRCM+40%RSBM;T5=80%DBRCM +20%RSBM; DM=Dry Matter; CP=Crude Protein; ME=Metabolizable Energy; CF=Crude Fiber; EE=Ether Extract; NFE=Nitrogen Free Extract; Ca=Calcium. Vitamin premix = 25 kg Broiler premix contains, Vitamin A 1000 000 IU, Vitamin D3 200 000 IU. Vitamin E 1000 mg, Vitamin K3 225 mg, Vitamin B1 125 mg, Vitamin B2 500 mg, Vitamin B3 1375 mg, Vitamin B6 125mg, Vitamin B12 2 mg, Vitamin PP (niacin) 4, 000 mg, Folic Acid, 100 mg, choline chloride 37,500 mg, Calcium 29.7 %, Iron 0.4 %, Copper 0.05 %,Manganese 0.6 %, Zinc 0.7%, Iodine 0.01 % Selenium 0.004 %*

4.2.3. Dry matter and nutrient intake of Sasso C44 broilers

Mean daily dry matter and nutrient intake of Sasso C44 broilers during the starter phase, finisher phase and entire experimental period is presented in Table 25. During the starter phase of growth, there was no statistically significant difference ($P \geq 0.05$) in daily DMI among treatment groups. However, birds in T1 showed higher ($P < 0.05$) total DMI than T5. Birds fed in T2 had higher ($P < 0.05$) daily CPI compared with T5. Birds in T5 had lower ($P < 0.05$) CFI compared with T1 and T3. There was no significant difference ($P \geq 0.05$) in ME intake of birds among the treatment groups. Higher ($P < 0.05$) Ca intake was observed for T3 and T4 than T2 and T5.

The mean dry matter and nutrient intake of birds during the finisher phase was that birds in T5 had the lowest ($P < 0.05$) daily DM, total DM, CP, CF and Ca intakes among the other treatment groups, and had lower ($P < 0.05$) MEI compared with T3.

During the entire experimental period, birds in T5 had the lowest daily DMI and total DMI ($P < 0.05$) compared with T1, T2 and T3. Furthermore, birds in T5 the lowest ($P < 0.05$) CP and CF intakes compared with other treatment groups. There was a similar ($P \geq 0.05$) MEI across all treatment groups. The average Ca intake of birds in T3 and T4 was higher than those in T1 and T2; and birds in T5 had the lowest ($P < 0.05$) Ca intake among other treatment groups.

Table 25. The DM and nutrient intake of broilers during starter phase (1-28 days), finisher phase (29-56 days) and entire experiment (1-56 days)

Parameters	**Experimental diets**						
	T1	**T2**	**T3**	**T4**	**T5**	**SEM**	**P**
Starter phase							
Mean daily DM intake (g/bird)	40.4[a]	39.9[a]	40.3[a]	38.6[a]	38.5[a]	0.282	0.051
Mean total DM intake (g/bird)	1130.9[a]	1117.6[ab]	1128.6[ab]	1081.5[ab]	1076.6[b]	7.907	0.047
Mean daily CP intake (g/bird)	10.6[ab]	10.7 [a]	10.5 [ab]	10.5 [ab]	10.2[b]	0.062	0.040
Mean daily CF intake (g/bird)	2.2 [a]	2.1 [ab]	2.2 [a]	2.0 [ab]	1.5[b]	0.081	0.019
Mean daily ME intake (kcal/bird)	161.2 [a]	174.4 [a]	160.5 [a]	157.9 [a]	155.8 [a]	3.173	0.434
Mean daily Ca intake (g/bird)	0.57 [ab]	0.50 [b]	0.60 [a]	0.60 [a]	0.50[b]	0.013	0.002
Finisher phase							
Mean daily DM intake (g/bird)	116.2[a]	116.4 [a]	119.1 [a]	116.9 [a]	111.8[b]	0.680	0.001
Mean total DM intake (g/bird)	3253.4 [a]	3259.6 [a]	3333.7 [a]	3272.6 [a]	3130.7[b]	19.093	0.001
Mean daily CP intake (g/bird)	26.2 [a]	26.1 [a]	26.6 [a]	26.2 [a]	25.1[b]	0.147	0.001
Mean daily CF intake (g/bird)	8.1 [a]	7.9 [a]	7.9 [a]	8.0 [a]	7.5[b]	0.064	0.002
Mean daily ME intake (kcal/bird)	431.2 [ab]	433.2 [ab]	438.6 [a]	427.4 [ab]	412.0[b]	3.018	0.024
Mean daily Ca intake (g/bird)	1.1 [a]	1.1 [a]	1.1 [a]	1.1 [a]	1.0[b]	0.015	0.001

Table 25. *Continued…*

	Experimental diets						
Entire experimental period	**T1**	**T2**	**T3**	**T4**	**T5**	**SEM**	**P**
Mean daily DM intake (g/bird)	79.0[a]	78.9 [a]	80.4 [a]	78.5 [ab]	75.8[b]	0.443	0.004
Mean total DM intake (g/bird)	4424.6 [a]	4417.1 [a]	4502.5 [a]	4392.7 [ab]	4245.8[b]	24.780	0.005
Mean daily CP intake (g/bird)	18.4 [a]	18.4 [a]	18.6 [a]	18.3 [a]	17.6[b]	0.099	0.002
Mean daily CF intake (g/bird)	5.2 [a]	5.0 [a]	5.1 [a]	5.0 [a]	4.5[b]	0.070	0.001
Mean daily ME intake (kcal/bird)	296.2 [a]	303.8 [a]	299.5 [a]	292.6 [a]	283.9[a]	2.308	0.078
Mean daily Ca intake (g/bird)	0.8 [b]	0.8 [b]	0.9 [a]	0.9 [a]	0.7[c]	0.020	0.001

Note: Means with a different superscript in a row are significantly different (P< 0.05);DM-Dry Matter; CP- Crud Protein; CF- Crude Fibre; ME-Metabolizable Energy; Ca-Calcium; g gram; SEM-Standard Error of the Mean;T1=0%DBRCM+100%RSBM; T2=20% DBRCM +80%RSBM; T3=40%DBRCM+60%RSBM; T4=60% DBRCM + 40% RSBM; T5=80% DBRCM+20%RSBM; SEM-Standard Error of Mean

4.2.4. Body weight change of broilers

The body weight changes of Sasso C44 broilers during the starter phase, finisher phase and the entire experiment are presented in Table 26. During starter phase of growth, birds in T5 had lower ($P<0.05$) mean daily body weight gain, final body weight and mean total body weight gain compared with T1.

The body weight change of birds during the finisher phase was not statistically different ($P\geq0.05$) in the mean daily weight gain, final body weight and mean total body weight gain among the treatment groups. However, birds in T5 had the lowest body weight and body weight gain among other treatment groups.

The body weight change of birds in terms of daily body weight gain, final body weight and total body weight gain during the entire experimental period was similar ($P\geq0.05$) among the treatment groups. However, birds in T5 had the lowest body weight and body weight gain among other treatment groups.

Table 26. Body weight change of broilers during starter (1-28 days), finisher phases (29-56) and entire experimental period (1-56 days) fed with graded level of dried blood rumen content mixtures as a replacement for roasted soybean meal

Parameters	**Experimental diets**						
	T1	**T2**	**T3**	**T4**	**T5**	**SEM**	**P**
Starter phase							
Initial bodyweight (g)	41.5^{a}	41.2^{a}	41.3^{a}	41.0^{a}	41.3^{a}	0.406	0.998
Mean final body weight (g)	772.4^{a}	768.8^{ab}	729.4^{ab}	753.8^{ab}	696.3^{b}	10.451	0.034
Mean daily weight gain (g/bird)	26.1^{a}	26.0^{ab}	24.6^{ab}	25.5^{ab}	23.4^{b}	0.374	0.033
Mean total gain (g)	730.9^{a}	727.7^{ab}	688.1^{ab}	712.8^{ab}	655.1^{b}	10.474	0.033
Finisher phase							
Initial bodyweight (g)	772.4^{a}	768.8^{ab}	729.4^{ab}	753.8^{ab}	696.3^{b}	10.451	0.034
Mean final body weight (g)	1713.4^{a}	1783.1^{a}	1811.3^{a}	1773.7^{a}	1521.1^{a}	41.612	0.203
Mean daily weight gain (g/bird)	33.6^{a}	36.2^{a}	38.6^{a}	36.4^{a}	29.5^{a}	1.414	0.363
Mean total gain (g)	941.0^{a}	1014.3^{a}	1081.9^{a}	1019.9^{a}	824.8^{a}	39.604	0.360
Entire experimental period							
Initial bodyweight (g)	41.5^{a}	41.2^{a}	41.3^{a}	41.0^{a}	41.3^{a}	0.407	0.998
Mean final body weight (g)	1713.4^{a}	1783.1^{a}	1811.3^{a}	1773.7^{a}	1521.1^{a}	41.613	0.203
Mean daily weight gain (g/bird)	29.9^{a}	31.1^{a}	31.6^{a}	31.0^{a}	26.4^{a}	0.745	0.203
Mean total gain (g)	1671.9^{a}	1741.9^{a}	1770.0^{a}	1732.6^{a}	1479.9^{a}	41.741	0.205

Note: Means with a different superscript in a row are significantly different (P< 0.05); g- gram; T1=0%DBRCM+100%RSBM; T2=20% DBRCM +80%RSBM; T3=40%DBRCM + 60% RSBM; T4=60% DBRCM + 40% RSBM; T5=80% DBRCM+20%RSBM; SEM-Standard Error of the Mean

4.2. 5. Feed and nutrient conversion ratio

The feed and nutrient conversion ratio of SASOO C44 broilers fed diets containing graded levels of dried blood rumen content mixture as a replacement for roasted soybean meal is presented in Table 27. There was a similar ($P \geq 0.05$) feed and nutrient conversion ratio among the treatment groups during the starter phase, finisher phase and the entire experimental growth period.

Table 27. Feed and nutrient conversion ratio of broilers fed diets containing graded levels of DBRCM during the starter phase (1-28 days), finisher phase (29-56 days) and the entire experimental period (1-56 days).

Parameters	**Experimental diets**						
	T1	**T2**	**T3**	**T4**	**T5**	**SEM**	**P**
Starter phase							
Feed conversion ratio (g DMI I/g gain)	1.5[a]	1.5[a]	1.6[a]	1.5[a]	1.6[a]	0.020	0.153
Protein conversion ratio (g CPI/g gain)	0.40[a]	0.40[a]	0.40[a]	0.400[a]	0.43[a]	0.007	0.461
Energy conversion ratio (kcal MEI/g gain)	6.20[a]	6.73[a]	6.53[a]	6.23[a]	6.70[a]	0.142	0.708
Fiber conversion ratio (g CFI/g gain)	0.10[a]	0.10[a]	0.10[a]	0.10[a]	0.07[a]	0.007	0.461
Calcium conversion ratio (g CaI/g gain)	0.02[a]	0.02[a]	0.02[a]	0.02[a]	0.02[a]	0.001	0.633
Finisher phase							
Feed conversion ratio (g DM I/g gain)	3.5[a]	3.4[a]	3.1[a]	3.2[a]	3.8[a]	0.125	0.513
Protein conversion ratio (g CPI/g gain)	0.77[a]	0.77[a]	0.70[a]	0.70[a]	0.83[a]	0.031	0.740
Energy conversion ratio (kcal MEI/g gain)	12.90[a]	12.57[a]	11.40[a]	11.77[a]	14.00[a]	0.435	0.418
Fiber conversion ratio (g CFI/g gain)	0.27[a]	0.23[a]	0.20[a]	0.20[a]	0.27[a]	0.013	0.309
Calcium conversion ratio (g CaI/g gain)	0.03[a]	0.03[a]	0.03[a]	0.03[a]	0.03[a]	0.001	0.865
Entire experimental period							
Feed conversion ratio (g DMI I/g gain)	2.7[a]	2.6[a]	2.6[a]	2.5[a]	2.9[a]	0.058	0.465
Protein conversion ratio (g CPI/g gain)	0.60[a]	0.60[a]	0.60[a]	0.60[a]	0.67[a]	0.013	0.371
Energy conversion ratio (kcal MEI/g gain)	9.97[a]	9.87[a]	9.50[a]	9.50[a]	10.73[a]	0.213	0.418
Fiber conversion ratio (g CFI/g gain)	0.20[a]	0.17[a]	0.20[a]	0.20[a]	0.20[a]	0.007	0.461
Calcium conversion ratio (g CaI/g gain)	0.03[a]	0.03[a]	0.03[a]	0.03[a]	0.03[a]	0.001	0.461

Note: Means with similar superscript in a row are not significantly different (P> 0.05);DMI-Dry Matter Intake; CPI- Crud Protein Intake; CFI- Crude Fiber Intake; MEI-Metabolizable Energy Intake; CaI-Calcium Intake; g-gram; T1=0% DBRCM +100%RSBM; T2=20% DBRCM +80%RSBM; T3=40%DBRCM+60%RSBM;T4=60%DBRCM+40%RSBM; T5=80% DBRCM+20%RSBM; SEM-Standard Error of the Mean

4.2.6. Performance index

The performance index of broilers fed diets containing graded levels of DBRCM as replacement for roasted soybean meal is presented in Table 28. There was no statistical difference (P≥0.05) in performance index during the starter phase, finisher phase and the entire experimental period. The mean mortality was not influenced (P≥0.05) across the treatment groups.

Table 28. Performance index of broilers fed diets containing graded levels of DBRCM during starter phase (1-28 days), finisher phase (29-56 days) and the enter experimental period (1-56 days)

Performance index	**Experimental diets**						
	T1	**T2**	**T3**	**T4**	**T5**	**SEM**	**P**
Starter phase	50.12	50.11	44.50	49.79	42.40	1.328	0.181
Finisher phase	49.78	57.05	58.50	55.33	40.12	3.311	0.419
Entire experiment	64.83	70.50	70.92	70.31	53.24	3.136	0.358
Mean mortality	0.7	0.0	0.3	0.7	1.0	0.133	0.212

Note: T1=0%DBRCM +100%RSBM; T2=20% DBRCM +80%RSBM; T3=40% DBRCM +60% RSBM; T4=60% DBRCM + 40% RSBM; T5=80% DBRCM+20%RSBM; SEM-Standard Error of the Mean

4.2.7. Carcass characteristics of Sasso C44 broilers

The carcass characteristics of broilers fed diets containing graded levels of DBRCM are presented in Table 29. The slaughter weight of birds fed on different levels of dietary treatments ranged from 1550.2-1736.8 g. There was no significant difference (P≥0.05) in slaughter weight among the treatment groups. There was no marked statistical difference (P≥0.05) in edible carcass yield for birds fed diets containing DBRCM compared with the birds in the control group. The dressing percentage of the edible carcass yield on the basis of slaughter weight ranged from 63.1- 66.6%. The slaughter weight, edible carcass yield and

dressing percentage were not influenced by sex ($P \geq 0.05$) when birds fed a diet containing different levels of dried blood rumen content mixture.

There was no a statistical difference ($P \geq 0.05$) in commercial carcass weight among the treatment groups. The dressing percentage based on the commercial carcass weight ranged between 53.7-56.6% and there was no difference ($P \geq 0.05$) among the treatment groups. The commercial carcass yield and dressing percentages were not affected ($P \geq 0.05$) by sex or dietary treatments. There was no a statistical difference ($P \geq 0.05$) in the commercial carcass components such as thigh weight, thigh percentage, drumstick weight, drumstick percentage, breast weight, breast percentage, back weight, back percentage, wing weight and wing percentage. However, drumstick weight and its percentage, breast percentage, wing weight and its percentage were significantly influenced ($P < 0.05$) by sex. Males were higher ($P < 0.05$) in drumstick, drumstick percentage, wing weight and wing percentage than females. Breast percentage in females was higher ($P < 0.05$) than that of males.

There was no difference ($P \geq 0.05$) in abdominal fat weight, abdominal fat percentage, and giblet weight and giblet percentage among treatment groups. However, abdominal fat and its percentage was significantly influenced ($P < 0.05$) by sex. Females had a higher ($P < 0.05$) abdominal weight and abdominal fat percentage than males. There was no difference ($P \geq 0.05$) in the total nonedible offal (TNEO), TNEO%, total edible offal (TEO) and TEO% among treatment groups. On the other hand, TNEO was affected by sex, where males showed a higher TNEO than females.

Table 29. Carcass characteristics of SASSO C44 broilers (1-56 days) fed diets containing graded levels of dried blood rumen content mixtures as a replacement for roasted soya bean meal

Parameters	**Experimental diets**							**Sex**		
	T1	**T2**	**T3**	**T4**	**T5**	**SEM**	**P**	**M**	**F**	**P**
Slaughter weight (g)	1707.5	1736.7	1736.8	1719.9	1550.2	31.839	0.311	1731.5	1648.9	0.072
Plucked weight (g)	1507.1	1516.8	1540.8	1520.8	1378.2	27.582	0.380	1532.8	1452.8	0.060
Plucked weight (%)	88.2	87.4	88.7	88.4	89.1	0.255	0.291	88.6	88.2	0.396
Commercial carcass weight (g)	937.4	984.7	962.0	925.0	833.1	22.775	0.281	957.9	899.0	0.096
*Dressing %	54.9	56.6	55.3	53.7	53.7	0.6741	0.698	55.2	54.5	0.613
Edible carcass yield (g)	1091.6	1159.3	1135.5	1104.7	977.9	26.290	0.226	1124.4	1063.2	0.121
**Dressing %	63.9	66.6	65.4	64.2	63.1	0.651	0.533	64.8	64.5	0.827
Thigh (g)	191.3	194.4	186.2	185.9	171.3	4.233	0.533	190.0	181.6	0.272
Thigh %	11.2	11.2	10.7	10.8	11.0	0.148	0.816	11.0	11.0	0.815
Drumstick (g)	174.3	177.2	171.0	168.5	150.9	4.082	0.292	180.5^{a}	156.2^{b}	0.005
Drumstick %	10.2	10.2	9.8	9.8	9.7	0.158	0.791	10.4^{a}	9.5^{b}	0.009

Table 29. *Continued…*

	T1	T2	T3	T4	T5	SEM	P	M	F	P
Breast (g)	280.1	305.8	301.9	274.2	244.6	8.833	0.172	274.8	287.8	0.287
Breast %	16.4	17.6	17.5	16.0	15.8	0.372	0.453	15.9^{b}	17.5^{a}	0.014
Back (g)	153.8	154.4	153.7	151.9	135.1	3.990	0.546	155.4	144.1	0.083
Back %	9.0	8.9	8.8	8.8	8.7	0.121	0.972	8.9	8.7	0.436
Wing (g)	138.0	153.0	149.2	144.7	131.3	4.140	0.531	157.2^{a}	129.3^{b}	0.001
Wing %	8.1	8.8	8.5	8.4	8.5	0.136	0.627	9.0^{a}	7.8^{b}	0.001
Abdominal fat (g)	18.9	23.2	16.4	17.7	17.1	1.106	0.327	16.1^{b}	21.2^{a}	0.008
Abdominal fat %	1.1	1.3	1.2	1.1	1.1	0.060	0.528	0.9^{b}	1.3^{a}	0.002
Giblet weight (g)	93.2	102.9	107.1	107.6	91.4	2.859	0.059	101.5	99.4	0.612
Giblet %	5.5	5.9	6.2	6.2	5.9	0.097	0.065	5.8	6.0	0.057
TNEO	497.0	525.8	506.0	500.5	431.3	12.526	0.144	511.7^{a}	465.4^{b}	0.048
TNEO %	29.2	30.2	29.2	29.1	27.8	0.417	0.575	29.5	28.2	0.436
TEO	154.2	174.8	173.7	179.7	144.9	5.1871	0.128	166.6	164.3	0.731
TEO %	9.1	10.0	10.0	10.4	9.3	0.1852	0.087	9.6	9.9	0.248

*Note: Means with a different superscript in a row are significantly different (P< 0.05); g-gram; T1=0%DBRCM+100%RSBM ; T2=20% DBRCM +80%RSBM; T3 =40% DBRCM +60%RSBM; T4=60% DBRCM + 40% RSBM; T5= 80% DBRCM+20%RSBM ; SEM-Standard Error of the Mean; M-Male; F-Female;TNEO- total nonedible offal, TEO= total edible offal, *= Dressing % calculated on the basis of commercially used (Eviscerated) carcass, **=Dressing% calculated by including edible offal (skin, gizzard and liver)*

4.2.8. Economic efficiency (EE)

The cost effectiveness of the newly included DBRCM to replace roasted soybean meal is presented in Table 30. There was a difference (P<0.05) in a kilogram of feed cost among treatment rations. T1 had the highest (P<0.05) and T5 the lowest (P<0.05) cost per kilogram feed. Feed cost per kilogram gain was the highest (P<0.05) for T1 and the lowest (P<0.05) for T4 and T5. Significant difference (P<0.05) was observed among treatment groups in the cost of total feed consumed. Birds in T1 had the highest (P<0.05) and those in T5 the lowest (P<0.05) cost of total feed consumed. The highest (P<0.05) economic efficiency was observed for birds fed on T4 and T5 and the lowest economic efficiency for birds on T1. The highest relative economic efficiency was observed for birds in T4 and T5.

