



PIG PRODUCTION UNDER SMALL SCALE INTENSIVE FARMING IN EAST  
SHEWA OF CENTRAL OROMIA, ETHIOPIA: MANAGEMENT, FEED  
RESOURCES, PERFORMANCE AND MARKETING PRACTICES

PhD Dissertation

By

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PhD Program in Animal Production

May, 2016

Bishoftu, Ethiopia

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A Thesis submitted to the College of Veterinary Medicine and Agriculture of Addis  
Ababa University in fulfillment of the requirements for the degree of Doctor of  
Philosophy in Animal Production

By

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May, 2016

Bishoftu, Ethiopia

Addis Ababa University  
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As members of the Examining Board of the final PhD open defense, we certify that we have read and evaluated the Dissertation prepared by Mulugeta Berihu Gebremdhin titled: ‘Pig Production Under Small Scale Intensive Farming In East Shewa Of Central Oromia, Ethiopia: Management, Feed Resources, Performance and Marketing Practices’ and recommend that it be accepted as fulfilling the Dissertation requirement for the Doctor of Philosophy in Animal Production.

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## **BIOGRAPHICAL SKETCH**

I, the author was born in Tigrai in 1986. I attended my primary and secondary education in Aksum. After completion of my high school education, I joined Mekelle University in 2006 and awarded BSc Degree in Animal, Range and Wild Life Sciences in 2008. Soon after graduation, I was employed by Agricultural Technical and Vocational Educational Training (ATVET) and served as instructor for two years. Then, I joined Mekelle University to pursue my MSc degree in livestock production and pastoral development in 2009. Immediately after graduation, I was employed by Aksum University as an instructor. Over the past four years of services in teaching, I have taught almost all types of animal science courses and published seven scientific articles in reputable journals.

## STATEMENT OF THE AUTHOR

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

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Date of Submission: \_\_\_\_\_

## ACKNOWLEDGMENTS

Many people have contributed in different ways to this thesis, and I am sincerely grateful to every one of you.

First and for most, I would like to express my sincere and deepest gratefulness to my supervisor, Professor Berhan Tamir for his intellectual advice, guidance, encouragement and regular discussions were very valuable and inspiring in the process of the proposal writing, research undertaking and thesis writing. His sense of hopefulness and parental direction at times when I felt defeated kept me struggling till the end of the project.

I am extremely indebted to the farmers of the three towns. Without their acceptance, hospitality and eagerness to share their time, primary data collection would not have been possible. I thank them whole heartedly for providing information and truthfully answering my questions.

I am grateful to national veterinary institute (NVI) nutrition laboratory section for crying out the feed chemical analysis.

Thanks to all enumerators and assistants that have helped me in collecting information in the field. A special thanks to Dr. Mehari for his support in data collection.

I am also deeply indebted to my family Hadas, Alula, Abraha, Alemseged, Rahyel, Hagos, Bsrat, Eskndr, Haftom, Filmon, Awetash and Berihu for their care and love, advice and selfless support in every respect during the course of the study.

There are so many others I could mention for making this a really fun time. Not to forget all the new friendships across the towns this project has brought with it. Thank you all!

My several friends, and colleagues too many to list here, were behind my project and God bless you all!

## LIST OF ABBREVIATIONS

ACOP	Association for Control of Organic Production
BCSPCA	British Columbia Society for the Prevention of Cruelty to Animals
Ca	Calcium
CF	Crude fiber
Com	Composite feed
CP	Crude protein
DM	Dry matter
EE	Ether extract
ETB	Ethiopian Birr
EUROSTAT	European Statistics
FAOSTAT	Food and Agriculture Organization (United Nations) statistics
GDP	Gross Domestic Product
IGAD	Intergovernmental Authority on Development
ME	Metabolizable energy
MMT	Million Metric Tone
WFP	World Food Program

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PhD Thesis  
Addis Ababa University (2016)