Table 30. Economic efficiency of diets containing graded levels of DBRCM as a replacement for roasted soybean meal

Parameters	**Experimental diets**						
	T1	**T2**	**T3**	**T4**	**T5**	**SEM**	**P**
Feed cost/kg (Birr)	6.54^{a}	6.04^{b}	5.60^{c}	5.10^{d}	4.64^{e}	0.179	0.009
Feed cost/ kg gain (Birr)	19.09^{a}	17.14^{ab}	15.59^{ab}	14.24^{b}	14.58^{b}	0.569	0.021
Total feed cost (Birr/bird)	31.82^{a}	29.44^{b}	27.52^{c}	24.63^{d}	21.56^{e}	0.964	0.001
Total revenue (Birr)	100.31	104.52	106.20	103.96	88.79	2.504	0.164
Net revenue (Birr)	68.50	75.08	78.68	79.33	67.24	2.314	0.340
Economic efficiency	2.16^{b}	2.55^{ab}	2.86^{ab}	3.22^{a}	3.12^{a}	0.124	0.010
Relative economic efficiency	1	1.18	1.32	1.49	1.44	≈	≈

Note: Means with a different superscript in a row are significantly different (P< 0.05); T1=0% DBRCM +100%RSBM; T2=20% DBRCM +80%RSBM; T3= 40% DBRCM +60%RSBM; T4=60% DBRCM + 40% RSBM; T5=80% DBRCM + 20%RSBM; SEM-Standard Error of the Mean; kg-kilogram; 1Birr =0.045USD

5. DISCUSSION

5.1. Household Characteristics

The small-scale commercial poultry farm operation in the study area was largely run by males than females. Similar results were reported by Charles *et al*. (2013) and Aromolaran *et al. (*2013) who noted that males were highly involved in small scale poultry production compared to females. Bamiro *et al.* (2013) reported also that the majority of the poultry farmers to be males. A similar report was also illustrated by Akintude *et al.* (2015), where in modern poultry farming males predominated females. However, the result contradicted with the report of Nebiyu *et al*. (2016) who noted that females involved in poultry farming more than males in Addis Ababa, Ethiopia. The higher involvement of males in small-scale commercial poultry operation in the study area might be due to the limited involvement of males' in house work, limited access to other job opportunities and affection to the job

There were age related differences in running of small-scale commercial poultry farming. The age profile of the large majority poultry farmers was in between 15-30 years in the study area. The highest involvement of this age group might be due to affection of the job or absence of other job opportunities. The results were nearly similar with the report of Charles *et al. (*2013) and Aromolaran *et al. (*2013) who reported that majority of the producers were between 21-40 years of age groups. However, the result were against the report of Razzaq *et al.* (2011), Nusirat *et al*. (2012), and Nebiyu *et al.* (2016) who indicated that in urban and peri urban areas, the small-scale commercial poultry production was run by 31-55 age groups.

The number of married households involved in poultry production in the current study was lower than that reported by Charles *et al*. (2013) and Aromolaran *et al.* (2013), who reported 75% and 63.3% married poultry producers, respectively. More than one third of small-scale farming was run by first degree graduates in the study area, which corroborated the results reported by Razzaq *et al*. (2011) and Charles *et al*. (2013), who noted 37.3 and 50% of the producers to be tertiary level graduates, respectively. Also Aromolaran *et al*. (2013) reported that nearly 77.5% of the farm owners were those who completed higher education. The farm experiences in the study area coincided with the reports of Charles *et al.* (2013),

where 41.7% of the producers had 1-5 years of experience. Also, Aromolaran *et al.* (2013) noted that 65% of the producers had less than five years of experiences. On the contrary, Bamiro *et al.,* (2013) reported that most poultry farmers had more than 6 years of experience.

The family size (1-3) of poultry farmers in the study area was lower than the value 1-5 family size reported by Charles *et al*. (2013), but a bit higher than a family size of two reported by Aromolaran *et al.* (2013). The farm activities in the study area were in line with Clauer (2010), caring for the birds and tending to their basic needs as a constant responsibility for 24 hours a day, 7 days a week. Muhammad *et al.* (2010) reported that farms with small flock sizes tended to use family labour while larger ones particularly those with over 500 birds used hired labour. The higher involvement of males in the farm activities in the study area was in agreement with the results reported by Adedeji *et al. (*2014) who noted 84.21% involvement of males. But, Okoh *et al.* (2010) noted that women contributed most to commercial poultry farming in terms of labour. It was also noted that almost 52% of the farms were being owned by women (Muhammad *et al.*, 2010).

5.2. Source of Day Old Chicks in Small-Scale Commercial Poultry Farms

Private large scale commercial poultry farms in the study area were the major sources of day old chicks, which was in agreement with the report of Solomon (2007) and Nzietchueng (2008), where large-scale commercial farms and occasionally government owned breeding and multiplication centres provided of foundation stock for most small-scale poultry farms. Similarly, Uduak *et al*. (2014) reported that about 98% of the farms obtained their birds from commercial hatcheries. Muhammad *et al*. (2011) reported that small farming commercial producers obtained day old chicks from local hatcheries or improved ones. Nebiyu *et al*. (2016a) also reported that the foundation and replacement breeds were sourced from privately owned large-scale poultry farms. Desalew *et al.* (2013) reported that the majority of poultry farmers in Ada'a and Lume districts purchased improved chicks from private hatcheries. However, Nusirat *et a.* (2012) reported the source of poultry stock to be veterinarian (39.5%), retail vendors (39.5%) and hatcheries (18.4%).

5.3. Housing of Chicks

The management system in small-scale commercial farms in the study area was intensive production system which was nearly in agreement with the report of Adedeji *et al.* (2014). Under intensive poultry production system, the deep litter management system was the common production system which was similar with the report of Akidarju *et al*. (2010) and Uduak *et al*. (2014), where the majority of the producers used deep litter system and few of them used the battery cage system. Muhammad *et al.* (2010) noted that small-scale poultry producers used a deep litter management system. Also, results of the current study were in agreement with that reported by Ahmed *et al. (*2011), where the majority of the women producers practiced deep litter management system whilst very few kept their birds in battery cages.

The majority of the houses in the study area had soiled floor, which was similar with that reported by Nebiyu *et al. (*2016b) who stated that about 84.4% of the small-scale intensive poultry houses in Addis Ababa had non-cement floor. Different results were reported by Ekenma (2015), where the majority (96.6%) of the poultry houses had concrete floors.

Almost all the producers used teff straw as litter material up to the depth of 6.2 cm in the study area, which was similar with Nebiyu *et al*. (2016b) who reported about 70.1% of the small-scale intensive poultry farmers in Addis Ababa. Different results were reported by Adeyemi and Malomo (2014) who reported that wood shaving is the most popularly used litter material followed by sawdust, crushed corn cobs and grasses. Ekenma (2015) reported that about 60% of the producers used sawdust as a litter material in poultry farms.

5.4. Feeds and Feeding Practices

The main source of poultry feed for small scale commercial poultry farms in the study area was similar with that reported by Nzietchueng (2008) where most of small-scale poultry farms obtained their feed from large-scale commercial farms. The results were also in line with that of Nebiyu *et al.* (2016a), where private feed manufacturers and large scale commercial farms were the source of feed. Price of commercial feed was higher farm produced feeds in the study area. The high cost of formulated feeds might be due to the high cost of feed ingredients which consequently affected the purchasing price of the commercial

feeds. The majority of the producers offered commercial feeds which were similar with the report of Nusirat *et al*. (2012), Uduak *et al*. (2014) and Ekenma (2015), who noted that small-scale commercial poultry producers placed their birds on commercial feeds. Almost half of the producers offered the feed for their chicks three times per day during morning, afternoon and evening, which were in agreement with the results reported by Rahman (2015) who noted that the farmers supplied feed three times in a day to the birds depending upon the number of birds in the farms. However, Adedeji *et al.* (2014) reported that about 89.47% the producers gave the feed twice per day.

The chemical composition (CP %) of the average chick starter commercial ration in the study area was similar with NRC (1994) recommendation for CP requirement of white and brown egg laying strains of chicks. However, the home produced feed didn't meet NRC (1994) recommendation of CP requirement of chicks. The CP% of home produced feeds was 14.5%, which was below the recommended level. This might be due to inappropriate proportion of ingredients used for the formulation of the ration, because during mixing of poultry diets the majority of the feed ingredients commonly used were maize, wheat, and barely. These feed ingredients favoured metabolizable energy than CP. If dietary protein is inadequate, there is a reduction of growth as a consequence of depressed appetite and, thus, intake of nutrients (NRC, 1994). The metabolizable energy obtained from the average commercial ration and home produced feed was higher than that of NRC's recommendation. Increasing the dietary energy concentration leads to a decrease in feed intake and vice versa thus affecting growth (Veldkamp *et al.*, 2005).

Small-scale poultry producers in the study area provided water regularly for their birds. The source of water disagreed that reported by Uduak *et al. (*2014) who noted that 58% of the farms used bore-hole as their source of drinking water. In disagreement to this, Charles *et al. (*2013) reported that 78.3% of the farms used the well water. According to Stephen (2012), providing of pipe water was preferred, but if bore or surface water from a dam or river is used then the water quality must be tested and permitted for use.

5.5. Prevalence of Diseases

Almost all the producers didn't know which type of disease occurred in their farms and didn't keep records of the disease occurred. However, few of them suspect coccidosis was the most frequent disease in the study area. Similar results were reported by Nusirat *et al.* (2012) who noted that about 33.3% of the producers reported that coccidiosis was the most common disease outbreak in their farms, followed by IBD (24.2%) and NCD (21.2%). Mortality rates due to coccidiosis were 14.5% and 13.3% in small-scale and large scale poultry farms, respectively (Safari *et al.*, 2004).

The producers suspect the predisposing factors of the disease in the study area could be environmental problem, management problem, and both environment and management problems. The result is in agreement with the report of Jones *et al*. (2005), where poor management practices and environmental variation (temperature and relative humidity) were considered to be the predisposing factor of the disease and adversely affected the health of the flock. Reiter and Bessei (2000) have emphasized the importance of local variation in temperature, and humidity affects the birds' health. The management practices especially poor healthcare and keeping the birds beyond standard rearing period affects the flock (Rahman, 2015). Weather or poor management practices can be also the cause of the disease and affect the flock in the farm (Akidarju *et al.*, 2010). According to Anna (2011), key factors that can increase the risk of disease include the number of birds on the farm, keeping with other species of birds, not using all-in and all-out management system, feed type and source, stress levels, breed type and so on. The most leading symptoms of diseases occurred in the study area were similar with the report of Akidarju *et al.(*2010),which included ruffled feather, loss of appetite, depression, weight loss, paralysis, twisting of necks, and others.

The non-exposure of chicken producers to disease outbreaks and no experience of reporting the cases to veterinarians despite close relations with the veterinarian to consult about disease management practices in the study area might be due to a good disease prevention program of the farms, which were partly in agreement with the findings of Uduak *et al.* (2014), where the majority of chicken producers never experienced reporting of any disease outbreak in small-scale commercial poultry farms. In line with this, Mobley and Kahan (2007) and Hamra (2010) reported that losses of chicken can be avoided by implementing a

good disease prevention program, and controlling diseases from the beginning, which are important activities for the success of the chicken operation. Nusirat *et al*. (2012) noted that chicken producers frequently reported outbreaks of coccidiosis, IBD and NCD.

More than half of the producers can treat their chicks by their own with *amprollium* and *oxytetracycline*. If a disease was severe, chick producers would call veterinarians for treatment of sick birds. Muhammad *et al.* (2010) reported that only few producers consulted a veterinarian for diagnosis and treatment, but majority of the producers self-diagnosed the problems and instituted treatment which included vitamin supplementation or antimicrobial therapy, with *enrofloxacin* and *gentamycin* being the most popular. All producers had an isolation room for sick birds, which was in disagreement with findings of Birhanu *et al.* (2015) who reported only two third of the producers had an isolation pen for diseased chicken. About two third of the producers in the study area practiced selective culling of unproductive chicks, this might be to reduce the cost of feed consumed and to bring the desired performance by giving preferential treatment by allowing affected chicks to consume alone in a separate trough. The usual culled birds in the farm were small sized and deformed shape chicks. This practice might help save the feed, preventing the spread of diseases and bringing uniformity of the stock (Saritha, 2015). An all-in all-out management system was practiced by almost all farms in the study area as opposed to reports of Birhanu *et al.* (2015) where only few farms practiced all-in all-out management system.

In agreement with the results of the present study, Muhammad *et al*. (2010) reported that all farmers vaccinated their flocks against Infectious Bursal Disease (Gumboro) in the first week. However, Bereket *et al.* (2014) reported majority of respondents did not vaccinate for common diseases in the area in small-scale intensive poultry farms, which supported the results of Nusirat *et al*. (2012) where respondents practiced vaccinations of their birds against the preventable diseases of Newcastle Disease (NCD), Infectious Bursal Disease (IBD), Fowl Cholera, and Fowl Pox. Birhanu *et al*. (2015) reported that about 84% of the farms used vaccines for prevention of NCD, Fowl Pox and Marek's diseases, whereas the majority of the farms used prophylactic antibiotics for prevention of bacterial diseases.

The mortality of chicks in the study area during the first 1-3 weeks of age was relatively low, which was in line with Geidam *et al.* (2006) who suggested a mortality rate exceeding 5% by third week is subject for investigation. The highest mortality was recorded during the

long rainy season and mortality rate can even reach 10% or more in the first week of age in poultry farms due to diseases, predation or high temperature (Anna, 2011). Akidarju *et al*. (2010) reported that about one third of the producers informed that sudden mortality occurred frequently due to different diseases in small-scale commercial farms. According to Muhammad *et al*. (2010), the level of chick mortality was 11.4% of the flock size in the first two weeks of life and the major predisposing factors associated with these mortalities appear to be chick quality, disease, stress and nutrition, and other management practices in small-scale poultry farms.

Early chick mortality is associated with disease, poor management, inadequate brooding temperatures and heat stress in hot climates (Chou *et al.,* 2004). Poor quality hatches have also been reported to increase first week mortality from 0.8-13% (With, 2001). The first week after hatching is known to be the highest risk period for raising chicks (Chou *et al.,* 2004). Most farmers recognized that conditions such as stress could affect their flocks in the initial first weeks, and other management factors and the source of chicks is predisposing to early chick mortality (Muhammad *et al*., 2010). Temperature and ventilation in the brood house are generally considered to be significant factors for mortality early in the chicks' life (Anna, 2011). Apart from genetic characteristics, disease, management and nutrition have been known to play a role in chick quality (Farooq *et al.,* 2002).

Among the diseases; Newcastle diseases, Infectious bursal diseases and coccidiosis were cited in their order of importance in chick mortality (Bereket *et al.,* 2014). The major diseases or conditions that farmers associated with mortality included stress (25.6%), Pullorum disease (13.3%), diarrhoea (13.3%), and coccidiosis (4.4%), Chronic Respiratory Disease (CRD) (1.1%) and management causes such as overcrowding and poor ventilation (8%) (Muhammad *et al.,* 2010)

5.6. Biosecurity Measures

The biosecurity measures like using protective clothes (overall), shoes/boots/, hand gloves and foot bath in the study area was similar with the report of Nusirat *et al*. (2012) who noted that more than two third of the producers use any form of protective clothing on their farms. Similarly, Birhanu *et al.* (2015) noted that 76% of the producers used separate clothes and shoes in and around Mekelle small-scale commercial poultry farms. Using of

foot bath in front of the farm entrance was in line with the report of Birhanu *et al. (*2015), where 80% of the farms were applying a footbath at the entrance door in small-scale poultry farms. Nearly similar finding were reported by Uduak *et al*. (2014), where 66% of the farms used the footbath. Small-scale farms are characterized by low levels of biosecurity and are more prone to the introduction of infectious agents (Akidarju *et al.,* 2010). The reason might be lack of knowledge about the use of biosecurity measures and its benefit. However, Adedeji *et al.* (2014) indicated that about 78.95% the producers practiced biosecurity.

Developing and practicing daily biosecurity procedures as best management practices on poultry farms will reduce the possibility of introducing infectious diseases. The risk of disease transmission between farms can be reduced through appropriate farm sitting and management. Disease outbreaks (from pathogenic bacteria and viruses) in poultry can spread between farms and significantly affect poultry growing enterprises. The risk of disease developing on a farm is influenced by many factors, including the management of litter, feed and water; disinfection of sheds; vermin removal; disposal of used litter and dead birds; and the effectiveness of biosecurity measures adopted for people and equipment entering the farm (Stephen, 2012).

5.7. Sanitation and Hygiene

The producers in the study area practiced the waste disposal via burning, burying and spreading of the waste on ground. Similar results were reported by Nusirat *et al*. (2012), where about 36.8% of respondents disposed the farm waste in the form of manure, burying and burning while the remaining disposed by other means such as piggery feed. The dead birds were mainly buried. Similar finding was reported by Uduak *et al.* (2014), where 52% of dead birds were buried around the farm. Contrarily, Birhanu *et al.* (2015) reported that 56% of dead birds in and around Mekelle were removed via throwing. Bereket *et al.* (2014) also reported that in small-scale intensive system of production about 55.6% of the producers disposed dead chicken via burying. However, burning/incineration process is expected to destroy all infective agents (NABC, 2004).

Cleaning of the floor and the farm equipment in the study area was in line with the report of Nusirat *et al*. (2012), where the floor, feeder and watering trough were cleaned in the farm. The changing of litter material was in agreement with the report of Uduak *et al.* (2014),

about 44.7% of the respondents' change their poultry litter weekly, biweekly (15.8%), every two weeks (23.7%) and monthly (15.8%). In contrast, Ekenma (2015) reported that almost 70% of the producers changed the litter material when the need arises. There was a good practice in cleaning and sanitizing of the poultry house at the end of production cycle, and spraying disinfectants in the study area. According to Smith (1999) before applying the disinfectants, it must be chosen carefully to avoid problems with newly introduced flocks.

5.8. Rodents and Predators

In the current study, more than two third of the farms didn't have any access for entrance of rodents and predators. This might be due to a great effort made in construction of the houses and effective management practices to seal entrances of rodents and predators. Stephen (2012) stated that effective pest control is achieved through appropriate design and management of the farm. The results were in line with Birhanu *et al*. (2015), where the majority (84%) of the farms had no access for predators and rodents in and around Mekelle, Ethiopia. A contradicting result was reported by Uduak *et al*. (2014), where 66% of the farms were bothered by pests such as rodents and lizards and the rest were free from pests. However, rats, cats and weasels attacked birds in some farms in the study area. Rodents and predators can also act as mechanical transmitters of pathogenic microorganisms in poultry farms (Annette and Clas, 2012). Similar report was noted by Bereket *et al*., (2014), cats and wild birds were identified as major predators for small-scale intensive production systems in the Bahir Dar zuria district.

5.9. Marketing of Chicks

The live weight of chicks in the study area was the major determinant factor for selling of birds. Similar result was reported by Nigussie *et al.* (2010) who stated that live weight highly affected the market price than plumage color and comb type. Also Michael (2008) reported that the selling price was highly affected by weight, however, breed and color also had on effect on selling price. The birds were sold to farmers by development agents of the agriculture office and to city dwellers mainly at farm gate and local markets. Similar result was reported by Okantah *et al.* (2003), where 83% of the producers sold their birds at the farm gate in peri urban areas. However a contradictory result was reported by Tembachako *et al.* (2015), where farmers sold their chicken to different markets which included individual households, hotels, supermarkets and restaurants.

Chicks were sold on average at 50.00 Birr starting at 45 days of age (which means age in days plus 5.00 Birr), a standard price fixed by the government. Beyond 45 days of growth period, the price was calculated by the growth period of chicks in days plus 5.00 Ethiopian Birr. Therefore, marketing of birds at an appropriate time at profitable price can make the system viable (Rahman, 2015).

5.10. Training and Extension Services

Almost half of the producers in the study area received both theoretical and practical training by agriculture offices and TVET College for once and twice per production period. The other half of the producers didn't receive any training. Even the frequency of training given was very minimum and didn't quench their need; as a result the producers were bothered about disease management practices and formulation of a balanced ration in their farms. Similarly, Bereket *et al*. (2014) noted that more than half of the respondents of small-scale poultry producers in the Bahir Dar zuria district got adequate training on poultry rearing. However, Ogbe, (2000) and Moges *et al*. (2010b) emphasized the importance of both theoretical and practical training of producers and extension staffs focusing on disease control, improved housing, feeding, marketing and entrepreneurship to help improve the productivity /profitability of chicken farms.

About two third of the producers in the study area had got extension services like technical advice and supply of day old chicks from experts of the agriculture offices. The consistency of the professional support was very minimum and couldn't help the producers to exert full potential for successful poultry production. An appropriate extension service delivery can lead to change the husbandry practices and can enhance the contribution of poultry to household livelihood (SAPPLPP, 2010). The results were in line with Ajayi and Aphunu (2008) and Umunna *et al.* (2012), where 61.7 and 83.3% of poultry producers had access to extension services and contact with extension agents, respectively.

The majority (69.4) of the producers in the current study were visited by professionals to give extension service, which disagreed the reports of Umunna *et al*. (2012), where 35.9% of the producers had been visited by extension agents once in two weeks (fortnightly), 23.3% of the farmers had access to extension agents once a month, 40.7% of the producers

had varied frequency of access from once in two months to once a year. The producers in the study area might critically need a holistic and multi-disciplinary support of services like training, extension, veterinary and credit to improve the productivity of the farm and to proceed with poultry production.

5.11. Sources of Finance and Credit Services

The source of finance for poultry farm operation in the current study was in line with reports of Fred *et al.* (2011), who noted that the source of capital was from borrowing, own saving and gift and inheritance making 22.5, 70, and 7.5%, respectively in urban and peri-urban areas. The same author reported that nearly 52.5% of the money was borrowed from commercial banks. Mgbakor *et al.* (2014) categorized the source of money was the individual money lenders (38%), neighbours and relatives (30%), whereby cooperative societies and commercial banks played minor role in making credit available. On the sourcing of capital, Ahmed *et al.* (2011) reported that 79% of respondents obtained capital for their business from family sources, 18% from personal savings and 3% got their capital from bank loans and none from cooperative source. Akanni (2007) reported that 61% of the small-scale poultry farm operators sourced their finance internally from personal savings while 20% sourced funds from loans obtained from co-operative societies and 10.28% could secure bank loans.

Usually the money obtained from different sources was used to purchase day old chicks, feed and medicaments in the study area which was in line with the reports of Fred *et al.* (2011), where about 81% of the total amount of the formal credit accessed was used for purchasing feed, 12% of the total income was used to buy birds and 7% was utilized to purchase vaccines, equipment, land and maintenance costs. Producers in the current study replied that getting credit from the credit institutions was very difficult, because one of the requirements for accessing a loan was saving 20% of the loan as a prerequisite. The same result was reported by Akanni (2007) who noted that most small-scale poultry farmers have limited finance to raise larger number of flocks and 73.3% of the producers were also faced with uneasy access to loan and credit procurement.

5.12. Record Keeping

The great majority (85.7%) of the producers had a tradition to record the farms activity in the study area, which was similar with Devonish *et al.* (2000), 84% of the farmers interviewed kept records on production (feed, egg production, labour, mortality, birth and breeding). Okantah *et al.* (2003) also found that majority of farmers (96%) kept production records (weight of birds sold, the amounts of feeds and drugs or vaccines administered). These high percentages prove that most farmers are more concerned about the productivity of their farm business. According to Devonish *et al.* (2000) and Okantah *et al.* (2003), it was found that 76% and 95% of the producers kept financial records, respectively. Aromolaran *et al.* (2013) reported that, almost 61% of the respondents kept records of egg laid for the day, this will help them to have adequate knowledge of the number of eggs produced and also know the likely number of layers that are yet to produce after reaching the laying age. This implied that the importance of record for farmers is mostly attached with their financial needs. However a contradictory report was noted by Muhammad *et al.* (2010), where 70% of the farmers did not keep records that indicated costs related to their production.

5.13. Production Constraints

In spite of the contribution of the poultry industry to the economy, the subsector is faced by challenges that hinder further growth. Among the constraints high cost of feed stood at the forefront and unavailability of formulated feeds and feed ingredients near to the town ranked as a second factor. This was in line with the report of Tadelle *et al*. (2003), who noted that poultry feed and nutrition is one of the most critical constraints to poultry production under both the rural smallholder and large-scale systems in Ethiopia. Similarly, Demeke (1996) who reported that the availability, quality and cost of feed are the major constraints to poultry production in Ethiopia which is not self-sufficient in cereal grains that form the bulk of concentrate feeds for poultry. The results coincided with the report of Nebiyu *et al. (*2016a), who noted that the price of feed was the first constraint in Addis Ababa small-scale intensive poultry farming. The results also agreed with the report of Aromolaran *et al.* (2013) who found that in small-scale commercial poultry farms, for about 55.8% of the respondents the lack of quality ingredients for feed formulation was a major constraint while 51.7% believed that the high cost of feed for their layering birds was a major constraint that prevented them from increasing egg production. The results of this

study coincided also with the report of Rajendran and Samarendu (2003) who noted that high cost of feed was the first constraint.

Unavailability of land/space was the third factor in small-scale poultry farms in the study area. The majority (71.4%) of poultry producers kept their chicken within their own dwelling by separating the room and 4.1% in hired houses. This is due to lack of capital to request land from the government and unable to establish their own farms/poultry house/. However, Nebiyu *et al.* (2016a) explained that the unavailability of land was the second constraint in Addis Ababa small-scale poultry production. The result also coincided with the report of Michael (2008) who noted that shortage of space was one of the major constraints among the other constraints reported by smallholder broiler producers in and around Debre Zeit, Ethiopia. Aromolaran *et al.* (2013) reported that 25% of the respondents replied that unavailability of land/space was a major constraint, while 57.5% and 17.5% of the respondents replied that land was minor and not constraint, respectively in Nigeria.

Lack of market linkage and promotion was the fourth constraint in the study area. Most of the poultry producers replied that the involvement of the government to link the market and give promotion service is still limited. Due to this reason, they were unable to sell birds at desired selling age and were exposed to unnecessary extra expenses. The result were in line with those of Jaafar and Gabdo (2010), who confirmed the inadequate market/market linkage as the major constraint in small-scale poultry enterprise. Small-scale poultry farmers also encountered problems in marketing of the products (Okantah *et al.,* 2003). Lack of market for birds was a more important constraint compared with lack of market for eggs (Nath *et al.,* 2012).

The purchasing price of day old chicks was very high and it was the fifth constraint in the current study. Producers replied that due to the high cost of day-old chicks, they were unable to maximize the number of birds during production time. The results coincided with the report of Aromolaran *at al*. (2013), who noted that a purchase of healthy day old chicks was the major constraint for 54.2% of the producers. The results were also in line with that of Nath *et al.* (2012), who reported a high cost of day old chicks as the second constraint among the economic constraints.

Lack of finance was the sixth factor in small-scale poultry farms in and around Debre Markos, because almost half of the poultry producers were beginners in the poultry production business. Similar results were reported by Micheal (2008), who noted that shortage of capital was one of the leading constraints of smallholder broiler producers in and around Debrezeit, Ethiopia. The result was in agreement with the report of Okoli *et al.* (2005), who noted that high cost of production inputs and lack of adequate finance were major constraints to run small-scale commercial poultry production business. Similar results were reported by Ghasura *et al.* (2013), where lack of finance was the seventh leading constraint. Bishop *et al.* (2009) also reported that lack of finance was the major constraint in intensive small-scale poultry production.

Lack of extension service was the seventh leading constraint which was similar with the report of Jaafar and Gabdo (2010), who stated that lack of extension service was the leading constraint among the six major constraints in small-scale poultry production enterprises,. Lack of training was the eighth ranking constraint in the study area. Inadequate training was the 11^{th} constraint in Addis Ababa small-scale intensive poultry farming (Nebiyu *et al.*, 2016a). Poor credit facilities were the 9^{th} factor, which was in line with the report of Ghasura *et al.* (2013) who noted that the poor credit facilities ranked, 8^{th} in small-scale poultry farmenterprises. The result coincided with the report of Nebiyu *et al.* (2016a) who reported that the lack of access to credit was the 10^{th} ranked constraint in Addis Ababa small-scale intensive poultry farming.

High cost of medicaments was the 10^{th} factor in the study area. Micheal (2008) reported that the medicaments were purchased from the town veterinary pharmacies and the medicaments were costly. The results were in agreement with the report of Nath *et al.* (2012), where high cost of medicine was also the major constraint in small-scale poultry production. The results also confirmed by Ghasura *et al.* (2013) who stated that high price of medicine was the fifth major constraint in Gujarat poultry farm entrepreneurs.

Similar to the current results, Ghasura *et al.* (2013) reported that the constraints in poultry farms were beyond rank ten where non-availability of improved birds in time, inability to pay constant attention, lack of support from family members, high charge of electricity and non-availability of laborers for poultry enterprise.

5.14. Chemical Composition of Dried Blood Meal, Dried Rumen Content and Dried Blood Rumen Content Mixtures

The DM content of dried blood meal (DBM) of 94% in this study was in line with NRC (1984) and Olomu (1995) with 91% and 94.1% DM, respectively. The CP (83.5%) content of DBM was in agreement with the results reported by Parr (1988), NRC (1994) and Olomu (1995) which ranged between 81.1-85%; however, it was higher than 76.7% reported by FAO (2010b) and lower than 88.5% and 88% reported by Gohl (1981) and Musharaf (1990) respectively. The EE of the DBM was within the ranges of 0.47-1.6% reported by Olomu (1995) and NRC (1994). The CF content DBM was similar with the 1.5% and 1.2% reported by Olomu (1995) and FAO (2010b) respectively. The ash content was in line with 4.18% and 4% reported by Olomu (1995) and FAO (2010), respectively.

The DM content of dried rumen content (DRC) in the current study was between 88 and 96.5% reported by Gohle (1981) and Mandung (1994). The CP content was equivalent with 18.52% reported by Esonu *et al.* (2006) and higher than 9.82% reported by Whyte and Wadak (2002). However, it was in the range of 9 – 20% reported by Ekwuoma (1992) and Whyte and Wadak (2002). The CF content was higher than 19.5%, 25.5%, and 15.3% reported by Gohle (1981), Mandung (1994) and Esonu *et al.* (2006), respectively; but lower than 39.95% reported by Whyte and Wadak (2002). The EE of the current study was nearly in agreement with the report of Gohle (1981), Mandung (1994), and Whyte and Wadak (2002), who reported values of 2.3%, 1.5% and 1.1%, respectively. However; the current result was lower than 8.79% reported by Esonu *et al.* (2006). The ash content of the feed was almost equal with 13.5% reported by Gohle (1981); but lower than 21.5% and 18.58% reported by Mandung (1994), Whyte and Wadak (2002), respectively and higher than 7.6% reported by Esonu *et al.* (2006)

The DM content of the dried blood rumen content mixtures (DBRCM) in the current study was similar to the report of Odunsi (2003), Onu *et al.* (2011) and Togun *et al.* (2009) who reported DM contents of 94%, 92.86% and 94.8%, respectively. The crude protein content of DBRCM was in conformity with the reports of Togun *et al.* (2009) who noted that 37.63% CP, but a bit higher than that reported by Dairo *et al.* (2005), and Adenui and Balogun (2003), who reported 33.81 and 31.42%, respectively. However, the results were incomparable with the report of Onu *et al.* (2011), Olukayode *et al.* (2008) and Odunsi,

(2003) who reported the CP content of the feeds were 45.35%, 47%, and 46.1%, respectively. The CF content of the feed was nearly comparable with Adenui and Balogun (2003), who reported 18.71%, but was incomparable with the reports of Odunsi (2003), Olukayode *et al*. (2008), Togun *et al.* (2009), and Onu *et al.* (2011), who reported a relatively lower CF content of 6.38%, 9.59%, 9%, and 8.81%, respectively.

The ash of the DBRCM was similar with the report of Togun *et al.* (2009) 7.5%. However, it was lower than the report of Odunsi, (2003), Olukayode *et al*. (2008) and Onu *et al.* (2011) who reported ash contents of 15.42, 11.6 and 23.4% respectively. The EE of the feeds in the current study was nearly comparable with the reports of Odunsi (2003) but higher than the report of Adenui and Balogun (2003), who reported EE of 2.13% and 0.88%, respectively, and lower than 6.55 and 4.10% reported by Olukayode *et al.* (2008) and Onu *et al.* (2011), respectively. The energy content of the feed (2328.5 kcal ME/kg DM) was nearly in line with the report of Adenui and Balogun (2003) and Onu *et al.* (2011) who noted ME of 2686 and 2599.49 kcal ME/kg DM.

The chemical composition of DBRCM in the current study had some variations from the reports of some authors. This variation might be due to the type of pasture and/or diet consumed by the animals and the proportion of the constituent mixtures, the gap between the feed eaten and the animal's slaughter, the microflora of the gut and the method of feed processing. When the animals fed dry grasses, straws (teff, barley, wheat etc), stovers (maize, sorghum) and energy concentrates, DBRCM might have lower CP content and higher metabolizable energy whereas when animals were fed with leguminous plants and protein concentrates, DBRCM might have higher crude protein and low energy content. Even, fasting before slaughter might affect the nutrient composition of the DBRCM. When a feed stayed longer in the gut without any degradation by micro flora, its nutritional content might be affected (Odunsi, 2003). Microbes in the rumen convert nutrients such as cellulose and Non-Protein Nitrogen (NPN) into microbial proteins such that the rumen acts as a natural continuous system for the production of single cell proteins (Javanovic and Cuperloric, 1977). Hungate (1966) revealed that the microbes of the rumen are able to synthesis beta-glucanases, which are needed for the breakdown of cellulose, hemicelluloses and phenolic polymers.

5.15. Dry Matter and Nutrient Intake (DMI) of Sasso C44 Broilers Fed Diets Containing Graded Levels of DBRCM

The results related to DMI of Sasso C44 broiler chicks fed with DBRCM during the experimental period were in line with the finding of Adenui and Balogun (2003) who reported a non-significant difference in dry matter intake by pullets on a 10% bovine blood rumen content mixture (BBRCM) diet and those on a control diet without BBRCM. The results of the current study were in disagreement with the finding of Onu *et al*. (2011), who reported higher feed intake by broilers during the finisher phase fed a diet without BBRCM than those fed diets with BBRCM. The results of the current study also disagreed with the report of Olukayode *et al.* (2008) who noted a higher feed intake for chicks fed a diet containing 10% sun dried rumen content blood meal than chicks fed a diet containing 15% sun dried rumen content blood meal (SDRBM). Esonu *et al.* (2011) also reported that birds fed fermented bovine blood and rumen digesta (FBBRD) during finisher phases of growth showed the highest feed intake values at 10% inclusion level. The present results also disagreed with the findings of Adenui and Balogun (2003) who indicated that grower pullets fed with different levels of BBRCM diets revealed a higher feed intake when fed a diet containing 20% BBRCM. In this connection, Shim *et al.* (1989) and Pond (1989) reported that feed intake to be higher on fibrous diets, which substantiated the higher feed intake of pullets on 20% BBRCM diet. However, when the inclusion level was increased to 80% DBRCM, the DMI was reduced, probably due to increasing fibrousness of the diets as the inclusion level of DBRCM was increased. Bolarinwa (1998) reported that the increased inclusion level of SDRBM increases the fiber content, which limited feed utilization in poultry production. Other than the fiber content, Onu *et al.* (2011) reported that the reduced intake of the birds on high inclusion level of BBRCM in diets could also be attributed to depressed appetite resulting from the unpleasant smell of the diets. Odunsi (2003) also reported that the high level inclusion of blood meal and / or rumen content would result in unpleasant odour and make it less palatable to birds causing a depression in consumption. The same author stated that, the diets became darker in colour and the odor more bring out with an increase in BBRDM. The combination of these two factors will negatively influence palatability resulting in low consumption.

The CPI of Sasso C44 broiler chicks during the entire period of the experiment was in agreement with the report of Thirumalesh *et al.* (2012), who reported that the average daily CP intake was 19.9 g/bird/day for finisher broiler chicks. The obtained result was also similar with the report of Kiros (2011), where the CPI of 14.2-18.4 g/d/b was recorded for the whole period of the experiment. The result also disagreed with the report of Das *et al.* (2010) who reported an average of CPI ranging from 13.5-13.8 g/ bird/ day. The CFI in the present study was similar with that reported by Kiros (2011) who noted a daily CFI of broilers ranging from 4.34-6.2 during the whole experimental period, which supported the results of Thirumalesh *et al.* (2012) who reported CFI for the whole period to range between 4.4-5.3g/b/day. However, Das *et al.* (2010) reported different values who indicated CFI of 2.56-2.61 g/bird/day. The Metabolizable energy intake (MIE) of during the entire experimental period was similar with that reported by Thirumalesh *et al. (*2012), who noted MEI of 306.6 and 307.7 kcal in summer and winter seasons, respectively during the whole period of the experiment. However, results of this study disagreed with the findings of Kiros (2011) who reported ME intake of 212.5-276.7 kcal.

With the lowest dry matter intake, the nutrient intake of the birds was also reduced. Onu *et al.* (2011) reported that the dry matter and nutrient intake decreased with increased level of BBRCM. This is probably due to increasing fiber content of the diets as the inclusion level of DBRCM was increased since fiber limits feed utilization in poultry production (Onifade, 1993; Bolarinwa, 1998). According to the report of Esonu *et al.* (2005), the crude fibre activates the intestine and more occurrences of peristaltic movement and enzyme production resulting in efficient digestion of nutrients. However, as the inclusion level was increased, the intake was reduced. The higher crude fibre content of the test material which tends to increase the total fiber content of the diets and dilute other nutrients, which may probably have interrupted intake, the digestibility and effective utilization of the nutrients in the diets (Esonu *et al.*, 2011).