**ABSTRACT**

*The objective of this study was to investigate the performance, management practices, and marketing practices, and associated factors limiting small scale intensive pig production in East Shewa of Central Ethiopia. The study used structured questionnaire administered to 105 household pig farmers, randomly selected from three towns namely, Addis Ababa (2 sub cities), Bishoftu (4 kebeles) and Adama (4 kebeles). Focus group discussions were also employed to check the reliability of the information obtained through questionnaire interview. Data generated included production purposes, socioeconomic profile, farm characteristics, feed types, feed sources, health practices, marketing practices and constraints. Data were analyzed using one way ANOVA, chi-square, Fishers exact test, index ranking and descriptive statistics. The results indicated that the mean farm experience in years ( $P<0.05$ ), mean farm size in hectare ( $P<0.05$ ) and average number of pigs ( $P<0.05$ ) per household were higher in Bishoftu town than in Addis Ababa and Adama towns. A higher ( $P<0.05$ ) percentage of wealthy households were detected in Bishoftu (65%) compared to households in Addis Ababa (48.6%) and Adama (33.3%). Brick walled housing was utilized by significantly higher ( $P<0.05$ ) percentages of respondents in Bishoftu (30%) compared to Addis Ababa (11.4%) and Adama (10%) towns. The percentages of households practicing feet and wheel bath were significantly higher ( $P<0.05$ ) in Bishoftu town (85 and 22.5%) than in Addis Ababa (20 and 2.9%) and Adama (20 and 3.3%) towns. The prevalence of diseases and constraints to pig production were dependent on the context of the towns i.e. mastitis was ranked 2<sup>nd</sup> in Addis Ababa while 6<sup>th</sup> in Bishoftu and 3<sup>rd</sup> in Adama. Land scarcity had the highest rank value (4<sup>th</sup>) in Addis Ababa while the lowest rank value in Adama (7<sup>th</sup>) and Bishoftu (8<sup>th</sup>). The results of the study revealed that the dominant type of pig enterprise was mixed type*

of operation. Significantly higher ( $p<0.01$ ) number of pig producers in Bishoftu town utilized commercial feeds than Addis Ababa and Adama towns. The amount of feed offered to individual pig category, i.e. piglet, weaned, grower, sow, boar and fattener was significantly higher ( $p<0.01$ ) in Bishoftu compared to feed offered in Addis Ababa and Adama. The EE% and ME% contents of homemade feeds in Bishoftu were greater than Addis Ababa and Adama. The crude protein content of homemade feeds of Adama was lower compared to homemade feeds of Bishoftu and Addis Ababa. The crude fiber content of the composite feeds in Bishoftu was lower than Addis Ababa and Adama. The body condition scores of piglets, weaned, growers, boars and fatteners were significantly higher ( $p<0.01$ ) in Bishoftu than in Addis Ababa and Adama. The mean services per conception age at first service and pre-weaning piglet mortality of pigs in Addis Ababa and Adama were greater ( $p<0.05$ ) than the value obtained in Bishoftu. The mean number of farrowing/sow/year litter size at weaning live weight at birth and at weaning were significantly ( $p<0.05$ ) greater in Bishoftu compared to in Addis Ababa and Adama. There were significantly shorter ( $p<0.05$ ) fattening period and higher ( $p<0.05$ ) market weight of pigs in Bishoftu than in Addis Ababa and Adama. Weighting balance was employed by higher ( $p<0.05$ ) percentage of respondents in Addis Ababa and Bishoftu than in Adama. The number of respondents which sold live pig were larger ( $p<0.05$ ) in Addis Ababa and Adama than in Bishoftu. The mean price of live pig per kg was higher ( $p<0.05$ ) in Addis Ababa ( $89.86\pm 1.91$ ) and Bishoftu ( $89.25\pm 2.67$ ) than Adama ( $69.3\pm 4.5$ ). Correspondingly, the average price of pork per kg was larger ( $p<0.05$ ) in Addis Ababa ( $119\pm 2.8$ ) and Bishoftu ( $119.3\pm 2.7$ ) than Adama ( $98.3\pm 3.8$ ). The study indicated that there were remarkable variations among the study sites in terms of management, feed characteristics, reproduction and fattening performances, marketing practices and challenges of piggery. Thus, context specific development interventions should be designed and implemented to increase productivity of pigs and thereby improve the income and livelihood of small scale intensive pig keepers.

**Keywords:** Pig production, Constraint, Small scale intensive, Performance, Marketing

## 1. INTRODUCTION

Ethiopia is the second-most populous country in Sub-Saharan Africa with a population of 96.5 million, and population growth rate of 2.5% in 2014 (World Bank, 2015). The human population of Ethiopia is increasing and is projected to be 109 million by 2025 (PDDESAUNS, 2012). The country is one of the fast growing countries in Africa. As a result the feeding habit of the people specially the young generation is changing (Gustavo and Zemelak, 2014). Given the recent growth in income in Ethiopia, there is a potential for growth in the demand for livestock products (Kibrom and Ibrahim, 2012).

The dietary protein consumption of Ethiopia is estimated at 56 g/person/day (FAO, 2010) which is lower than the average dietary protein consumption of the world (85 g/person/day), developed countries (104 g/person/day) and developing countries (80 g/person/day). Likewise, it is at the same level as the dietary protein consumption of Africa (62 g/person/day) as well as low-income food-deficit countries (57 g/person/day) (FAO, 2010). The low protein consumption is partly due to the high cost of animal protein sources such as meat of cattle, goat, sheep and poultry.

The tourist arrivals into Ethiopia increased from 184,078 in 2011 to 560,000 in 2012, a three-fold increase. However, Ethiopian tourism currently suffers from large infrastructure and food services limitation (Henok, 2012). The same author forecasted that the tourist arrivals will reach 1.2 million by 2017. This implies that the livestock sector should get better to carry the food demand of the tourist flow to improve its share in the Ethiopian Economy.

Based on Ethiopia's Revenues and Custom Authority (2010), Ethiopia imported about 100 tons of meat paying around five millions ETB during the years of 2005-2009. Pork covers 21% of the volume of meat imported. According to the same Authority, the main reason given by firms for importing meat from abroad is the unavailability of some types of meat (pork sausages) and higher quality meat in domestic markets.

So, for possible meat import substitution and to fulfill the protein requirement of the country, it is, therefore, necessary to search for a cheaper alternative source of protein to meet the ever increasing demand for it. This demand can be met by rearing fast-growing species with efficient feed conversion rates such as pigs (Mekuriaw and Asmare, 2014). Pig is one of the most prolific and fast growing livestock species that can convert food waste to valuable products (Rodriguez-Estevez *et al.*, 2010). Pig production is becoming increasingly important economic activity because of better production efficiency per unit area of land (FAO, 2009). Pigs are not only a source of quality animal protein but also a source of income (Ikwap *et al.*, 2014). Pigs have higher turnover rate due to large litter sizes, shorter gestation period (114 days) and more efficient carcass yielder than cattle, sheep or goat, dressing out at about 70% compared to 52.5% for cattle and about 50% for sheep and goat (Tewe and Adesehinwa, 1995).

The significance of pig production can include: the diversification of resources and the reduction of socioeconomic risks; the promotion of linkages between systems and resource components, the generation of value added products and to bridge food gap (Devendra, 1993; Ajala *et al.* 2007). Raising pigs has significant contribution in many tropical countries (Kambashi *et al.*, 2014). Pig production plays an important role in improving the income, bridging animal protein supply gap, enhancing employment status of small-scale farmers and it is the key element for reducing poverty of the poor (Ajala *et al.*, 2007; Birhan *et al.*, 2015).

Efficient and profitable swine production depends upon an understanding of the concepts of genetics, environment, herd health, management, and nutrition (DeRouchey *et al.*, 2007). These factors interact with each other, and their net output determines the level of production and profitability. Feed represents 55-85% of the total cost of commercial swine production, in most tropical countries (Izunobi, 2006). The economics of feeding pigs apart from depending on availability of feedstuff also depends on competition for the feedstuff between human and other animals found in the same locality (Okoli, 2005). The range of feedstuffs that tropical farmers can offer to their livestock is often less limited, but it is vital that the right feed proportions are fed to the animals. A deficiency of an item

in the diet may cause ill-health and hence low productivity (Okoli *et al.*, 2004). For a feed to be regarded as being of good quality, it must contain appropriate levels of carbohydrates, proteins, fats, vitamins and minerals among others. Other secondary considerations include content of anti-nutritional factors and fiber levels (Esonu, 2006). A feed may however contain adequate amount of nutrients in balanced proportions, yet these nutrients may not be available to the animals (Iyayi, 2004). This implied that, understanding feed characteristics is vital so as to uphold a profitable pig venture.

Pig production efficiency in commercial pig production is partially dependent up on reproductive performance. This could be determined by the number of piglets at birth, at weaning, farrowing /sow/year, birth weight, weaning weight, age at first service, age at first farrowing, farrowing interval (Mota *et al.*, 2002; Rekwot *et al.*, 2003; Phengsavanh *et al.*, 2010). Similarly, the pig grows from 1.5 kg at birth to a slaughter weight 100–120 kg in about 5 months. It reproduces at a high rate because it is a litter-bearing species (Stern *et al.*, 2005). The sow is pregnant 114 days, gives birth to 10–15 piglets per litter, and normally produces two litters a year (Whittemore, 1998). The feed energy requirements per kilogram of meat produced are 45 MJ/kg carcasses as compared with 100–180 MJ/kg for cattle, and 25 MJ/kg for chicken (Bradford, 1999). Poor reproductive performance of pigs could negatively affect the economic benefit of a pig enterprise (Rekwot *et al.*, 2001).