5.16. Body Weight Change of Sasso C44 Broilers Fed Diets Containing Graded Levels of DBRCM

The result of the current study using DBRCM for Sasso C44 broilers confirmed the report of Olukayode *et al.* (2008) who noted that final body weight and body weight gain were superior for birds fed 10% SDRBM compared with all other diets in both the finisher phase

and the entire period. Similar results were observed by Esonu *et al.* (2011), who reported that the body weight gain of the birds were numerically increased linearly up to 10% inclusion level of FBBRCM and then decreasing trend was observed. A similar result was observed by Adenui and Balogun (2003), who indicated that pullets fed different levels of BBRCM did not show differences in growth rates of birds as the BBRCM level of their diet was increased. The results were in line with Emmanuel (1978), who concluded that the whole rumen contents did not affect growth when included in the diets of broilers from 1-21 days of age. The results were in disagreement with the finding of Onu *et al.* (2011) who noted a linearly increased body weight gain with increasing level of bovine blood rumen content meal of broilers.

The improved weight gain of birds fed BBRCM diets could be attributed to a higher protein content of the diets which were efficiently metabolized for growth (Onu *et al.,* 2011). According to Esonu *et al.* (2004), chicks have difficulties to utilize high fibre diets when the inclusion level is increased and adult birds utilize high fibre materials than chicks. So that the finisher birds could tolerate DBRCM diets better than the starter chicks in the current study, because at this stage, they have a more developed gastro intestinal tract to handle the fibre contents of the diets (Esonu *et al.,* 2004). Due to this reason, a similar final body weight and body weight gain was observed in finisher and the entire experimental period up to 80% DBRCM inclusion level.

5.17. Feed and Nutrient Conversion Ratio of Sasso C44 Broilers Fed Diets Containing Graded Levels of DBRCM

The inclusion of DBRCM up to 80% for the replacement of RSBM in Sasso C44 broiler diets didn't affect the feed and nutrient conversion ratio in both growth phases. This was in conformity with the report of Esonu *et al.* (2011) who noted no differences among the groups, fed diets containing different levels of fermented bovine blood rumen digesta (FBBRD). However, the contradictory results were reported by Onu *et al.* (2011), where improvement in feed conversion ratio of birds was achieved as the level of BBRCM inclusion in the diets increased in finisher phases. Similarly, the opposite results were observed in the report of Adeniji and Balogun (2002) and Odunsi (2003), where a significant difference in FCR of birds fed different levels of blood rumen content mixtures was observed. Pond *et al.,* (1989) reported that the lowest feed conversion ratio of broiler

chicks fed a diet containing 6% of BBRCM inclusion in both growth periods might be related with a high fiber content of the diets since diets with high fibre contents reduce feed/gain ratio.

5.18. Carcass Characteristics of Sasso C44 Broilers Fed Diets Containing Graded Levels of DBRCM

In this study, the slaughter weight of Sasso C44 broiler chicks was not statistically influenced by diet and sex, however, male birds were heavier than females, which confirmed the findings of Donald and William (2002) and Faria *et al.* (2010), who reported that males grow more quickly and efficiently than females, and a higher slaughter weight and carcass weight in males to be related to their higher muscle development as influenced by the production of androgen hormone. In line with this, Asrat (2007) indicated the difference between males and females might be due to the higher feed intake of males than that of females and sex hormones in the females favour fat deposition and adipose tissues are less dense than muscle tissues.

The lack of differences in carcass weight of birds fed diets containing different levels of DBRCM might be due to lack of differences in the final body weight of birds. The carcass weight was not influenced by sex when birds fed the treatment diets. Similar study was observed by Steven and John (2008), who noted comparable weights of male and female birds yielded similar weights of carcass portions. These results were in line with Steven and John (2008) and Engku *et al.* (2007), who reported a similar dressing percentage for females and males, probably due to similar slaughter weight of males and females. The results were confirmed by Steven and John (2008), who noted that comparable weights of male and female birds have similar yields of carcass and may have similar dressing percentage of the commercial carcass yields.

The edible carcass yield in the present study was in agreement with that reported by Onu *et al.* (2011), where carcass characteristics, carcass yield and organ weights of broiler chicks were not adversely affected by BBRCM inclusion levels. The same result was observed by Esonu *et al.* (2011), who reported a non- significant difference in the live weight and dressing percentage of birds fed on different levels of FBBRD. However, Olukayode *et al.* (2008) noted that statistically significant differences in carcass yields was observed in birds

which received SDRBM compared with the control diet. Edible carcass yield was not significantly influenced by sex, whereas, the edible carcass meat of males was higher than that of females. The results were in conformity with the results reported by Steven and John (2008) who noted that the yield of edible meat of females may be less than for the males if both are fed the same diet.

The gizzard, liver and skin were included as part of the edible carcass yield in view of the fact that these are consumed in Ethiopia. A higher dressing percentage was recorded when calculated by considering these parts. The results related to dressing percentage were in line with the report of Onu *et al.* (2011), who confirmed no differences in the dressing percentage of the birds fed bovine blood rumen content mixture (BBRCM) and had no adverse effects on the carcass yield. Esonu *et al.* (2011) also confirmed no significant differences in weight gain and dressing percentage of birds fed different levels of fermented bovine blood rumen digesta (FBBRD).

Under the Ethiopian context total edible offal includes skin, gizzard and liver. The total edible offal (TEO) was not influenced by diets and sex; which was in agreement with reports of Onu *et al.* (2011), where the organ weight of birds was not significantly influenced by the addition of BBRCM in broiler diets. The results supported also the reports of Okorie (2005) where no significant differences in organ weights among birds that were given dried rumen content were reported. In Ethiopia, the total nonedible offal (TNEO) components include blood, shank and claws, feather, head, crop, oesophagus, proventriculus, spleen, pancreas, kidney, heart, lung, small intestine, large intestines and abdominal fat. Males had significantly higher TNEO than females, which agreed with the findings of Steven and John (2008), who noted that the yield of edible meat of females may be less than for the males when both are fed the same diet. Probably this indicates that the total nonedible offal also lower in females than males.

Abdominal fat and abdominal fat percentage were affected by sex. Females had higher abdominal fat and abdominal fat percentage than males. The results were in line with the report of Melese *et al.* (2013), who confirmed that the female broilers tend to deposit more fat than the male broilers. This is always true for the same age and feeding program. Female birds are fatter than males because female hormones stimulate fat deposition (Scanes *et al.*, 2004).

The success of poultry meat production has been strongly related to improvements in growth and carcass yield, mainly by increasing breast proportion and reducing abdominal fat (Musa *et al.,* 2006). Breast meat is the most liked meat from the view point of commercial carcass components for its low fat content and faster rate of accumulation of muscle tissues by birds than other parts. Breast meat was not significantly influenced when birds were fed a diet containing DBRCM compared with the control group. However, it was significantly influenced by sex. Females had higher breast meat than males, which was in line with the report of Musa *et al.* (2006) who reported that female broilers had greater breast meat compared with male broilers. Similar result was reported by Steven and John (2008) who confirmed that the female birds had higher breast meat than males. The result also coincides with the report of Faria *et al.* (2010), who also noted that females have higher breast meat yield than males, and males have higher thigh yields than females.

The weight of giblets (liver, heart and gizzard) was not affected by the diet containing dried blood rumen content mixture compared with the control group. The individual components of the giblet weight was similar with the report of Onu *et al.* (2011) who noted that the giblet weight and its components were not influenced by a diet containing BBRCM. The giblet percentage was similar with Onu *et al*. (2011), who reported the giblet percentage ranged from 6.6-7.4% and there was no significant difference among the treatment groups.

5.19. Economic Efficiency (EE)

The results related to EE coincide with the report of Onu *et al.* (2011), who noted that the reduction in the cost of diets containing higher levels of bovine blood rumen content mixture (BBRCM) because the cost per kilogram of processed BBRCM was by far cheaper than soybean meal. The same results were reported by Olukayode *et al.* (2008), who indicated that feed cost per unit weight gain was lower for all SDRBM diets than the SDRBM-free diet. The results were also in agreement with Esonu *et al.* (2011), who reported that the dietary inclusion of fermented bovine blood rumen digesta (FBBRD) reduced cost of producing a kilogram of feed which is reflected in the cost of a kg of meat produced. The same author reported that feed cost declined with increasing dietary level of FBBRD and feed cost saving increased with dietary level of FBBRD. Adenui and Balogun (2003) reported that for pullets fed different levels of BBRCM, a reduction in the price of

feed was observed with the increase in the levels of BBRCM in the test diets. The reduction in the price of feed with increase in the level of BBRCM in the diet was a result of the cheap price per kg of the BBRCM. The BBRCM can still be far cheaper compared with prices of most conventional protein supplements available.

6. CONCLUSION AND RECOMMENDATIONS

6.1. Conclusion

Based on the results of the current study, it could be concluded that only 49 small-scale commercial poultry farms were found. From which, 75.5% of the small-scale poultry farms were run by private producers who initiated by themselves and the rest were organized by small and micro enterprise offices. Most of the farms were run by males between 15-30 years of age. All the producers started their business using day old chicks which were sourced from Ethiochik PLC, Andassa multiplication center and Gerado poultry farms. The breeds of the chicks were Bovans Brown, Bovans White, Koeckoeck, and SASSO T44. Bovans Brown represented 83.1% of the total populationin the farms. The purchasing prices of the chicks varied according to the breed. The average flock size was 844.3 and the flock density was 13.7 chicks per m^2. All chicks were reared in a deep litter housing system covered with teff straw as litter material with a depth of 6.2 cm.

Most of the farms used commercial rations which were mainly sourced from the Ethiochick PLC at Mekelle, Alema (Bishoftu) and Andassa poultry farms. The price of the commercial rations was higher than that of the farm produced ration. The farm produced feed was prepared from maize, wheat, barley, roasted soybean meal and noug seed cake. Majority of the producers didn't know the amount of feed offered, however, half of them offered three times per day during morning, afternoon and evening irrespective of the amount offered. Water was provided regularly at morning, noon, evening, and mid night from pipe as a main source.

Nevertheless, almost all the producers didn't know which type of disease occurred in their farms and did not have the experience of recording the prevailing diseases. However, few of the producers suspect Coccidosis based on the symptoms observed. The leading and frequently observed symptoms of diseases were ruffled feather, loss of appetite, depression, diarrhoea, weight loss, paralysis, twisting of necks, and others. All farms had accustomed to vaccinating their chicks at least twice during the production cycle for NCD, Gumboro, fowl pox and Fowl Cholera/Typhoid/. Prevention and treatments were the major systems for controlling measures of diseases, due to this reason; the average mortality of chicks was only 4.7%.

About half of the producers had taken training and got extension services. The training and extension service did not, however, address all the producers' problems. Majority of the producers had a good habit to record the farms activity and most of them recorded only production cost, feed offered and mortality. However, the records in the study area did not provide complete, current and accurate information to support the decision-making process.

The chicks were reared up to 45 days of age and sold to farmers and town dwellers at farm gate and local market. If there is no market, average production length extended up to 78 days. The mean production cycle of chicks in small-scale commercial farms was 2.7 times per year, and the majority of the farms used an all-in and all-out management system. However, the production was hindered by different constraints like high cost of feed, shortage of feed, land limitation, lack of market linkage and promotion services, high cost of birds for starting the business, lack of finance, inadequate extension services, inadequate training and others.

All the producers and the experts strongly needed the government's intervention to alleviate the constraints faced by improving market linkage and promotion, providing training on poultry husbandry practices, provision of land and fulfilling the financial needs through facilitating credit services, avail the commercial feed factory in the town, improving extension services, strengthening the capacity of the experts by providing continual training, fulfilling sufficient transportation facilities and allocating adequate budget for per diem are among the interventions required to improve the current status of small-scale commercial poultry production.

Dried blood rumen content mixture did not result in any ill-health of Sasso C44 broiler chicks during the starter and finisher phases. Hence, it could safely replace roasted soybean meal up to 60% for starter and up to 80% for finisher phases of broiler feeding to maximize the economic efficiency of the production without affecting the body weight gain, feed conversion ratio, performance index and carcass characteristics of birds. As a result dried blood and rumen content mixture could be considered as an important and cheap non-conventional feed ingredient for economical feeding of chickens in general and Sasso C44 broilers in particular.

6.2. Recommendations

From this study it could be recommended that

- Establishing poultry feed unit (plant) is needed in the town to formulate a balanced ration and provide the ration at reasonable cost.
- Providing opportunities for producers to establish a large-scale commercial layer farms is of paramount importance in the town to produce both table and fertile eggs for consumption and hatching purposes.
- Establishing a hatchery unit in the town is highly recommended as a source of day old chicks to distribute to small-scale commercial farms at affordable price rather than bring from remote sources.
- Research is needed to know the overall performance of chicks distributed from the small-scale commercial poultry farms to farmers under farmers' management condition to take the correct remedial measures.
- The government intervention is needed to develop and implement short and long term strategies that help to alleviate the identified constraints faced in small-scale-commercial poultry farms.
- It is important to develop technological means to collect and process the blood and the rumen content rather than collecting them manually to save time and cost for incorporating in the feed with the other feedstuffs.
- Abattoirs should be encouraged to explore establishment of blood meal and /or rumen content processing in their facilities and market it as poultry feed
- Technology dissemination about the benefit of DBRCM is very advisable especially for small-scale, medium-scale and large-scale commercial broiler producers to reduce their production cost and maximize their economic efficiency.
- The DBRCM levels tested in the current experiment need be also tested in layer chicken breeds before deciding on inclusion of DBRCM in the ration of layers
- Testing ratios of blood rumen content mixtures other than 1:1ratio tested in this work for different classes of poultry is warranted

- Further research is necessary to know the effect of dried blood rumen content mixture on dry matter intake, body weight change, FCR and performance index, carcass characteristics and economic efficiency beyond 60% for starter phases and 80% for finisher phases in broiler chicks ration.

7. REFERENCES

Abedullah, Maqbool A. and Bukhsh K. (2007): Issues and Economics of Poultry Production: A Case Study Of Faisalabad, Pakistan. Pakistan Vet. J. 27(1): 25-28.

Abubakar M.B., Ambali A.G., Tamjdo T., (2007): Rural Chicken Production: Effects of Gender on Ownership, And Management Responsibilities in Some Parts of Nigeria and Cameroon. Int. J. Poult. Sci. 6: 413–416.

Addo A., Bart-Plange A. and Akowuah J. O. (2012): Particle Size Evaluation of Feed Ingredient Produced in the Kumasi Metropolis, Ghana. ARPN Journal of Agricultural and Biological Science , 7(3):177-181

Adedeji O.S, Amao S.R., Alabi T.J, Opebiyi O.B. (2014): Assessment of Poultry Production System in Ilesha West Local Government Area of Osun State, Nigeria. Sch J Agric Vet Sci 1(1):20-27.

Adegbola T.A., Anugwa O.I., Nwosu C.C., Okorie A.U. and Orji B.I.(1986): Animal Science. Introduction to Trop. Agric. London: Longman, pp: 198-239

Adejoro S.O. (1991): Strategies for Animal Health Care Management in the Tropics. World Poultry-Misset. 7 (4), 84-85

Adeniji A. A. (1996): The Values of Bovine Blood Rumen Content Meal as A Feed Stuff for Pullets (Ph D Thesis). Department of Animal Production, University of Ilorin, Nigeria.

Adeniji A. A. and Balogun O. O. (2002): Utilization of Flavour Treated Blood-Rumen Content Mixture in the Diet of Laying Hens. Nigeria Journal Animal Production 29(1): 34-39

Adeniji A. A. and Jimoh A. (2007): Effects of Replacing Maize with Enzyme-Supplemented Bovine Rumen Content in the Diets of Pullet Chicks. International Journal of Poultry Science. 6 (11): 814-817

Adeniji A.A. (2008): Replacement Value of Maize With Enzyme Supplemented Decomposed Bovine Rumen Content In The Diet of Weaner Rabbits. Journal of Animal and Veterinary Advances, 3:104-108.

Adeniji A.A. and Balogun O.O. (2001): Evaluation of Blood Rumen Content Mixture in the Diets of Starter Chicks. Nig. J. Anim. Prod., 28(2), 153- 157

Adeniji A.A. and Oyeleke M.M. (2008): Effects of Dietary Grit Fed on the Utilization of Rumen Content by Pullet Chicks, Department of Animal Production, University of Ilorin, Ilorin, Nigeria. Journal of Applied Sciences Research, 4(10): 1257-1260

Adeniji A.A., (2001): The Potential of Bovine Blood Rumen Content Meal as A Feedstuff for Livestock. Trop. Anim. Prod. Invest., 4(1): 151-156.

Adenui A. A. & Balogun O. O. (2003): Influence of Bovine Blood-Rumen Content Meal In The Diets of Growing Pullets on Their Subsequent Laying Performance. Department of Animal Production, University of Ilorin, Nigeria, Ghana. journal of Agricultural sciences 6: 47-51.

Adeyemi OA, Malomo A (2014): Survey of Poultry Wastes Management in Abeokuta, Ogun State, Nigeria. Adv. J.Environ. Manag. 1(2):014-019

Adeyemo O and Adeyemi I. (2009): Cattle Cruelty and Risks of Meat Contamination at Akinyele Cattle Market and Slaughter Slab in Oyo State, Nigeria. Trop. Anim. Health Prod. 41:1715-1721

Ahmed A., Mijinyawa M.S., Adamu A.Y. and Suleiman A.D. (2011): Smallholder Poultry Management Practices and Constraint Among Women Poultry Farmers in Kano State, Nigeria. Nig. Vet. J., 32: 151- 153.

Ajayi M.T. and Aphunu A., (2008): Farmers Perception of Extension Agents Effectiveness and Introduction of Extension Reforms in Delta state in Nigeria. Asset Series C, 2(1):191-202

Akanni K. A. (2007): Effect of Micro-finance on Small-scale Poultry Business in South Western Nigeria. Emir. J. Food Agric. 19 (2): 38-47

Akidarju M.S Onyemaechi E.G. And Dauda M.G. (2010): An Assessment of Some Poultry Management Practices and Disease Recognition by Poultry Farmers in Maiduguri Arid Zone, Nigeria. World's Poultry Science Journal, 66: 285-296

Akintunde, O.k. Adeoti, A.I. Okoruwa, V.O. Omonona, B.T. and Abu, A.O. (2015): Effect of Disease Management on Profitability of Chicken Egg Production in Southwest Nigeria. Asian journal of poultry science, 9(1):1-18.

Alabi. R.A. and Osifo R.A., (2004): Constraints to Self-sufficiency in Backyard Poultry Production in Edo State, Nigeria. Proceed. 9th Ann. Conf. Anim. Sci. Assoc. Nig., pp: 177-180.

Alemu Y. and Tadelle D. (1997): The Status of Poultry Research and Development in Ethiopia, Research Bulletin No.4, Poultry Commodity Research Program Debrezeit agricultural research centre. Alemaya University of Agriculture, Ethiopia. pp. 62

Alemu Y. (1995): Poultry Production in Ethiopia. World's Poultry Science Journal.51: 197-201.

Anna Bassett (2011): Animal Welfare Approved. Technical paper no. 8 www.animalwelfareapproved.org

Annette B, Claes F. (2012): Rodents in Pig and Chicken Farms- A Potential Threat to Human and Animal Health. Infect ecol epidemiol, 2:17093-17101.

Apantaku S.O., (2006): Analysis of Participation of Farmers in Participatory Poultry Production Research in Lagos state, Nigeria. Livestock Research for Development 18 (7). Available from: http://www.lrrd.org/lrrd18/7/apan18094.htm.

Araujo L. F., Junqueira O. M., and Araujo C. S. S. (2004): Protein Levels Reduction of Broilers in the Initial Phase. Cienc. Rural. 34: 375-377.