Improving the local market system could enhance the benefit of smallholder producers (Tadesse *et al.*, 2013). This explained that the financial benefit to farmers for rearing pigs depends on remunerative marketing opportunities. According to Gausi *et al.* (2004), smallholder's producers have propensity to pay no attention to new technology even when it appears to be better than their current practices due to market impediments. Farmers required being aware of the preferred traits of animals as well as pricing patterns so that they can design breeding and fattening program and breed selection consistent with the best seasonal prices and consumers' preference (Ehui *et al.*, 2000). Understanding the pig marketing system may lead to innovations, interventions, or education opportunities to increase marketing efficiencies and improve product quality,

which ultimately increase profitability of farmers and make safe protein sources more accessible to resource-poor people (Levy, 2014).

Small scale pig production was a very recently introduced economic activity in Ethiopia (Tekle *et al.*, 2013). The population was estimated to be 29,000 heads representing 0.1% of African pig population and they are concentrated in central part of the country (FAO, 2005; Abdu and Gashaw, 2010). For the last number of years, adequate emphasis was not given for pigs unlike other livestock distribution (Abdu and Gashaw, 2010). A better understanding of current systems and key factors that determine pig production are needed before designing interventions to assist farmers (Phengsavanh *et al.*, 2010). Similarly, before deciding on any planned use for pigs, assessment of management practices and constraints of pig production are required in order to make more efficient and sustainable pig rearing activity (Kambashi *et al.*, 2014). Furthermore, an in-depth investigation of the characteristics of the pig farming is essential for introducing any scientific intervention and to transform the existing pig production system to a profitable enterprise (Patr *et al.*, 2014).

Although there are studies conducted in general, on characterization of free range pig production in some places of the country (Abdu and Gashaw, 2010; Tekle *et al.*, 2013; Mekuriaw and Asmare, 2014), there is limited information in relation to production objective, management practices, performance, marketing practices and limiting factors of small scale intensive pig production in Central Oromia, Ethiopia. The current scarcity of information might delay to work out intervention strategies and the way forward of pig production. It is perceived that the results of the present research will be utilized by different stakeholders to mainstream this production system as a pathway to improved livelihoods and family food security of smallholder producers. Therefore, in view of the above mentioned facts, the present study was planned with the following general and specific objectives.

**General objective:**

The general objective of the present study was to investigate the management practices, feed resources, performance and marketing practices of pig production under small scale intensive farming in three locations of Central Oromia, Ethiopia, representing different agro ecologies.

**Specific objectives:**

- Investigate socioeconomic and farm characteristics of small scale intensive pig production;
- Examine health management practices and factors affecting small scale intensive pig production system;
- Characterize feed resources and body condition scores of small scale intensive pig production system;
- Analyze the reproduction and fattening performance of small scale intensive pig production system; and
- Assess marketing practices and constraints of small scale intensive pig production system in East Shewa of central Oromia, Ethiopia.

## 2. LITERATURE REVIEW

### 2.1. Pig Farming Systems

In many parts of the developing world, pigs are kept under low-input systems where they roam freely to scavenge food which allows poor farmers the opportunity to enter into livestock keeping without large capital investments (Lian *et al.*, 2013). Pig-keeping enterprises found in and around towns and cities, play an important role in feeding urban populations (Johan and Arie, 2011). Pigs are an important source of household income and food security in many rural based economies of developing countries (Ly, 2000). In line with this, pig production plays an important role in smallholder farming systems, as a source of income and capital accumulation for use at critical times: rice shortage, medical treatment or marriage (Phengsavanh *et al.*, 2011). Similarly, smallholder pig farming is an important livelihood source in many rural communities of Kenya (Mutua *et al.*, 2011).

According to Devendra (1993), pig production can play three important functions, namely: (1) the diversification of resources and the reduction of socioeconomic risks, (2) the promotion of linkages between systems and resource components (land, water, crops, and animals), and (3) the generation of value added products (e.g., the recycling of fibrous crop residues to produce meat, and the use of manure). Pigs are kept primarily for pork production. In addition to pork, pigs supply pigskin for soft leather, bristles for brushes, lard (fat) for cooking, hormones for medicinal purposes and manure for soils and fish ponds. By-products such as pig skin and hair are used in the manufacture of light leather and brushes.

Furthermore, pig production has the following advantages: well adapted to both specialized and diversified farming, have quick returns, efficient way of producing meat, can be raised on pasture where they will not require expensive housing and equipment, breeding stock and feeding stock are readily available, labour requirements are low as one person can manage a large swine-breeding herd, easy multiplication, very good avenue

for improvement of house hold incomes and access the minerals in the soil to meet their nutritional requirements (Waiswa and Saamanya, 1999).