Arbor Acres (2009): Broiler Nutrition Supplement. Retrieved on 26 April 2012.

Aromolaran Adetayo K., Ademiluyi I.O. & Itebu O. Jennifer, (2013): Challenges of Small Poultry Farms in Layer Production in Ibadan Oyo State Nigeria Global Journal of Science Frontier Research Agriculture and Veterinary Sciences, 13 (2):1-9

Asrat Tera Delebo, (2007). Assessment the Impact of Feeding Fish Meal Prepared at Small-scale Level on Feed Intake, Growth And Carcass Traits of Rhode Island Red Chicks. MSc thesis summited to Hawassa University, Awassa, Ethiopia. pp 74-84.

Association of Official Analytical Chemists (A.O.A.C) (2000): Official Methods of Analysis. 13th Edition, Washington D.C.America.

Atawodi, S.E., Mari D., Atawodi J.C. and Yahaya Y. (2008): Assessment of Leucaena and leucocephala Leaves as Feed Supplement in Laying Hens. African Journal of Biotechnology. 7 (3): 317-321.

Bamiro O. M., Abiodun O. Otunaiya and Isaac A. (2013): Profit Efficiency in Poultry Production in Peri-Urban Lagos, Nigeria. International Journal of Applied Agricultural and Apicultural Research, 9 (2): 120-130.

Bell D.D. & Weaver W.D. (2001): Commercial Chicken Meat and Egg Production. Fifth edition. Los Angeles, California, USA, Kluwer.

Bereket Addis , Desalew Tadesse and Shigdaf Mekuriaw (2014): Study On Major Causes Of Chicken Mortality And Associated Risk Factors in Bahir Dar Zuria District, Ethiopia.African Journal of Agricultural research 9(48):3465-3472

Beutler L. E., (2007). The Psychotherapist as a Neglected Variable in Psychotherapy: An Illustration by Reference to the Role of Therapist Experience and Training. Clinical Psychology: Science and Practice, 4: 44–52

Birhanu Haftom, Tehetna Alemayhu, Yohannes Hagos and Awot Teklu (2015): Assessment of Bio-Security Condition in Small-scale Poultry Production System in and Around Mekelle, Ethiopia. European Journal of Biological Sciences 7 (3): 99-102

Bishop O. Ovwigho, Mmereole F.U.C., Udeh I and Akporhuarho P.O. (2009): Comparison of Constraints to Poultry Producers in Delta State Nigeria, International Journal of Poultry Science 8 (5): 480-484

Bisrat Gebremichael Urgessa (2013): Defect Assessment of Ethiopian Hide and Skin: The Case of Tanneries in Addis Ababa and Modjo, Ethiopia, Ethiopian Leather Industry

Development Institute (LIDI), Addis Ababa, Ethiopia. Global Veterinaria 11 (4): 395-398

Bolarinwa B. B. (1998): Evaluation and Optimum Use of Fibrous Ingredients in The Diets Of Broilers. Ph.D.Thesis, University of Ibadan, Ibadan, Nigeria.

Branckaert, RDS and Gueye, E.F. (2000): FAO's Program for Support to Family Poultry Production. http://www.husdry.kvl.dk/htm/tune99/24.branckaert.thm.

Breedt H.T. and Uitenweerde R.T. (2000): Small-Scale Poultry Housing in South Africa. Printed by ARC-ILI, 141 Cresswell Road, Silverton, Pretoria. PP 7-15

Burgos S., Hong Hanh P.T., Roland-Holst D.and Burgos S.A. (2007): Characterization of Poultry Production Systems in Vietnam. International Journal of Poultry Science 6 (10): 709-712

Bush J. (2006): The Threat of Avian Flu Predicted Impacts on Rural Livelihoods in Southern Nation, Nationalities and Peoples Region (SNNPR), Ethiopia. The Food Economy Group, May 2006.

Catootjie Lusje Nalle (2009): Nutritional Evaluation of Grain Legumes for Poultry. PhD Dissertation in Poultry Nutrition submitted to At Massey University, Palmerston North, New Zealand PP 1-2

Charles Olawale Farayola, Anthony Ademola Adeyemo, Stanley Chibueze Nwachukwu and Abdulfatah Yusuf (2013): Extension Strategy Development and Training Needs for Small-scale Commercial Poultry Farmers in Nigeria. J. World's Poult. Res. 3(4): 99-105

Cheeke PR. (2005): Livestock Feeds and Feeding. 3rd ed. Upper Saddle River, New Jersey: Pearson Prentice Hall; 2005.

Chinrasri A. (2004): Poultry Production technology. Apichart printing press. Mahasarakem Province, Thailand. PP 206.

Chou,C.C., Jiang D.D. and Hung Y.P., (2004): Risk Factors For Cumulative Mortality In Broiler Chicken Flocks In The First Week Of Life in Taiwan. Br. Poult Sci., 45: 573-577

Clauer (2010): Small–scale Poultry Production Raising Fowl in Urban Areas. Agriculture Communication and Marketing, the Pennsylvania State University

CSA (Central Statistical Agency) (2013a): Livestock Statistics 2013. CSA, Federal Democratic Republic of Ethiopia, Addis Ababa, Ethiopia

CSA (Central Statistical Agency) (2013b): Population Projection of Ethiopia for All Regions at Woreda level from 2014-2017.August 13, Addis Ababa Ethiopia

CSA (Central Statistical Agency) (2013c): Agricultural sample survey 2012/13. Report on livestock and livestock characteristics, Statistical Bulletin Addis Ababa, Ethiopia, 2: 570.

CSA (Central Statistical Agency) (2016): Livestock and Livestock Characteristics. Federal Democratic Republic of Ethiopia Central Statistical Agency, Agricultural Sample Survey, 2:1-94

Dafwang I. I., Olomu J. M., Offiong S. A. and Bello S. A.(1986): The Effects Of Replacing Fish Meal With Blood Meal In The Diets Of Laying Chickens, Journal of Animal Production Research. 6: 81-92.

Dairo F.A.S. (2005): Assessment of Rumen Content on the Haematological Parameters Of Growing Rabbits: Proc. of 10th Annual Conference of Animal Science Association of Nigeria (ASAN), Sept. 12-15. University of Ado Ekiti, Nigeria. Pp. 301–302.

Dairo, F. A. S., Aina, O. O. and Asafa, A. R. (2005): Performance Evaluation of Growing Rabbits Fed Varying Levels of Rumen Content and Blood Rumen Content Mixture. Nigerian Journal of Animal Production, 32 (1): 67–72.

Das T. K., Mondal M. K., Biswas P., Bairagi B. and Samanta C. C. (2010): Influence of Level of Dietary Inorganic and Organic Copper and Energy Level on the Performance and Nutrient Utilization of Broiler Chickens. Asian-Austtralian journal of animal sciences 23(1) : 82 – 89

Dave Wilson (2007): Soybeans roasting on an open fire. Rodale Institute, America. PP. 1./www.nefarm.org/

Dawit, A., Tamrat, D., Stotaw, F., Nzietcheung, S. and Roy, D. (2008): Overview and Background Paper on Ethiopia's Poultry Sector. Relevance for HPAI Reseasrch in Ethiopia. www.hpai-reserach net. Accessed 06 April 2011.

Deininger, K., & Jin, S. (2006): Tenure security and land-related investment: Evidence from Ethiopia. European Economic Review, 50(5): 1245-1277

Solomon Demeke (1996): Study on Egg Production of White Leghorn under Intensive, Semi- Intensive and Rural Household Conditions in Ethiopia. Livestock Research for Rural Development. 8 (2). Retrieved fromftp.sunset.se/wmirror/www.cipav.org. co/lrrd/l rrd8/2/ethiop1.htm

Desalew, T., Singh, H., Ashenafi, M., Wondimeneh, E. and Tadelle, D. (2013): Study on productive performances and egg quality traits of exotic chickens under village production system in East Shewa, Ethiopia. African Journal of Agricultural Research, 8 (13): 1123-1128.

Devonish, E., Pemberton, C. A., Ragbir, S. (2000). Record Keeping Among Small Farmers In Barbados, Department Of Agricultural Economics And Extension. University of the West Indies, St Augustine, Trinidad and Tobago

Dominguez-Bello M.G., Michelangeli F., Ruis M.C., Garcia A., Rodriguez E .(1994): Ecology of The Folivorous Hoatzin (Opisthocomus hoazin) On The Venezuelan Plains. The Auk, 111 (3): 643-651

Donald D.B. and William D.W. (2002): Commercial Chicken Meat and Egg Production. 5thed. Kluwer Academic Publishers. USA. pp 224-226.

Downes T.E.H., Nourse L.D., Siebrits F.K. and Hastings J.W. (1987): The Relative Nutritive Value of Irradiated Spray-Dried Blood Powder and Heat-Sterilized Blood Meal as Measured In Combination With Whey Protein. South African journal of Animal Science 17(2):55-58

EI Boushy R. Y. and Vanderpoel F. B. (2000): Handbook of Poultry Feed From Waste Processing and Use. 2nd Ed. Netherlands. pp 301- 310

Ekenma Kalu (2015): Poultry Litter/Manure Management Practices in Intensively Managed Poultry Farms in Portharcourt. Journal of Agriculture and Veterinary Science 8(3): 53-58

Ekwuoma, I. (1992): The chemical composition of Rumenal contents of cattle, sheep and goats. Project Report. Department of Animal Production, University of Agriculture, Abeokuta.

El-Deek, A.A, Al – Harthi, M., Yakout, H. M. (2008): Use of Enzymes to Supplement Diets Containing Date Waste Meal for Lohmann White Layers. International Journal of Poultry Science. 7 (4): 397-407

Emaikwu, K.K., Chikwendu, D.O. and Sanni, A.S. (2011): Determination of Flock size in Broiler Production in Kaduna State of Nigeria. Journal of Agricultural Extension and Rural Development. 3 (1): 202-211

Emebet Moredaa and Kidane G. Mesekel (2016): Importance of Traditional, Small Scale and Commercial Poultry Production in Ethiopia: A Review. British Journal of Poultry Sciences 5 (1): 01-08

Emmanuel, B. (1978): Effect of Rumen Content of Fraction Thereon In Performance Of Broiler Birds. J. of poultry science, 19: 13-16.

Engku Azahan E.A., Marini A.M. and Noraziah M (2007): Evaluation on The Effects of Sex On Growth And Carcass Characteristics of Broilers, Kuala Lumpur, Malaysia. J. Trop. Agric. and Fd. Sc. 35(2): 313– 318

Ensminger M.E (1992): Poultry Science. 3rd edition. Danville: Interstate Publishers, Australia. PP 1-469.

Ensminger, M.E., Oldfield J.E. and Heinemann W.W. (1990): Feeds and Nutrition. 2nd Edn. Ensminger Publishing Company, Clovis, CA., USA., Pages: 1552

Esonu B. O., Ogbonna U. D, Anyanwu G. A. and Emenalom O. O. (2006): Evaluation of Performance, Organ Characteristics and Economic analysis of Broiler Finisher Fed Dried Rumen Digesta. Inter. Journal of Poultry Science 5(2): 1116 – 1118.

Esonu B. O., Azubuike J. C., Emenalom O. O., Etuk E. B., Okoli I. C., Ukwu H. O. and Nneji C. S. (2004): Effect Of Enzyme Supplementation On The Performance Of Broiler Finisher Fed Microdesmis puberula Leaf Meal. International journal of poultry sciences 3: 112-114.

Esonu B. O., Azubuike J. C., Udedibie A. B.; Emenalom O. O. Iwuji T. C and Odoemenam V. (2011): Evaluation of the Nutritive Value of Mixture of Fermented Bovine Blood and Rumen Digesta for Broiler Finisher. Journal of Natural Sciences Research 1(4):65-71.

Esonu B.O., Emenelom, O.O., Udedibie A.B.I., Herbert U., Ekpor, C.F., Okoli, I.C. and Iheukwumere, F.C. (2001): Performance and Blood Chemistry Of Weaner Pigs Fed Raw Mucuna (Velvet bean) Meal. Trop. Anim. Prod. Invest 4:49-54.

Esonu, B. O., Ogbonna U. D., Anyanwu G. A. and Emenalom O. O. (2006): Evaluation of performance, Organ characteristics and Economic analysis of Broiler finisher fed Dried Rumen Digesta. Inter. Journal of Poultry Science 5(2): 1116 – 1118.

Etalem Tesfaye , Getachew Animut , Mengistu Urge and Tadelle Dessie (2013): Moringa olifera Leaf Meal as an Alternative Protein Feed Ingredient in Broiler Ration. International Journal of Poultry Science 12 (5): 289-297.

FAO (2007): Worldwide: FAO Warns Of Disease Risks in Commercial Production. Poultry International 46:13

FAO (2010b): Atlas of Philippines, originated by Fisheries and Aquaculture Dept. hppt://www.faoorg/DOCREP/003/W6928E/w6928e1k.htm#TopOfpage Retrieved on 26/4/2010

FAO (2010a): Poultry Meat and Eggs. Viale delle Terme di Caracalla, 00153 Rome, Italy. PP 5-7

FAO (2011): Poultry Production and Its Contributions, News & Features Archive

FAO (2013b): Poultry Development Review. PP 23-45

FAO (2012): Global Poultry Trends. The Poultry Site. PP1-5 http://.thepoultrysite.com/articles/2515/global-poultry-trends-2012-poultry-increases-its-share-of-global-meat-production

FAO (2013a): Global Poultry Trends- The Poultry Site. PP 1-7 http://www.thepoultrysite.com/articles/2928/global-poultry-trends-2013-asia-produces-onethird-of-worlds-broilers

FAO (2013): The State of Food Insecurity in the World. Pp 1-6 http://www.fao.org/docrep/018/i3458e/i3458e.pdf

FAO (1996): Food and Agricultural Organization of the United Nations. Production Year Book, Volume 48, Rome, Italy.

FAO (2007): Poultry sector country review, Animal Production and Health Division, Emergency center for trans-boundary animal diseases socio economics, production and biodiversity unit, Food and Agriculture Organization of the United, Nations, Rome., Italy. Avialable at ftp://ftp.fao.org/docrep/fao/011/ai320e/ai320e00.pdf

FAO (2008): The Structure, Marketing And Importance Of The Commercial And Village Poultry Industry: An Analysis Of The Poultry Sector In Ethiopia.Animal Production and Health Division.

FAO (2003): Egg Marketing. FAO Agricultural Services Bulletin 150, Rome, Italy, PP 1-10

Faria PB., Bressan MC., Souza XR de., Rossato LV., Botega LMG., Gama LT da., (2010): Carcass and Parts Yield of Broilers Reared Under a Semi-Extensive System. Brazilian Journal of Poultry Science, 12 (3): 153 - 159

Farooq M, Mian M. A, Durrani, F. R and Syed M. (2002): Egg production performance of commercial laying hens in Chakwal district, Pakistan. Livestock Research for Rural Development, 14 (2).

Fred Nimoh, Addo Kwasi and Enoch Kwame Tham-Agyekum(2011): Effect of formal credit on the performance of the poultry industry: The case of urban and peri-urban Kumasi in the Ashanti Region,Ghana. Journal of Development and Agricultural Economics Vol. 3(6): 236-240

Garret H.E. and Woodworth R.S. (1969): Statistics in Psychology and Education, Vakils, feffer and Simons Pvt. Ltd., Mumbai.

Geidam Y.A., Bukar M.M. and Ambali A.G. (2006): Chick Quality Control: A Key to Sustainable Poultry Production in Nigeria. Nig. Vet. J., 27: 1-6.

Ghasura R.S., Sheikh A.S, Aswar B.K, Rajpura R.M., Charan Rohit (2013): Constraints Faced By Poultry Farm Entrepreneurs in Banaskantha District, Gujarat. International Journal of Rural Studies (IJRS), 20 (2): 1-5

Gohl, B. (1981): Tropical feeds: Feed information summaries and nutritive value: FAO Animal production series, FAO, Rome, Italy. Pp. 301 – 405.

Grain (2006): Fowl Play: The Poultry Industry's Central Role in the Bird Flu Crisis. Grain Briefing.(available at http://www.grain.org/briefings_files/birdflu2006-en.pdf).

Gueye E.F. (2003): Poverty Alleviation, Food Security and the Well-Being of the Human Population Through Family Poultry in Low Income Food-Deficit Countries. Senegalese Institute of Agricultural research (ISRA), B.P.2057, Dakar-hann, Senegal.

Guéye E.F. (2004): Gender Aspect in Family Poultry Management Systems In Developing Countries. www.fao.org/ag/againfo/themes/en/infpd/documents/papers/2004/12gender318.pdf . (Accessed 20 th , September, 2008).

Hailu Mazengia (2012): Review on Major Viral Diseases Of Chickens Reported in Ethiopia. Journal of Infectious Diseases and Immunity Vol. 4(1), pp. 1-9

Hamra C.F. (2010): An Assessment of the Potential Profitability of Poultry Farms: A Broiler Farm Feasibility Case Study.Msc thesis submitted to the Faculty of The University of Tennessee at Martin, South Lebanon. Pp 1-43

Hassan J. F.,Abdulmelk, M. E., Ogundipe S. O. & Adeyinka I. A. (1993): Effect of Age On Utilization of High Fibre Diet By Egg-Type Chicks. Proc. 18th A. Con! Nig. Soc. Anim. Prod., Owerri-Nigeria. pp. 37.

Henn JD., Bockor L., Ribeiro AML., Coldebella A. and Kessler A. M. (2014): Growth and Deposition of Body Components of Intermediate and High Performance Broilers. Brazilian Journal of Poultry Science, 16 (3): 319-328

Horton H.R., Moran L.A., Ochs R.S., Rawn, J.D. and Schrimgeour A. (2002): Principles of Biochemistry. 3d revised. Edition Prentice Hall, Upper Saddle River, NJ.

Hungate R.E. (1966): The Rumen and Its Microbes. Academic Press, New York and London. PP. 533

Ibrahim Kayode Banjoko, Abraham Falola, Fatai Bolaji Babatunde, Rukayat Atolagbe (2014): Assessment of Risks and Uncertainties in Poultry Farming in Kwara State, Nigeria. Science, Technology and Arts Research Journal Sci. Technol. Arts Res.J. 3(4): 64-70

Ja'afar-Furo M.R. and Gabdo B.H. (2010): Identifying Major Factors of Poultry Production as Sustainable Enterprise among Farmers Using Improved Methods in Rural Nigeria. International Journal of Poultry Science 9 (5): 459-463

Jacob J.P., Butcher G.D., and Mather F.B. (1998): Vaccination of Small Poultry Flocks, University of Florida, Gainesville, 32611.

Javanovic M. and Cuperlovic M. (1977): Nutritive Value Of Rumen Contents For Monogastric Animals. Animal and Feed Science Technology, 2: 351-360.

Jensen H. A. and Dolberg F. (2003): A Conceptual Tool for Using Poultry as a Tool in Poverty Alleviation. Revised Version. Paper delivered at the International Conference on Staying Poor: Chronic Poverty and Development Policy, IDPM, University of Manchester.

Jones T. A., Donnelly C. A., and Stamp Dawkins M. (2005): Environmental and Management Factors Affecting the Welfare of Chickens on Commercial Farms in the United Kingdom and Denmark Stocked at Five Densities. Poultry Science 84:1155–1165

Joni M. Rynsburger (2009): Physiological and Nutritional Factors Affecting Protein Digestion in Broiler Chickens. MSc thesis Submitted to the College of Graduate Studies and Research in the Department of Animal and Poultry Science, University of Saskatchewan, Saskatoon, SK, Canada. PP 1-2

Jurgens M. H. (1978): Animal Feeding and Nutrition. 4th ed. Kendall/Hunt Publishing Company, Iowa, USA.