Dick and Geert (2004) characterized and classified the pig farming systems in the tropics as: free-range scavenging pig keeping (provides a household emergency fall-back fund, and with little investment of time or money and is typical of small farmer mixed holdings), semi-intensive pig keeping (animals are housed and more attention is paid to their health and feeding, with modest inputs and production is higher and the pigs are also marketed) while, intensive pig keeping (produce meat for the market efficiently and profitably, usually with larger numbers of pigs and requires significant inputs of time and money, with careful calculation of the costs and the resulting benefits). In contrast, the pig management system is also classified broadly into two groups: tethered/penned and stall-fed (Rameswar *et al.*, 2007).

Traditional pig production still predominates though semi intensive and intensive piggeries have been increasing in number near population centers such as Battambang (Kaufmann *et al.*, 2000). Pig producers in South-Eastern Botswana are mainly concentrated in the cities and big villages where the market and the demand for pig products are high (Chabo *et al.*, 2000). In developing countries, such as in Vietnam (Lemke *et al.*, 2006), India (Rameswar *et al.*, 2007), and in Africa (Lekule and Kyvsgaard, 2003), different production systems co-exist due to different resource availabilities, values and functions, knowledge and traditions. Most pigs are raised under traditional management conditions, but there is a trend for increasing pig production in commercial systems close to densely populated areas to meet the consumer demand for pork in Laos (Lampheuy, 2012).

The change of pig-rearing system from scavenging to backyard during the rainy season concurs in Zimbabwe so that the pigs do not damage crops which are also a source of livelihood for farmers in mixed crop–livestock production systems (Chiduwa *et al.*, 2008). Pigs kept under all production systems can be the host of a variety of pathogens, allowing pigs to roam freely increases the disease transmission risk to the pig itself, to

other wild and domestic animals, and to humans (Lian *et al.*, 2013). The pig free range system in Kenya is characterized by high mortality rates, low off take, low reproductive rates, minimal health care or supplementary feeding, lack of proper housing and high levels of inbreeding (Samuel *et al.*, 2012).

The number of pigs kept by household varies between an average of 1.4 and 3.7 animals, depending on the region in Laos (Vivien, 2004). The mean number of pigs owned per farm was 5.0 ( $\pm 3.4$ ), 1.8 ( $\pm 1.2$ ) and 1.5 ( $\pm 0.9$ ) for the pre-weaned, growing and adult pig categories in rural villages of Western Kenya (Mutua *et al.*, 2011). The same authors reported inadequate feeding is a major challenge in pig production in rural villages of Western Kenya followed by diseases, limited access to breeding boars, poor profits and free range pigs as sources of conflicts with neighbours when they uproot crops. Pig management is the control of a number of factors such as housing, feeding, breeding, health and records to allow pigs perform to the maximum of their genetic potential at least cost (Waiswa and Saamanya, 1999).

The purpose of pig production is mainly targeted for additional income and profit for the household where the keepers are farmers or non farmers with small land holding and people engaged in other types of work (Mekuriaw and Asmare, 2014). This confirmed reports of (Florence *et al.*, 2010; Dennis *et al.*, 2012 and Nath *et al.*, 2013), who stated that the majority of farmers involved in pig production as a source of secondary income. The condition in Ethiopia disagreed to the situation in Namibia, Uganda and Kenya where pig keeping is for income and pork consumption (Petrus *et al.*, 2011 and Muhanguzi *et al.*, 2012).

### ***2.1.1. Pig housing***

It is a building or roofed construction which may provide with pens for pig keeping. Housing of pigs is important as it provides an environment which improves feed efficiency; reduce on the labour in husbandry and management tasks like feeding and handling. In addition, housing will increase efficiency in control of diseases and parasites

thus it minimizes mortality and encourage production of healthy pigs (Waiswa and Saamanya, 1999). Irrespective of whether pigs are raised intensively or extensively, certain minimum housing standards must be met and pigs require clean, dry and well-ventilated quarters that will protect them from the sun and from rain (Morton and Darwin, 2010).

The pig farm site should be: at an elevated place that cannot be flooded by rain water, protected from the sun (shade from trees) and have ample fresh air, away from residences (around 8-10 meter away downwind), in case of a large scale pig farm, the site selected needs also to be: well connected to roads throughout the year, suitable for manure disposal, connected to reliable water and electricity sources (FAO, 2009). The pig house should: be built on dry land, have good access, close to food and water supplies, have good drainage around it, have good ventilation, provide shade, provide shelter from rain, provide shelter to keep the pigs warm at night, protect the pigs from strong winds to keep them healthy and have extra pens for sick pigs. Inappropriate housing can lead to rapid disease transmission, worm infestation and heavy losses of pigs (Faustin and Niels, 2003).