Kamran Z., Mirza M. A., Haq A., and Mahmood S.. (2004): Effect of Decreasing Dietary Protein Levels With Optimal Amino Acids Profile On The Performance of Broilers. Pak. Vet. J. 24:165-168.

Kazooba T. C. (2006): Causes of Small Business Failure in Uganda: A Case Study from Bushenyi and Mbarara Towns. African Studies Quarterly, 8(4). Retrieved from http://web.africa.ufl.edu/asq/v8/v8i4a3.htm

Kiros Abebe (2011): Evaluation of Sugar Syrup as a Partial Substitute for Maize in Broilers' Ration. MSc thesis Submitted to the School of Graduate Studies in Haramaya University, Ethiopia. pp 24-32

Lawrence Yaw Kusi, Senyo Agbeblewu, Isaac Kwadwo Anim, Kwamena Minta Nyarku (2015): The Challenges and Prospects of the Commercial Poultry Industry in Ghana: A Synthesis of Literature. International Journal of Management Sciences, 5(6): 476-489

Leeson S., Caston L. and summers J.D. (1996): Broiler Response to Diet Energy. Poultry Science Journal. 75:529-535.

Li D.C. (2009): Better Utilization of By-Products from the Meat Industry Department of Animal Science. National Chung-Hising University Taichung Taiwan Roc.www.agnet.org/library/teb/515/eb/515.pdf Retrieved on 4/11/2009.

Lussier R. N. (1996): Reasons Why Small Businesses Fail: And How To Avoid Failure. The Entrepreneur Executive, 1(2): 10-17.

Mack S., Hoffmann D. and Otte J. (2005): The Contribution of Poultry to Rural Development. World's Poultry Science Journal, 61(1): 7–14.

Mandung P.D. (1994): The effect of graded level of dried bovine rumen content on the performance of weaner rabbits. B.Sc. Thesis submitted to the Department of animal Production, University of Agriculture, Makurdi, Nigeria.

Mann I. (1984): High protein from Blood and Ruminal Content Using a Solar Drier. World Anim. Rev. 50:24-28.

Martinez W. S. (1999): Vertical Coordination In The Pork and Broiler Industries: Implications For Pork And Chicken Products. Agricultural Economic Report No 777, U.S. Department of Agriculture, Washington D.C.

May J.D., Malone G.W., Chaloupka M.J.W. and Huff W.E. (1982): The Effect of Floor Type on the Development of Breast Blisters and Feather Follicle Infections in Broilers. Poultry Science 61: 250-254

McDonald P, Edwards R A, Greenhalgh J F D and Morgan C A. (2002): Animal Nutrition, India, 6th ed, Pearson Education Plc. Ltd Publishers, 2002.

Mekonnen G/Egziabher Muhiye (2007): Characterization of The Smallholder Poultry Production and Marketing System of Dale, Wonsho and Loka Abaya Weredas of SNNPRS,Ethiopia. MSc. Thesis submitted to the Department of Animal and Range Sciences, Hawassa University, Ethiopia

Melesse A., Dotamo E., Banerjee S., Berihun K. and Beyan M. (2013): Studies on Carcass Traits, Nutrient Retention and Utilization of Koekoeck Chickens Fed Diets Containing Different Protein Levels with Iso-Caloric Ration. J Anim Sci Adv, 3(10): 532-543

Melkamu B.Y. (2013): The Effect of Feeding Different Levels of Dried Tomato Pomace on the Performance of Rhode Island Red (RIR) Grower Chicks. International Journal of Livestock Production, 4(3): 35-41.

Mgbakor Miriam N., Uzendu Patrick O. and Ndubisi Divine O. (2014): Sources of Agricultural Credit to Small-Scale Farmers in EZEAGU Local Government Area of Enugu State, Nigeria. IOSR Journal of Agriculture and Veterinary Science 7(8):1-8

Michael Temesgen Mengistu (2008): Assessment on Husbandry Practices and Production Performance of Briolers under Smallholder Management in and Around Debrezeit Town, Ethiopia. MSc thesis submitted to the School of Graduate Studies of Addis Ababa University PP.39-40.

Mobley R. and Kahan T. (2007): Practical Management of Health Issues in a Poultry Production System: Symptoms, Sources, and Prevention of Common Diseases, Florida A&M University, Tallahassee, Florida.

Moges F., Azage T. and Tadelle D. (2010b): Indigenous Chicken Production And Marketing Systems In Ethiopia: Characteristics and Opportunities For Market-Oriented Development. IPMS (Improving Productivity and Market Success) of Ethiopian Farmers Project Working Paper 24: Nairobi, Kenya, ILRI.

Mohamed A, Hailemariam S, Gebremedhin G, Gebeyew K (2016): Challenges and Opportunities of Small Scale Poultry Production System in Jigjiga Zone, Somali Regional State, Ethiopia. Poult Fish Wildl Sci 4:144.

Mohammed G., Igwebuike J.U., Ubosi C.O. and Alade N.K. (2008): Comparative Study of The Nutrient Composition, Amino Acid Profile And Microbial Assay Of Fresh And Dry Cattle, Camel, Sheep, And Goat, Rumen Contents. Proc. of the 13 Ann. Conf. of .Anim.sci.Assoc. of Nig. (ASAN) Sep 15-19, 2008. PP 518-520

Mohammed G., Igwebuike J. U. and Alade N. K. (2011): Performance of Growing Rabbits Fed Graded Levels of Bovine Blood-Rumen Content Mixtures. Agric and Biol. J. North America. 2 (4): 720-723

Mohammed G., Igwelbuke J.U. and Kwari I.D. (2005): Performance of Growing Rabbits Fed Graded Levels of Goat Rumen Content. Global Journal of Pure and Applied Sciences, 11 (1):39– 43.

Moreki J C. (2010): Opportunities and Challenges for the Botswana Poultry Industry in the 21st Century: A Review. Livestock Research for Rural Development 22 (5):1-5

Muhammad M., Muhammad L.U., Ambali A.G. and Mani A.U. (2010):A Survey of Early Chick Mortality on Small-Scale Poultry Farms in Jos, Central Nigeria. International Journal of Poultry Science 9 (5): 446-449

Muhammad Y, Ousuf K, Han, Muhammad A Rshad , Muhammad S Hahid, Mahmood and Ftikhar H Ussain (2011): Epidemiology of Newcastle Disease in Rural Poultry in Faisalabad, Pakistan. Int. J. Agric. Biol., 13: 491–497

Murphy M. (1996): Small Business Management. London: Financial Times and Pitman Publishing.

Musa H.H., Chen G.H, Cheng J.H., Li B.C. and Mekki, D.M. (2006): Study on Carcass Characteristics of Chickens Breeds Raised under the Intensive Condition. International Journal of poultry Science 5(6):530-533.

Musharaf, N.A. (1990): Feeding and Feed Resources. In: Smallholder Rural Poultry Production 9-13 October 1990 Thessaloniki Greece. Technical Centre for Agricultural and Rural Corporation. Wageningen. Netherlands, 1: 145-160

NABC (National Agricultural Biosecurity Centre) (2004): Carcass Disposal: A Comprehensive Review. Report written for the USDA Animal and Plant Health Inspection Service. Kansas State University, USA.

Nahashon S. N., Adefope N., Amenyenu A. and Wright D. (2005): Effect of Dietary Metabolisable Energy and Crude Protein Concentrations on Growth Performance And Carcass Characteristics of French Guinea Broilers. Poultry Science Journal 84: 337-344

Nath B.G., Pathak P.K. and. Mohanty A.K. (2012): Constraints Analysis of Poultry Production at Dzongu Area of North Sikkim in India. Iranian Journal of Applied Animal Science (2012) 2(4), 397-401

Nebiyu Yemane, Berhan Tamir and Ashenafi Mengistu (2016a): Constraints, Opportunities and Socio-Economic Factors Affecting Flock Size Holding in Small-scale Intensive

Urban Poultry Production in Addis Ababa, Ethiopia. Agric. Biol. J. N. Am., 2016, 7(3): 146-152

Nebiyu Yemane, Berhan Tamir and Ashenafi Mengistu (2016b): Poultry Waste Management Practices under Small-scale Intensive Urban Poultry Production in Addis Ababa, Ethiopia. Academia Journal of Agricultural Research 4(4): 212-217

Nigussie Dana (1999): On-Farm Evaluation of Rhode Island Red (RIR) and Local Chickens under Different Management Regimes in the Highland of Ethiopia. MSc Thesis, Department of Animal Nutrition and Management, SLU, Sweden.

Nigussie Dana, Liesbeth H. Van der Waaij, Tadelle Dessie, and Johan A. M. van Arendonk (2010): Production Objectives and Trait Preferences of Village Poultry Producers of Ethiopia: Implications For Designing Breeding Schemes Utilizing Indigenous Chicken Genetic Resources . Trop Anim Health Prod. 42(7): 1519–1529.

North M.O. (1981): Commercial chicken. Production Annual. 2nd Edition, AV., publishing company I.N.C., West post Connecticut, USA

NRC (National Research Council) (1994): Nutrient Requirements of Poultry. 9th Revised Edition. National Academic Press, Washinton DC.

NRC (National research council) (1984): Nutrient requirement of poultry, 8th edn. National Academy of Science, Washington DC. PP 35-47

Nusirat Elelu, Jaji Z., Badiru A., Olowoleni F. and Ambali1A.G. (2012): Assessment of Management and Health Practices in Some Selected Poultry Establishments in Ilorin, Kwara State, Nigeria. International Journal of Poultry Science 11 (8): 524-528

Nzietchueng S. (2008): Characterization of Poultry Production Systems and Potential Pathways for the Introduction of Highly Pathogenic Avian Influenza In Ethiopia. Draft Report. International Livestock Research Institute.

Odunsi A. A. (2003): Blend of Bovine Blood and Rumen Digesta as a Replacement for Fishmeal and Groundnut Cake in Layer Diets. International Journal of Poultry Science 2 (1): 58-61

Ogbe A. (2000): The Management and Disease Problems Associated With Rearing Chickens In Jos-Plateau State. Proceedings of 37 the annual congress of the Nigerian Veterinary Medical Association, Uyo , 6-10 Nov., 18-19.

Ogunjumo S. O. (2001): Deep litter Vs Battery cage system: A comparative Analysis. AgVet International, 2(1): 8-1

Ojano-Dirain C. P., and Waldroup P. W. (2002): Protein and Amino acid Needs of Broilers in Warm Weather: A Review. Int. J. Poult. Sci. 1:40-46.

Ojebiyi O. O., Farinu G.O. and Babatunde G.M. (2010): Nutritive Value and Chemical Composition of Three Differently Processed Cassava Peel And Blood Meal As A Potential Livestock Feed Ingredients. J. Agric. Forestry and Soc. Sci. 8 (1): 195-207

Ojebiyi O.O. and Saliu A.S. (2014): Effects of Feeding Bovine Rumen Content-Blood Meal (50:50) Mixtures on Performance And Slaughter Characteristics of Growing Rabbits. The Journal of Animal & Plant Sciences, 24(2): 2014, Page: 430-434.

Ojo S.O., (2003): Productivity and Technical Efficiency of Poultry Egg Production in Nigeria. Int. J. Poult. Sci.,2: 459-464.

Okantah S. A. Aboe P. A. T., Boa-Amponsem K., Dorwar. P. T. and Bryant M. J , (2003): Small-scale Chicken Keeping in Peri-urban Accra and Kumasi. Final Technical Report of United Kingdom Department for International Development (DFID)-funded Project 74pp, DFID. R7631, Livestock Production Research Programme, Achimota, Ghana.

Okoh S. O., Rahman S.A. and Ibrahim H.I. (2010): Gender Participation in Commercial Poultry Production in Karu and Lafia Areas, Nasarawa State, Nigeria. Livestock Research for Rural Development 22 (9):1-5

Okoli I. C., Anyaegbunam C. N., Etuk E. B., Opara M. N., and Udedibie A. B. I.(2005): Entrepreneurial Characteristics and Constraints of Poultry Enterprises In Imo State, Nigeria. Journal of Agriculture and Social Research (JASR) Vol. 5 (1), 25-32

Okorie K. C. (2005): The Effects of Dried Pulverized Rumen Content on the Performance, Carcass And Organ Characteristics Of Broiler Finisher. Animal Production and Resource Advances. 2: 96-100

Olomu J.M. (1995): Monogastric Animal Nutrition. Principles and Practice. A Jachem Publication, Benin City. Pp 164-177.

Olukayode M., Babafunso S. and Segun A. (2008): Conversion of Abattoir Wastes Into Livestock Feed: Chemical Composition of Sun-Dried Rumen Content Blood Meal And Its Effect on Performance of Broiler Chickens, Conference on International Research on Food Security, Natural Resource Management and Rural Development University of Hohenheim, Nigeria. pp 1-10

Omoruyi S. A., Orhue, U. X., Akerobo A. A., Aghimien C. I. (1999): Prescribed Agricultural Science for Senior Secondary Schools, Revised Edition, Idodo Umeh Publishers Limited, Benin City.

Omotosho O.A. and Ladele A.A. (1988): Management Problems In Large Scale Poultry Business In Nigeria.Farm Manage. Nig. J., 3: 27-35.

Onifade A. A. (1993): Comparative Utilization of Three Dietary Fibres In Broiler Chickens. PhD. Thesis, University of Ibadan, Nigeria.

Onu P. N. (2007): The Influence of Heat- Treated Sheep Manure on the Performance, Carcass Characteristics and Economics of Production of Starter Broilers. Journal of Animal and Veterinary Advances 6(11): 1323- 1327

Onu P.N., and Okongwu S.N. (2006): Performance Characteristics And Nutrient Utilization of Starter Broilers Fed Raw And Processed Pigeon Pea (Cajanus cajan) Seed Meal. International Journal of Poultry Science, 5(7): 693–697.

Onu P.N., Otuma M.O., Odukwe C.A. and Aniebo A. O. (2011): Effects of Different Levels of Bovine Blood / Rumen Content Mixture on Productive Performance, Carcass Characteristics and Economics of Production of Finisher Broilers. International Journal of Food, Agriculture and Veterinary Sciences: 1 (1): 10-16.

Opara C. C., (1996): Studies on the Use of Alchornia Cordifolia Leaf Meal as Feed Ingredient in Poultry Diets. MSc Thesis, Federal University of Technology, Owerri, Nigeria. PP 11-15

Pica Ciamarra U. and Otte J. (2010): Poultry, Food Security and Poverty in India: Looking beyond the Farm-gate. World's Poultry Science Journal, 66(2): 309–320.

Poggio M. (2006): Farm Management Records, Available: www.srdc.gov.au, retrieved on 4th November, 2008, 9:20 GMT.

Pollock D. L. (1997): Maximizing Yield. Poult. Sci. 76:1131-1133.

Pollock D. L. (1999): A Geneticist"S Perspective From Within a Broiler Primary Breeder Company. Poult. Sci. 78:414-418.

Pond W. G (1989): Plant Utilization by Pigs. Comm. Agric. Bur. 10:13-15

Pond W. G., Dickson J. S. & Itacheck W. M. (1989): Comparative Response of Swine and Rats to High Fibre or High Protein Diets. Journal of Animal Science. 67: 716- 723.

Primefact (2007): Small-scale Poultry Keeping, Housing layers. 3rd edition. State of New South Wales pp 1-2 www.dpi.nsw.gov.au/primefacts

Rahman S (2015): Management of Broiler Farms in Aizawl District of Mizoram, India. Livestock Research for Rural Development. 27(61):1-4.

Rajendran K. and Samarendu Mohanty (2003): Comparative Economic Analysis And Constraints In Egg Production Under Cage Vs. Deep Litter Systems Of Rearing In India. International Journal of Poultry Science 2 (2): 153-158

Ranjhan S. K. (2001): Animal Nutrition in the Tropics, 6th Ed. Vikas Publishing House. PVT Ltd., New Delhi, pp. 209, 466.

Razzaq A., Ali T., Saghir A., Arshad S. and Cheema A.(2011): Training Needs Assessment of Poultry Farmers In Tehsil Faisalabad.The Journal of Animal & Plant Sciences, 21(3):629-631

Reddy D.C. (1991): Poultry Production in Developing Versus Developed Countries. World Poultry-Misset 7 (1):8-10.

Reiter K. and Bessei W. (2000): Effect of Stocking Density of Broilers on Temperature in the Litter and At Bird Level. Arch. Geflugelkd 64:204–206.

Rios Rincon, F. G., Bermudez-Hurtado R. M. and Estrada-Angulo A. (2010): Dried Ruminal Contents as a Substitute for Alfalfa Hay in Growing-Finishing Diets for Feedlot Cattle. Journal of Animal and Veterinary Advances 6: 505- 508

Roberts M.B.V. (1976): Biology A Functional Approach. Second edition. The English Language Book Society and Nelson. PP 162.

Robyn G Alders (2012): Challenges and Opportunities for Small-Scale Family Poultry Production In Developing Countries, 24th World´s Poultry Congress 5 - 9 August - 2012 • Salvador - Bahia – Brazil

Rosegrant M W, Fernandez M, Sinha A, Alder J, Ahammad H, de Fraiture C, Eickhout B, Fonseca J, Huang J, Koyama O, Omezzine A M, Pingali P, Ramirez R, Ringler C,Robinson S, Thornton P, van Vuuren D, Yana-Shapiro H, (2009): Looking into the Future for Agriculture and AKST (Agricultural Knowledge Science And Technology) in Agriculture at a Crossroads (eds. B D McIntyre, H R Herren, J Wakhungu, R TWatson), Island Press, Washington DC. PP 307-376

Safari M. Kinung'hi, Getachew Tilahun, Hafez M. Hafez, Moges Woldemeskel, MosesKyule, Matthias Grainer and Maximillian P.O.Baumann (2004): Assessment of Economic Impact Caused by Poultry Coccidiosis in Small and Large Scale Poultry Farms in Debre Zeit, Ethiopia. International Journal of Poultry Science 3 (11): 715-718

Sainsbury David (1993): Poultry Health and Management. 3rd edition. Wiley-Blackwell publisher, London, England, pp 1- 220

Salinas-Chavira J., Dominguez-Munoz M. Bernal-Lorenzo R., Garcia-CastilloR. F. and ArzolaAlvarez C. (2007): Growth Performance and Carcass Characteristics of

Feedlot Lambs Fed Diets with Pig Manure and Rumen Contents. Journal of Animal and Veterinary Advances 6(11): 1323- 1327

SAPPLPP (South-Asia Pro-Poor Livestock Policy Programme) (2010): Small- scale Poultry Farming and Poverty Reduction in South Asia: From Good Practices to Good Policies in Bangladesh, Bhutan and India

Saritha pujari (2015): Process of Culling in Poultry Farming. http://www.yourarticlelibrary.com/zoology/process-of-culling-in-poultry-farming /24096/ PP1-5

SAS (Statistical Analysis Systems, Version 9.2), (2008): Statistical Analysis Systems for mixed models. SAS Institute Inc, Cary, NC, USA.

SASSO C44 broiler Breeds: http://www.sasso.fr/Best Chicken Breeds Alternative Growth- for Free Range Poultry Breeding. html, retrieved on 20/03/ 2016).

Scanes C.G., Brant G. and Ensminger M.E. (2004): Poultry Science. 4th ed. Pearson Prentice Hall. New Jersey. pp: 105-106

Shim K. F., Chen T. W., Teo L. H. & Khin M. M. (1989): Utilization of Wet Spent Grains by Ducks. Nutrition reports international, 40: 261-266.