Housing types could be open range, tethering, open range, enclose, pen system and scientific (Rameswar and Jain, 2011). However, housing in most developing countries in the tropics is characterized by lack of wind protection, lack of bedding materials, poor sanitation, poor spacing and wet floors leading into disproportionate food wastage, physical damage through fighting, predisposition regardless of the type of housing system used, the design needs to provide adequate space, good ventilation and appropriate temperature to allow for the safe, efficient and humane movement of pigs (National Farm Animal Care Council, 2013).

Dennis *et al.* (2012) stated mud and grass, bricks and concrete, corrugated iron sheets and tree shades are the pig housing types in Nangabo Sub-County, Wakiso district. Similarly, total confinement of pigs is rarely done and most farmers lack pens to house their pigs where the neighbour conflicts were an important challenge (Florence *et al.*, 2011). In

contrast, Wood walled system, Brick walled system, Stone walled system, Wall made of soil, fence were the major pig housing type in Southern Botswana (Nsoso *et al.*, 2003). The cement block walls with zinc roof and concrete floor has been advocated because of its durability and high level of hygiene (Ironkwe and Amefule, 2008).

### ***2.1.2. Pig feeding***

Pigs must be provided with daily access to feed which is fresh, palatable, and free of known gross contaminants, physical or toxic substances and micro-organisms, that maintains their health and meets their physiological requirements (Department of Primary Industries, 2008). Sound feeding practices that provide for adequate nutrient needs are integral to the health and wellbeing of pigs in all stages of production. Nutrient requirements vary according to the genetics and sex of the pig and the surrounding environment (Greg and Graeme, 2006).

Feeding follows a phase structure due to the change in nutrient requirements when pigs grow (Heugten and Kempen, 2001). This implies that pigs differ widely in their response to various diets and general recommendations are inappropriate for any individual set of circumstances. Feed costs represent 60-70% of the total cost of production in the pig industry and the profit from a pig enterprise depends on efficient and economical use of the feeds (Waiswa and Saamanya, 1999). Feed is either supplied by feed companies or prepared on farm feed mills which consists of a balanced mix of grains such as barley, wheat, corn, canola meal and even peas or lentils. Hence, Sows are fed limited amounts of feed typically once a day to keep their weight moderate and helps to prevent farrowing difficulty while growing pigs are provided with high-energy feed at all times to maximize weight gains (BCSPCA, 2009).

The primary goal of the feeding program in the nursery should be to provide a palatable, digestible, nutritious diet which allows uniform and rapid pig growth (Richard *et al.*, 2000). The major feed sources for pig production include household waste, grass, brewer's residue and commercial feed (Nath *et al.* 2013) and kitchen waste, sorghum

bran, rotten fruits and brewer's residue (Nsoso *et al.*, 2003). Likewise, pigs feed on cassava, potatoes and crop residues (sweet potato vines, banana peelings), grasses and ruminal contents from the local abattoirs (Dennis *et al.*, 2012). In addition, farmers provide feed to pigs one to two times a day. In urban areas, feed sources were kitchen and restaurant waste, and likewise crops and agriculture residues were in rural areas however, supplements and concentrates were used on a limited scale (Deny, 2012).

Most villagers in Rural Southwest China fed their pigs three times a day and filled the water troughs in the pig pen as needed (Jian, 2010). Feeding just a small amount in an unbalanced way causes a low performance of sows and of fattening pigs raised in smallholder farms in Central Vietnam and makes it impossible to reach a good production level (Pham *et al.*, 2010). Mukota pigs are traditionally fed on feeds such as forages, pumpkins and kitchen wastes (Mashatise *et al.*, 2005). Feed resources that were offered to pigs included Mexican clover (*Richardia brasiliensis*), kitchen swill, maize cobs, vegetables, ground nut hulls, brewers dried grain and pumpkins (Chiduwa, 2008). Ironkwe and Amefule (2008) noted house hold waste followed by brewer' residue (rice and wheat wastes), grasses and Commercial feeds as the major source of pig feed in their appraisal of indigenous pig production and management practices in rivers state, Nigeria.

### ***2.1.3. Pig healthcare***

Healthy pigs convert feed in to meat efficiently and grow faster which are important advantages to successful niche pork production. Such condition decreases the death and cull of pigs (Peter *et al.*, 2007). The same authors explain the signs for healthy pigs as active curious, hungry, clean and dry likewise, for sick pigs listless, uninterested, off feed, rough hair with dirty rears. An effective swine herd health program addresses proper nutrition, housing, and ventilation; animal welfare and comfort; appropriate pharmaceutical use; and disease prevention and control strategies.