Simeamelak MT, Yohanse B, Amare A. (2011): Introduction and Evaluation of Modified Hay-Box Brooder, Fayoumi Chicken and Layers Housing, Addressing Small-Scale Semi-Intensive Poultry Farming at Beresa Water shade, Gurage Zone, Ethiopia. Int. J. Livestock Prod. 2(8):124-132

Sklan D and Noy Y. (2003): Crude Protein and Essential Amino Acid Requirements in Chicks during the First Week Post Hatch. British Poultry Science.44: 266 – 274

Smith A.J. (1990): The Integration of Rural Production in to the Family Food Security System. CTA- Seminar Proceedings on Smallholder Rural Poultry Production. 9-13 October, 1990. Thessaloniki, Greece

Smith T.W. (1999): Sanitation, Cleaning and Disinfectants, Mississippi State University.

Smith J. Anthony (1993): The Tropical Agriculturalist Poultry Edition.

Solomon Demeke (2007): Poultry Sector Country Review, FAO Animal Production and Health Division, Ethiopia, PP: 1-48

Sonaiya E. B, Brackets R. D and Gluey E .F, (1999): Research and Development Options for Family Poultry. First INFPD/FAO Electronic Conference on Family Poultry:7 December 1998-5 March 1999.

SPSS (2012): Statistical Package for Social Science, SPSS 20 for Windows. SPSS Inc. Chicago, Illinois

Stahler P. A., (1970): Production of Valuable Animal Feed Components through Processing of the Rumen Content of Slaughtered Cattle and Products, Publication number US3545977A

Stephen Carroll (2012): Best Practice Management for Meat Chicken Production in New South Wales –Manual 2 (Meat Chicken Growing Management).ISBN 978 1 74256 250 6.PP 4-20

Steven Leeson and John D. Summers (2008): Commercial Poultry Nutrition. Third Edition, Published By Nottingham University Press, England. PP: 230-289

Subhash Sarker, Joynal Abedin and Fakhrul Islam (1999): Performance of Commercial Poultry Farms: A profitability and efficiency analysis. Bangladesh J. Agric. Econ., 22: 63-75.

Tabina Khawaja, Sohail Hassan Khan and Noor Nabi Ansari (2007): Effect of Different Levels of Blood Meal on Broiler Performance during Two Phases of Growth. International Journal of poultry science, 6 (12): 860-865

Tadelle D., Alemu Y. and Peters K.J. (2000): Indigenous chicken in Ethiopia: Genetic potential and attempts at improvement. World Poult. Sci. J., 56: 45-54.

Tadelle D.; Nigusie D.; Alemu Y and Peters K. J., (2003): The Feed Resource Base and Its Potentials for Increased Poultry Production in Ethiopia. World's Poultry Science Journal, 58: 77-87 Cambridge University Press.

Tembachako Deliwe, Chisango Future Fortune T. and Kwesu Ishmael (2015): Assessment of Entrepreneurial Skills for Smallholder Broiler Producers in Zimbabwe: A Case of Mazowe District in Mashanaland Central Province. The International Journal Of Science & Technoledge, 3(9):235-241

Thirumalesh T., Ramesh B.K. and Suresh B.N. (2012): Influence of Season on Nutrient Intake and Performance of broilers In Arid Region of Karnataka. Indian Journal of Animal Resources, 46 (1): 78 – 81

Togun V.A., Farinu G.O., Ojebiyi O.O., Awotunde A.I. (2009): Effect of Replacing Maize With A Mixture of Rumen Content And Blood Meal on the Performances of Growing Rabbits: Initial Study With Mash Feed. World Rabbit Sci. 17: 21- 26

Torimiro D.O., Lawal B.O. and Agbelemoge A. (2002): Comparative Study of Cooperative and Non-Cooperative Poultry Farmers in Ijebu Division of Ogun State, Nigeria. NigerianJournal of Rural Sociology, 3: 33-42

Tukur H.M., Maigandi S.A. and Mohammed A.A. (2001): Effect of Different Drying Methods in Chemical composition of Forestomach Digesta. Proceedings of the 25th Annual Conference of the Nigerian Society of Animal Production. Vol. 26,

Uduak Akpabio, Jacob KP Kwaga, Junaidu Kabir, Veronica J umoh, Otalu Jr Otalu (2014): Assessment of Some Poultry Management Practices in Kaduna State, Nigeria. World J Public Health Sciences; 3(1):1-4

Umunna M.O., Adeeko A., Onifade O.T., Adigun O.S. and Apapa A.N. (2012): Poultry Farmers' Access to Extension Services in Atisbo Local Government Area of Oyo State, Nigeria. African Journal of Basic & Applied Sciences 4 (6): 221-225

Van Eekeren N., Maas A., Saatkamp H.W., Verschuur M. (2006): Small-scale Chicken Production. Fourth revised edition: 2006. Agromisa Foundation and CTA, Wageningen, the Netherlands.

Veldkamp T., Kwakkel R.P., Ferket P.R. and Verstegen M.W.A. (2005): Growth response to dietary energy and lysine at high and low ambient temperature in male turkeys. Poultry Science Journal 84: 273-282.

Veldkamp T., Kwakkel R.P., Ferket P.R. and Verstegen M.W.A. (2005): Growth Response to Dietary Energy and Lysine at High And Low Ambient Temperature in Male Turkeys. Poultry Science Journal 84: 273-282.

Waheed Attia and Eltaieb Ibrahim (2005): Inclusion of Some Wastes in Rabbit Diets. Department of Animal Production, Faculty of Agriculture, Alazhar University.pp 14-26.

WFP (World Food Program) (2014): Comprehensive Food Security and Vulnerability Analysis (CFSVA), Ethiopia, PP 8-9

White E.P. and Wadak I. (2002): Evaluation of rumen content on the growth performance of weaner rabbits. Proc. 7th Ann. Conf. Anim. Sci Ass. Of Nig. (ASAN). Sept. 16 – 19, 2002. University of Agric. Abeokuta, Nigeria, pp. 143-146.

Wijnands J.H.M, Napol Dufera, Lute J.C.M, Van Loo E.N. (2011): Ethiopian Soybean and Sunflower Value Chains: Opportunities and Challenge, Addis Ababa ,Ethiopia, pp1-20

Wikipedia, the Free Encyclopaedia (2010): Blood. http://en.wikipedia.org/wiki/blood

Wiseman J. (1987): Feeding of Non-Ruminant Livestock. Butterworth and C.Ltd. pp. 370

With L. (2001): Problems Associated with Hatching Coab500 Broiler Chicks in New Zealand conditions http://www.jcu.edu.au/school/bms/avpa/avpa_NZ_2001/. Accessed 9 July, 2007

WRC (Water Research Commission) (1990): The Water Research Commission report by the Cape Water Programme, CSIR, and Stellenbosch.

Yusuf T.M., Tiamiyu S.A. and Aliu R.O. (2016): Financial analysis of poultry production in Kwara State, Nigeria. African Journal of Agricultural Research, Vol. 11(8: 718-723

Zeitler M.H., Kirchgessner M. and Schwarz F.J. (1984): Effects of Different Proteins and Energy Supplies on Carcass Composition of Carp (Cyprinus carpio, L.) Aquaculture, 36: 37-48.

8. APPENDICES

Appendix 1. Questionnaire Used in the Study

Addis Ababa University

College of Veterinary Medicine and Agriculture

Department of Animal Production Studies

PhD Program in Animal Production

Interview Questions for Producers

I. Management Practices of small-scale farms

A. Household characteristics

Name of the farm_____

1) Sex
   1. Male 2. Female
2) Age
   1. 15-30 2. 31-45 3. 46-60 4. >60
3) Marital Status
   1. Married 2. Unmarried 3. Divorced 4.Widowed
4) Estimated average family size
   1. 1-3 2. 4-6 3.7-9 4. >6
5) Do you have any experience in poultry production
   1. Yes 2.No
6) How many experience years do you have
   1. 1-3 2. 4-6, 3. >more than 6
7) How many members do you have
   1. 1-3 2. 4-6 3. >6
8) What is your members sex composition
   1. Male_____ 2. Female_____
9) Which one is more involved in farm
   1. Male, 2. Female,
10) How many times per week
   1. 0 2. 1-2 3. 3-4 4. 5-7
11) Which one has the role on routine activity for poultry keeping?

1. Member of the farm 2. Family labour 3. Hired labour

12) How much time (approx.) in hr. do you spend each day on poultry keeping ___?

13) How many workers involved per day

1. 1-3 2. 4-6 3. more than 6

14) The educational level of each member

1. Layman 2. Read & write 3. 1-4 4. 5-8 5. 9-10 6. 11-12

7 . Diploma 8. Degree

15) Have you assigned the worker?

1. Yes 2.No

16) How many in number

1. 1-3 2. 3-6 3. 7-9 4.>9

17) What is your religion

1. Orthodox 2. Protestant 3. Muslim 4. Others, specify_____

18) Ethnic groups_____

19) Occupation (major_____)

B. Production type

1) Which type of production you run?

1. Egg type (breed___) 2. Meat type (breed____) 3. Dual (breed_____)

2) Which age group of poultry you rear

1. Starter (0-8 weeks) 2. Grower (9-20 weeks) 3. Layer 4. Broiler 5. Breeder

3) Flock Composition

Chick	
Male	Female

C. Source of chicken

1) Source of chicken

1. Privet farm 2. Government farm

2) What is the name of the farm for your poultry source_____
3) Number of flocks entered----------
4) Is there chicken replacement in the farm?
    1. Yes 2. No
5) Foundation of replacement stock
    1. Purchase 2. Inherited 3. Hatched 4. Other_____
6) What is the fate of replaced chicken
    1. Marketing 2. Home consumption 3. Gift to kin 4. Others

C. Housing

1) What type of management system do you practice for your poultry rising?
    1. Extensive 2. Intensive 3. Semi-intensive 4.Others
2) What type of poultry houses do you have
    1. Deep litter 2. Cage system
3) If you have the deep litter system, the floor management is ?
    1. Deep litter with concrete floor 2. Deep litter with soiled floor 3.others specify_____.
4) Area of the in floorm2_____
5) Number of opening sides for the poultry house_____
6) Orientation of the house
    1. East-west 2. North-south 3.other possible sided
7) Housing density and lighting management

Class	Type of house	No of birds/m^2	Lighting in hrs.
Starter			

8) The chicken house was made of?
    1. Totally cemented block 2. Totally muddy 3 Partly cemented block and partly muddy 4. If others, specify_____
9) What is the bedding material of your house floor?

1. Straw, specify_____2. Sawdust 3. Wooden shivering 4. other, specify_____

10) How often do you clean the house?

1. Daily 2 weekly 3. Monthly 4. once per production cycle

11) Which one does you used as disinfectant?

1. Formalin only 2. Formalin and Berekina 3 Berekina only

12) What system do you use when you receive the new flock of chicks in your poultry house?

1. All in all out 2. At any time 3. If other ways, specify_____

13) How many days in one production per cycle took under your farming condition? __

14) Does the house have enough ventilation?

1. Yes 2. No

15) Degree of ventilation access for the house

1. Bad 2.good 3. Very goods 4. Excellent

D. Feed & Feeding Strategy

1) Do you feed commercial feed (concentrates)? 1.Yes 2.No

2) If yes what type?

1. Commercial feeds only 2.On farm produced feeds only 3. Both Commercial plus farm produced 4.House hold wastes (kitchen wastes) 5. Others (specify)_____

3) Where is your feed source

1. Factories 2. Retailers 3. Commercial farms
4. Government farms 5. Feed mills 6. Others specify

4) What is the name of your feed source_____

5) What type of feed mush you provided

Feed type	Amount	price
Starter mash		

6) Have you know the nutrient content of the feed

1. Yes 2. No

7) Do you know the amount of feed offered per bird

1. Yes 2. No

8) If yes how many grams of feed offered per bird _____

9) How many times you offered per day

Frequency	**Morning**	**Afternoon**	**Evening**	**At mid night**
Once				
twice				
thrice				
More than threes				

10) How many feeding trough do you have _____

11) Do you have feed store

1. Yes 2. No

12) For how long it stores

1. 1-4 months 2. 5-8 3. 9-12, 4. > 12 months

F. Water and watering strategy

1) Do you provide water for your bird

1. Yes 2. No

2) If yes have you know the amount of water given to chicken per day

1. I know 2. I don't know

3) How much water is given per chicken in ml_____

4) Frequency and time of water offering per day

Frequency	**Morning**	**Afternoon**	**Evening**	**At mid night**
Once				
twice				
thrice				
More than threes				

5) What is the source of water

1. Well water 2. Rain water 3. pipe water 4.bore hole water

6) How many watering trough do you have_____

G. Breed used and flock size

Poultry Population and breed type at the time of filling questionnaire

Class	Age	Population	Breed type
Egg type	Starter(0-8 weeks)		
	Grower(9-20 weeks)		
	layer		
Dual	Starter(0-8 weeks)		
	Grower(9-20 weeks)		

H. Poultry and poultry Products Marketing

1) To whom you sell your birds

   1. Farmers by agriculture office 2. Retailers 3. Town dwellers

   4. Hotels 5. Others, specify_____

2) Where to sell your poultry and poultry products?

   1. Local market 2. At farm gates 3. Retailers 4. Retailers and local market

3) Factors that affect the selling price of chicken.

   1. Color 2. Comb type 3. Breed 4. Weight

   5. Age 6. others (please specify) _____

4) How do you transport poultry and poultry products to markets? _____

5) What are the problems relating to poultry marketing in your experience?

   1. Poor market linkage and promotion, 2. Price fluctuation
   3. Lack of market place. 4. Poor infrastructure (road, market…)

6) How far the market place from the residence area? _____

I. **Poultry Health Management**

1) Do you vaccinate your chicken?

   1. Yes 2. No

2) Vaccination for which disease

1. NCD 2.Gumbero 3. Fowl Box 4. Infectious Bursal Disease (IBD) 5. Fowl Cholera

3) How many times you vaccinate your chicken
   1. Once, 2. Twice 3. Thrice 4. Fourth 5. More than fourth
4) What is your immediate measure when you observe sick birds in the flock?
   1. Isolation 2. Immediate slaughter 3. Leave with the flock 4. Treating with different drugs until recovery or death 5. other_____
5) Do you experience serious disease outbreaks previously?
   1. Yes 2. No
6) What type of disease (s) do you frequently observe in your flock?

Disease (Local name)	Major symptoms	Season of occurrence	Treatments applied

7) Do you know the name of the vaccine
   1. Yes 2. No
8) Do you have close relation with the nearby veterinarian
   1. Yes 2. No
9) 9. Is there any accustom to inform for vaccination or treatment
   1. Yes 2.No
10) For how long it stay without recovery in days
   1. 1-3 2. 4-6 3.7-9 4. 10-12
11) Have you adhered or no adhered with vaccination schedule
   1. Adherence 2. non adherence
12) What is your immediate measure when you observe sick birds in the flock?
   1. Isolation and follow up 2. Immediate slaughter if older 3. Isolation and treat them until recovery
13) At what case, you call the veterinarian
   1. at sick 2.at death one or more than one chicks
14) Have you accustomed to treat your chicken

1. Yes 2.No

15) What type of disease affect your chicken

1. NCD 2.Gumborrow 3. Coccidiosis 4. Others specify_____

16) What is the cost of vaccine and treatment

1. Cheap 2. Medium 3. Expensive

17) Do you have any experience on serious disease outbreaks?

1. Yes 2.No

18) What do you do when birds become sick?

1. Treat myself 2. Call in the Vet.Doctor 3.Kill them immediately

4. Consume them immediately 5.Sell them immediately 6.Other_____

19) Is there any isolation room

1. Yes 2.No

20) Reporting of disease outbreak

1. Yes 2.No

21) Have you accustomed to record the disease

1. Yes 2. No

22) Number of disease out break_____

23) Which age group has the highest mortality?

1. Starter (1-3wks) 2. Growers stage (4-6wks) 3.Adult (more than 6 wks)

24) In which season do you lose most of your chicks?

1. Long dry season (oct.-Jan.) 2. Short rainy season (Feb.-Mar.) 3. Short dry season (Apr.-May) 4. Long rainy (Jun.-Sep.)

25) What could be the possible source of infection?

1. House management condition 2. Environment. 3. Not clearly understood 4. If other (specify) _____

26) Major control measures of disease _____

J. Major symptoms of disease

1) Which symptoms frequently seen in your farm

1. skin abrasions
2. swelling in the footpads
3. paralysis
4. sitting on the hock

5. depression (dejection),
6. enteritis (diarrhoea)
7. swelling of head and eyes
8. coughing,
9. respiratory rales/panting
10. pecking (cannibalism)
11. drooling saliva
12. torticollis (twisting of the neck)
13. prostration
14. ruffled feathers
15. reduced egg production
16. loss of appetite
17. body weight loss

K. Pests and predators

1) Presence of rodents
    1. Yes 2. No
2) What is the name of pest_____
3) Presence predators
    1. Yes 2.No
4) What is the name of the predator_____

L. Mortality

1) Weekly mortality_____
2) Reasons of mortality_____
3) Mortality type
    1. Sudden mortality 2.sporadic mortality 3. very minimal mortality

M.Training and extension service

1) Have you taken training
    1. Yes 2.No

2) From whom

   1. GOS 2. NGOS----------

3) How many times you trained

   1.1 2. 2 3.3 4.4 5. 5 6. >5

4) For how many days trained per training_____

5) What looks like the training

   1. Practical 2. Theoretical 3.both

6) Was it helpful for your farm

   1. Yes 2.No

7) Is there any professional man supervises you

   1. Yes 2. No

8) Is there any extension service given to you related to poultry husbandry practice

   1. Yes 2.No

9) If yes, what was (were) the extension service you get?

   1. Supply/distribution/ of chicks, 2. Technical advice only about the husbandry practices 3. Provisions of feed and medicaments 4. complete package

10) How many times per month you get extension service

    1. 1 2.2 3.3 4.4 5. 5 6. >5

11) Have you got improved or exotic breed of chicks

    1. Yes 2. No

12) If yes, which chicken breeds you received? _____,_____

13) How long does it take you to reach to the extension aget (distance)?_____kilometer

N. Sanitation and Hygiene

1) How many times you washed the feeder per week

   1. Daily 2.Once 3. Twice 4. Thrice 5.more than thrice

2) How many times you washed the waterer and feeder per week

   1. Daily 2.Once 3. Twice 4. Thrice 5.more than thrice

3) How many time you clean the room per week

   1. Daily 2.Once 3. Twice 4. Thrice 5.more than thrice

4) What type of litter material you use

1. Saw dust 2. Straw____ 3. Wooden shavings 4. Other, specify

5) How many times to change it per month

1. Once 2. Twice 3. Thrice 4. More than thrice

6) How many centimetres depth of the litre_____

O. Waste disposal

1) Is there any waste disposal

1. Yes 2. No

2) What type of waste disposal you use

1. Burning, 2. Burying 3. Spread on the surface of the earth 4. Selling the manure 5. Home use the manure

3) Where to dispose your dead birds

1. Burning 2. Burying 3.throwing

P. Source of money and credit services

1) What is the source of money?

1. My own 2.Credit from GOs 3. Credit from private 4. Family or friends 5. Bank 6. Cooperatives

2) Are there any institutions giving credit services for poultry production?

1. Yes 2. No

3) What is the name of the institution to provide credit? _____

4) How is the tax of credit?

1. High 2. Medium 3.Low

5) For which purposes you spend money

1. Purchase of birds 2. Purchase of feeds, 3. Purchase of medicaments 4. All

Q. Culling

1) Do you purposely cull your birds at any time

1. Yes 2. No

2) For what purpose do you cull the poultry

1. For consumption 2.For sale 3.For sacrifice 4.Other----------

3) What factors determine which bird you will cull?

1. Small size 2. Deformed shape 3. Small size and deformed age

R. Hours of light

1) Have you hoover
    1. Yes 2. No
2) If yes how many chicks hooved per hover_____
3) Chicks light per day _____
4) Growers light per day_____

S. Biosecurity

1) Wearing of protective cloth
    1. Yes 2.No
2) Wearing of boots
    1. Yes 2. .No
3) Using of hand gloves
    1. Yes 2. No
4) Have you a foot footbath
    1. Yes 2.No

T. Record Keeping

1) Do you keep records in your farm?
    1. Yes 2. No
2) If yes, on what parameters
    2. Production costs 2. Total feed cost 3. Mortality record 4. weight gain 5. Medical history 6.feed intake 7. Water intake 8. All production related parameters

II.**Constraints of small-scale poultry farms**

Constraints of small-scale poultry farms

No	Constraints occurred	Rank
1	Cost of feed,	
2	High cost of medicine and vaccine,	
4	Unavailability of feed and feed ingredients,	
5	Cannibalism	
6	Lack of veterinary care	
7	Poor credit facilities ,	
8	High initial investment,	
9	Market linkage and promotion problems	
10	Labour problem	
11	Unavailability of land/space,	
12	Unavailability of waste disposal,	
13	Lack of technical know-how in handling poultry,	
14	Mortality of adult birds, mortality of day-old/young chicks ,	
15	Diseases out- break,	
16	Inability to diagnose sick birds,	
17	High rate of morbidity of birds,	
18	Loss of birds and eggs due predators,	
19	Lack of finance ,	
20	Electric disturbance	
21	Lack of training	
22	Non-availability of improved birds in time,	
23	Inability to pay constant attention,	
24	Difficulty for water,	
25	High rate of interest on loans,	
26	High cost of birds,	
27	Losses due to change in environmental conditions,	
28	Lack of extension service,	
29	Lack of equipment etc.	

III. **For future Expansions of small-scale commercial poultry farms**

1) Do you feel the need to improve your poultry farm
   1. Yes 2. No
2) If yes, to what size? ----------
3) What could be the barriers for future expansion of your poultry production

1._____

2._____

3._____

4. _____

5. _____

6. _____

7._____

8._____

9._____

10_____

4) Could you suggest the possible solutions addressed by the government as soon as possible

1._____

2._____

3._____

4. _____

5. _____

6. _____

7._____

8._____

9._____

10_____

Interview Questions in and around Debre Markos Agriculture Office

1. The total number of farms in the area_____
2. The total number of farms run by their own initiation_____
3. The total number of farms organized by small and micro enterprise offices_____
4. Where is source of their chicken_____
5. Do you know the breeds of the chicks_____
6. Why the producers refuse to run layer farming_____
7. Where is the source of the feed _____
8. Have you facilitate for vaccination and treatment of disease_____
9. What was the frequent disease occurred in their farm_____
10. What seems the awareness of the producers in the disease outbreak and the general management of birds
11. Have you given training (Yes, No), For how long in days_____ and the frequency_____
12. Is there any credit institutions to give money for them(Yes, No), If Yes, Name of institution_____
13. Is the training both theoretical and practical (Yes, No)
14. Can they implement to their farms (Yes, No), If No, what was the reason_____
15. Have you given extension service (Yes, No)
16. In what areas you have given extension service
17. How many times you gave extension service per production cycle_____
18. Is there any market linkage and promotion(Yes, No), If No why_____
19. Have you got any support from Zone Agriculture Department to build your capacity (Yes, No)
20. Is there any infrastructure to support the producers with your full potential (Yes, No)

21. Is there any producers cease from the poultry production (yes, No)
22. What was the main reasons for ceasing

_____

_____

23. What are the general problems faced in poultry farms

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

24. What are the good opportunities to join in poultry production

_____

_____

_____

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_____

_____

Interview Questions for Small and Micro Enterprise Offices

1. The total number of farms organized by small and micro enterprise offices_____
2. What is the source of money? _____
3. Is there any credit institutions to give money for them?(Yes, No), If Yes, Name of institution_____
4. How many producers organized in one poultry farm_____
5. Is there any supervision and support by your own office? (Yes, No)
6. What was the main support for these producers?

   _____

   _____

   _____

   _____
7. Is there any producers released from the poultry production?(yes, No)
8. What was the main reasons for releasing

   _____

   _____
9. What are the general problems faced in poultry farms

   _____

   _____

   _____

   _____

   _____

   _____

   _____
10. What are the good opportunities to join in poultry production

    _____

    _____

    _____

Interview Questions for East Gojjam Zone Agriculture Office

1. Is there any training and support for Woreda animal production experts (Yes, No)
2. What was your role in providing farm inputs to the town?

   _____
   _____
   _____
   _____

3. Is there any market linkage and promotion for markwting of birds? (Yes, No)
4. Is there a good coordination and feedback with Woreda experts and producers (Yes, No)
5. What are the general problems faced in poultry farms as a zone

   _____
   _____
   _____
   _____
   _____
   _____
   _____
   _____
   __

6. What are the good opportunities to join in poultry production?

   _____
   _____
   _____
   _____
   _____
   _____
   _____

Appendix 2. Garrett Ranking Conversion Table

Percent	Score	Percent	Score	Percent	Score	Percent	Score
0.09	99	11.03	74	52.02	49	90.83	24
0.20	98	12.04	73	54.03	48	91.67	23
0.32	97	13.11	72	56.03	47	92.45	22
0.45	96	14.25	71	58.03	46	93.19	21
0.61	95	15.44	70	59.99	45	93.86	20
0.78	94	16.69	69	61.94	44	94.49	19
0.97	93	18.01	68	63.85	43	95.08	18
1.18	92	19.39	67	65.75	42	95.62	17
1.42	91	20.93	66	67.48	41	96.11	16
1.68	90	22.32	65	69.39	40	96.57	15
1.96	89	23.88	64	71.14	39	96.99	14
2.28	88	25.48	63	72.85	38	97.32	13
2.69	87	27.15	62	74.52	37	97.72	12
3.01	86	28.86	61	76.12	36	98.04	11
3.43	85	30.61	60	77.68	35	98.32	10
3.89	84	32.42	59	79.17	34	98.58	9
4.38	83	34.25	58	80.61	33	98.82	8
54.92	82	36.15	57	81.99	32	99.03	7
5.51	81	38.06	56	83.31	31	99.22	6
6.14	80	40.01	55	84.56	30	99.39	5
6.81	79	41.97	54	85.75	29	99.55	4
7.55	78	43.97	53	86.89	28	99.68	3
8.33	77	45.97	52	87.96	27	99.80	2
9.17	76	47.98	51	88.97	26	99.91	1
10.06	75	50	50	89.94	25	100	0

Appendix 3. Cost of birds and feed ingredients

Feed type	**Price/kg (ETH BIRR)**
Purchasing cost of day old broiler per bird	18
Maize (Kg)	4.2
Wheat middling(Kg)	6
Soybean /fullfat/(Kg)	9
NSC(nuag seed cake) (Kg)	4
DBRCM(Dried blood rumen content mixture)(for labour) (Kg)	1
Salt(Kg)	5
Lysine (Kg)	125
Methionine (Kg)	200
Vitamin premix (Kg)	35
lime stone(Kg)	1

Appendix 4. Carcass characteristics of SASSO C44 broilers (1-56 days) fed graded level of dried bovine blood rumen content mixture as a replacement for soya bean meal

Parameters	T1	Experimental diets				SEM	P	Sex		P
		T2	T3	T4	T5			M	F	
Slaughter weight(g)	1707.5	1736.7	1736.8	1719.9	1550.2	31.839	0.311	1731.5	1648.9	0.0721
Plucked weight(g)	1507.1	1516.8	1540.8	1520.8	1378.2	27.582	0.380	1532.8	1452.8	0.0597
Plucked weight (%)	88.2	87.4	88.7	88.4	89.1	0.255	0.291	88.6	88.2	0.3961
commercial carcass yield(g)	937.4	984.7	962.0	925.0	833.1	22.775	0.281	957.9	899.0	0.0956
*Dressing %	54.9	56.6	55.3	53.7	53.7	0.6741	0.698	55.2	54.5	0.6129
Edible weight(g)	1091.6	1159.3	1135.5	1104.7	977.9	26.290	0.226	1124.4	1063.2	0.1209
**Dressing %	63.9	66.6	65.4	64.2	63.1	0.651	0.533	64.8^{b}	64.5	0.8269
Thigh(g)	191.3	194.4	186.2	185.9	171.3	4.233	0.533	190.0	181.6	0.2724
Thigh%	11.2	11.2	10.7	10.8	11.0	0.148	0.816	11.0	11.0	0.8152
Drum stick(g)	174.3	177.2	171.0	168.5	150.9	4.082	0.292	180.5^{a}	156.2^{b}	0.0052
Drum Stick%	10.2	10.2	9.8	9.8	9.7	0.158	0.791	10.4^{a}	9.5^{b}	0.0092
Breast(g)	280.1	305.8	301.9	274.2	244.6	8.833	0.172	274.8	287.8	0.2873
Breast%	16.4	17.6	17.5	16.0	15.8	0.372	0.453	15.9^{b}	17.5^{a}	0.0138
Back(g)	153.8	154.4	153.7	151.9	135.1	3.990	0.546	155.4	144.1	0.0825
Back%	9.0	8.9	8.8	8.8	8.7	0.121	0.972	8.9	8.7	0.4363
Wing(g)	138.0	153.0	149.2	144.7	131.3	4.140	0.531	157.2^{a}	129.3^{b}	0.0008
Wing%	8.1	8.8	8.5	8.4	8.5	0.136	0.627	9.0^{a}	7.8^{b}	0.0005
Abdominal fat(g)	18.9	23.2	16.4	17.7	17.1	1.106	0.327	16.1^{b}	21.2^{a}	0.0081
Abdominal fat%	1.1	1.3	1.2	1.1	1.1	0.060	0.528	0.9^{b}	1.3^{a}	0.0019
Leg length(cm)	22.6	23.1	22.0	23.3	21.6	0.576	0.908	23.7	21.3	0.0553
Shank & claws (g)	61.8	67.1	69.8	66.1	57.1	1.905	0.244	69.4^{a}	59.4^{b}	0.0067
Head(g)	49.1	50.7	52.1	49.4	46.2	1.400	0.793	49.5	49.5	0.9833
Neck (g)	52.6	54.6	56.9	57.4	49.2	1.665	0.577	56.0	52.4	0.1373
Liver(g)	42.8	44.2	49.4	43.4	35.3	1.770	0.146	45.2	40.8	0.0990
Kidney(g)	9.3	11.7	13.0	12.3	10.7	1.595	0.335	11.3	11.5	0.7912
Heart(g)	8.5^{b}	10.6^{ab}	9.1^{ab}	11.5^{a}	8.6^{b}	0.404	0.038	10.2	9.1	0.0741
Spleen(g)	2.0	2.6	2.0	2.1	1.9	0.111	0.263	2.3	2.0	0.1640
Pancreas(g)	7.0^{ab}	8.2^{a}	6.5^{ab}	6.3^{ab}	5.2^{b}	0.294	0.002	7.2	6.0	0.0569
Gizzard(g)	41.9	48.2	48.6	52.8	47.4	1.3606	0.155	46.0	49.5	0.0697
lung(g)	7.7^{a}	8.3^{a}	7.7^{a}	7.5^{ab}	6.3^{b}	0.225	0.032	7.7	7.3	0.1756
Crop(g)	8.3	9.0	8.9	7.0	6.2	0.421	0.105	8.6^{a}	7.1^{b}	0.0274
Skin(g)	69.5	82.4	75.7	83.6	62.3	2.938	0.082	75.4	74.0	0.7350
Blood(g)	41.3	50.9	51.2	56.3	47.5	2.066	0.228	52.5	46.5	0.0571
Feather(g)	159.2	169.0	144.8	142.8	124.4	5.446	0.066	146.4	149.7	0.6121
Large intestine(g)	8.3	7.8	7.4	7.8	6.6	0.402	0.802	7.5	7.7	0.8108

Small intestine(g)	95.9	85.9	96.9	94.1	75.5	3.505	0.267	103.7[a]	75.8[b]	0.0010
Oesophagus(g)	5.7	5.1	5.2	4.6	4.9	0.207	0.685	4.6[b]	5.5[a]	0.0208
Proventriculus(g)	13.9	15.6	15.0	14.7	13.1	0.313	0.051	14.9	14.0	0.1283
Ceca(g)	19.7	15.9	14.5	13.8	12.3	0.942	0.102	15.0	15.5	0.6660
Proventriculus length (cm)	13.9	16.0	15.5	16.2	11.8	0.694	0.212	15.8	13.5	0.0718
Oesophagus length(cm)	20.1	18.3	17.4	20.3	15.1	0.670	0.052	19.0	17.5	0.2211
Crop length(cm)	11.1	10.4	10.4	12.2	9.2	0.386	0.152	11.1	10.2	0.2848
Large intestine length(cm)	19.1	18.3	19.3	19.9	14.5	0.715	0.095	17.7	18.7	0.3979
Small intestine length(cm)	185.2	174.7	169.8	176.8	163.7	3.974	0.576	180.9	167.1	0.1731
Cecal length(cm)	23.9	23.9	24.5	23.2	19.1	0.860	0.285	23.5	22.3	0.3475
Shank length(cm)	20.2	20.3	21.0	20.5	18.5	0.556	0.739	19.8	20.3	0.7074
Vent(g)	23.6	16.7	13.7	16.1	13.0	1.941	0.483	17.4	15.8	0.6786
Duodenal loop(g)	14.5	16.0	19.6	20.6	18.4	0.899	0.162	14.3	21.4	0.0001
Giblet weight(g)	93.2	102.9	107.1	107.6	91.4	2.861	0.214	101.5	99.4	0.6124
Giblet %	5.5	5.9	6.2	6.2	5.9	0.097	0.0652	5.8	6.0	0.0567
TNEO	497.0	525.8	506.0	500.5	431.3	12.526	0.1440	511.7[a]	465.4[b]	0.0481
TNEO%	29.2	30.2	29.2	29.1	27.8	0.417	0.5751	29.5	28.2	0.4361
TEO	154.2	174.8	173.7	179.7	144.9	5.1871	0.1282	166.6	164.3	0.7305
TEO%	9.1	10.0	10.0	10.4	9.3	0.1852	0.0871	9.6	9.9	0.2478

Appendix 5. Interview with Small-scale commercial poultry producers

Appendix 6. Chicks in small-scale commercial poultry farms

Appendix 7. Collecting, boiling and drying of blood in the experimental site

Appendix 8. Collecting, boiling and drying of rumen content

Appendix 9. Management of experimental chicks during the experiment

LIST OF PUBLICATIONS

1. **Melkamu Bezabih Yitbarek**, Berhan Tamir Merso and Ashenafi Mengistu Wosen (2016): The Effect of Dried Blood Rumen Content Mixture (DBRCM) on Carcass Characteristics of SASSO C44Broiler Chicks. European Scientific Journal 12(12):166-185. URL:http://dx.doi.org/10.19044/esj.2016.v12n12p166
2. **Melkamu Bezabih Yitbarek**, Berhan Tamir Merso and Ashenafi Mengistu Wosen (2016): Effect of Dried Blood-Rumen Content Mixture (DBRCM) on feed intake, body weight gain, feed conversion ratio and mortality rate of SASSO C44 broiler chicks. Journal of Livestock Science (ISSN online 2277-6214) 7: 139-149
3. **Melkamu Bezabih Yitbarek**, Berhan Tamir Merso and Ashenafi Mengistu Wosen (2016): Disease Management and Biosecurity Measures in Small-scale Commercial Poultry Farms in and round Debre Markos, Amhara Region, Ethiopia. Journal of Veterinary Medicine and Animal Health. Vol. 8(10): 136-144. http://www.academicjournals.org/JVMAH
4. **Melkamu Bezabih Yitbarek**, Berhan Tamir Merso and Ashenafi Mengistu Wosen, (2016): Constraints of Small-Scale Commercial Poultry Farms Analyzed by Garett's Ranking Technique in and around Debre Markos, Amhara Region, Ethiopia. World's Veterinary Journal 6(4):203-209
5. **Melkamu Bezabih Yitbarek**, Berhan Tamir Merso and Ashenafi Mengistu Wosen, (2016): Sanitation and waste management of small scale commercial poultry farms in and around Debre Markos, Amhara Region, Ethiopia. International Journal of Advanced Life Sciences 9(4):527-533 http://www.unitedlifejournals.com/ijals/articles.php?iid=33&iPageNum=3
6. **Melkamu Bezabih Yitbarek**,and Solomon Tesfaye Gurum(,2013): Production and Marketing of Chicken at Kimbibit Woreda in North Shoa Zone, Oromiya Region, Ethiopia. International Journal of Scientific and Research Publications, 3(3) :2250-3153. www.ijsrp.org
7. Demelash Biffa, Etana Debela and **Melkamu Bezabih**, (2003): The Effect of Breed and Age of Chicken on the Amount of Feacal Excretion of Eimeria Oosyst and Mortality Rate Due To Coccidiosis. Ethiopian Journal of Animal production (EJAP). 3 (1): 119-130

8. **Melkamu Bezabih Yitbarek**, (2012): Effect of Dried Tomato Pomace Feeding on Feed Intake, Body Weight Gain and Economic Efficiency of Rhode Island Red Grower Chicks. International Journal of Natural Sciences (2012),2(4): 99- 103 www.ijns.net

9. **Melkamu Bezabih Yitbarek**, (2013): The Effect of Feeding Different Levels of Dried Tomato Pomace on the Performance Of Rhode Island Red (RIR) Grower Chicks. International Journal of Livestock Production Vol. 4(3): 35-41

10. **Melkamu Bezabih Yitbarek (**2013): Carcass Characteristics of Rhode Island Red (RIR) Grower Chicks Fed on Different Levels of Dried Tomato Pomace (DTP). International Journal of Advanced Research,1(2): 17-22

11. **Melkamu Bezabih Yitbarek** and Andargie Zewudu (2013): Performance Evaluation of Local Chicken at Enebsie Sar Midir Woreda, Eastern Gojjam, Ethiopia, World Research Journal of Agricultural Sciences & Technology 1(1): 01 – 06

12. **Melkamu Bezabih Yitbarek** and Wube Atalel (2013): Constraints and Opportunities of Village Chicken Production in Debsan TiKara Keble at Gonder Zuria Woreda, North Gonder, Ethiopia._International Journal of Scientific and Research Publications,_Volume 3, Issue 9.

13. **Melkamu Bezabih Yitbarek** (2015): Phytogenics as Feed Additives in Poultry Production: A Review. International Journal of Extensive Research, 3: 49-60

14. Melese Gashu Nigatu and **Melkamu Bezabih Yitbarek**, (2014): Assessment of Chicken Production under Farmers Management Condition in East Gojam Zone, Amhara Regional State, Ethiopia, in Greener Journal of Animal Breeding and Genetics Vol. 1 (1): 001-010. www.gjournals.org

15. **Melkamu Bezabih Yitbarek** and Birhan Tamir (2014): Silage Additives: Review, in Open Journal of Applied Sciences 4:258-274

16. **Melkamu Bezabih Yitbarek** and Fekadu Regassa (2014): Reproductive Immunization of Domestic and Wild Animals: Review. International Journal Of Scientific & Technology Research, 3 (4):399-412

17. **Melkamu Bezabih Yitbarek** and Gebreyohannes Berhane (2014): Livestock Production Systems Analysis: Review. American International journal of Contemporary Scientific Research, 1(2): 2349-4425. www.americanij.com

18. **Melkamu Bezabih Yitbarek** and Birhan Tamir (2013): Mycotoxines and/or Aflatoxines in Milk and Milk Products: Review. American Scientific Research Journal for Engineering, Technology, and Sciences (ASRJETS), 7(1): 1-32 www.americanij.com

19. **Melkamu Bezabih Yitbarek** (2014): Apparent defects and grading of hides and skins in East Gojjam Zone, Amhara Region, Ethiopia. International Journal of Agricultural Science Research, 3(11): 232-242