Successful swine production requires the application of health-conserving, disease preventing, and parasite-controlling measures to the breeding, feeding, and managing of

the herd. By nature, pigs possess clean habits. However, in many cases they are kept in old, crowded, and filthy quarters and such conditions favor the attack by the common diseases and parasites of swine (Michael, 1996). An effective herd health management practices contributes to animal well-being by providing an approach for disease prevention, rapid diagnosis and effective treatment. Prevention of disease rather than treatment of disease are better for animal welfare and are more economical for the producer and many outbreaks of disease in swine herds can be avoided by using management practices that include strict sanitation and immunization programs (National Farm Animal Care Council, 2013).

A herd health management practices include: vaccination, observation of all animals for injury or signs of disease, accurate and reliable record keeping, prevention, detection and treatment of disease or injury, pest control, animal handlers. Swine fever, foot and mouth disease, parasitic infestation, seasonal flu, diarrhea, piglet anemia are the major disease problems (Rameswar and Jain, 2011). Similarly, Samuel *et al.* (2012) noted that African swine fever, influenza a, porcine cysticercosis, foot and mouth disease, helminthes, pneumonia, and meningitis are the major pig diseases in Kenya. The main diseases that affect pig production are the classic swine fever, foot and mouth disease, blue ear disease, asthma, enteritis, diarrhea and atrophic rhinitis and controlled by locally produced vaccines that are administered to the pigs via intramuscular from one to three times a year in a commercial pig farm in Beijing, China (Roxana, 2010).

In warm weather, the cleaning involved sweeping pig wastes into the manure pit and washing the floor with a broom and a bucket of water but in cold seasons, straw and stalks were often deposited on the floor to keep pigs warm. This meant that, in addition to sweeping and washing, villagers also needed to replace the filthy layer with clean materials and it added more than half an hour to a farmer's workday in Rural Southwest China (Jian, 2010). The main pig disease problems reported in rivers state, Nigeria were helminthiasis, cough, diarrhea, skin disease mainly sarcoptic mange and lice infestation (Ironkwe and Amefule, 2008). The same authors claim that Mange and lice infestation

can cause considerable losses because of the extreme itching and continuous scratching of the affected area, especially when prevalence is high during the dry season.

In several cases, the entire body surface becomes affected, loss of appetite and body weight gain depressed. In semi-arid north-eastern Zimbabwe, the major causes of piglet mortality are crushing, diarrhea and predation (Mashatise *et al.*, 2005). Disease control measures such as deworming, spraying, and vaccination, were found to be rare in the districts, with poor extension services and inability to pay for services being contributory factors in Kikuyu Division, Central Kenya (Wabacha *et al.*, 2004). Helminth infestations, according to Nganga *et al.* (2008), can reduce performance and lead to subsequent economic losses.

The local belief that letting the pigs bathe in the mud would control for the common ectoparasites may potentially serve as a control strategy for ectoparasites but the practice may predispose the pigs to acquiring diseases such as African Swine Fever if pigs congregate at rivers; ASF is known to cause serious economic losses on pig farms in Mozambique (Penrith *et al.*, 2007). Due to its isolated geographical position and strict import regulation, New Zealand has been isolated from the following diseases: African swine fever, Hog cholera virus, Menangle disease, Porcine Reproductive Respiratory Syndrome (PRRS) and Swine influenza (New Zealand Pork Industry Board, 2004).

## **2.2. Performance of Pigs**

Raising pigs for meat production includes several stages: Gestation (pregnancy of the sow), farrowing (giving birth to the piglets), nursery (caring for young piglets) and grow-finish (growth of weaned piglets to slaughter weight) with this the gestation period of a sow is 115 days, average litter size is 10-12 piglets, weaning age 3 to 4 weeks, stay in nursery is 4 to 8 weeks while and it takes 5 to 6 months to raise a pig from farrow to finish to reach the market weight of 110-120 kg (BCSPCA, 2009). Chabo *et al.* (2000) reported litter size at birth (10.2), litter weight at birth (0.8 kg), litter size at weaning (6.5), litter weight at weaning (6.4kg), Survival rate (birth-weaning) (63.6%), mortality

(36.4%), weaning age (4 weeks) and farrowing per year (2) for Duroc pig breed in South-Eastern Botswana. Tekle *et al.* (2013) reported mean herd size was  $12 \pm 2$ , average farrowing rate was twice per year, litter size ranged from 8 to 13 with a mean of 11 piglets per farrowing, mean age at first farrowing was 8 months and average lactation length was  $28.0 \pm 2.8$  days.

Baffour-Awuah *et al.* (2005) looked at performance of pigs under an intensive management system at the Babile pig breeding station in the upper West region of Ghana and reported an average litter size at birth of 7.7 with mean birth weight of 0.99 kg; average litter size at weaning was 6.0 and mean weaning weight at 42 days was 6.7 kg with an average pre-weaning growth of 135.6 g/day. The litter size of pig production in free range, restrained, semi penned and penned systems were  $5.6 \pm 1.19$ ,  $6.0 \pm 1.15$ ,  $7.0 \pm 2.28$ ,  $5.69 \pm 1.97$  respectively (Deny, 2012). In Germany, the life span of a fattened pig is approximately 180 to 220 days (Langkabel and Fries, 2013).

Post weaning growth performance depends upon the weaning age, weaning weight, coping ability, health status, feed intake, diet composition, digestive capacity, genetic potential for growth, quality of management and the environment, nutritional program and diseases status (Dedecker, 2000). Ochetim (1993) stated that the average litter size at birth 6.5, average piglet weight at birth 1.0 kg, weaning weight 8.7 kg, farrowing interval 232-253 days and pre-weaning mortality 50% in the South Pacific. (Nath *et al.*, 2013) recorded the litter sizes at birth (local,  $4.3 \pm 0.45$ ; crossbreed,  $7.2 \pm 0.33$ ), at weaning (local,  $2.79 \pm 0.24$ ; crossbreed,  $6.1 \pm 0.21$ ), and age at first farrowing (local,  $365.39 \pm 7.96$  days; crossbreed,  $337.24 \pm 8.79$  days) while characterizing smallholder pig production system in Sikkim Himalayan region.

### **2.3. Pig Breeds**

Pig production in Kenya is practiced mainly as intensive and semi intensive smallholder systems, and large scale commercial enterprises (Githinji *et al.*, 2007) where the Large White (LW) is the main breed utilized due to its desirable growth potential and high

fecundity. Indigenous pigs are well adapted to tropical conditions as they are adapted to local production conditions and environments, and are less susceptible to common diseases and parasites, such as ascaridiosis (Zanga *et al.*, 2003). In addition, they have the ability to survive long periods of feed and water deprivation (Anderson, 2003). Local pigs, in particular, unlike imported genotypes, are less reliant on external inputs and are, therefore, potentially part of a sustainable agricultural system for resource-poor farmers. They are generally hardy, and can survive and reproduce on low plane of nutrition (Mashatise *et al.*, 2005).

Local pigs are mainly kept by farmers in developing countries (Chiduwa *et al.*, 2008). Local pigs are suitable for smallholder farmers. In Asia, many different native pigs and local breeds can be found (Anil *et al.*, 2006). Pigs of predominantly indigenous breeds are kept by smallholders as a supplementary source of income for smallholder pig production accounting for 96 percent of the total pigs produced in Lao PDR (Vivien, 2004). In Zimbabwe, indigenous pigs are generally known as Mukota and are predominantly black and much smaller than the commercial or imported breeds, such as the Large White and Landrace (Obert, 2006).

The indigenous pigs have an enhanced capacity to utilize fibrous diets, hence increase the efficiency of utilization of agricultural by-products (Kanengoni *et al.*, 2004), which are usually burnt or thrown away. Indigenous pigs are also able to reproduce at low planes of nutrition (Kanengoni *et al.*, 2002). They not only require low-inputs, in terms of feed, but they also thrive in local environments. The indigenous breeds have a tendency to lay down fat, which enhances survival chances in areas with permanent or seasonal nutritional stress.

They are more mobile and better equipped to scavenge and root. The Mukota is considerably less susceptible to heat and more resistant to most local diseases and parasites (Holness, 2005). Studies by Zanga *et al.* (2003) have shown the Mukota pig to be resistant to some parasites, such as *Ascaris suum*. These characteristics contribute to hardiness and survivability when crossed with an exotic breed (Holness, 2005). Attributes

of Mukota pigs are largely related to their hardiness and adaptation to survive under smallholder farming environments where resources are largely limiting. They are adapted to the low- and medium-input environmental systems (Chimonyo *et al.*, 2005). About 93% of the households that own pigs keep the local Mukota pigs and the remainder keep imported and cross breed pigs (Mashatise *et al.*, 2005).

Farmers considered traits such as body size shape vitality of sows and availability of replacement stock when choosing replacement boars. Research in Meghalaya indicated that 87.5% upgraded pigs were more suitable for smallholder producers than pure Hampshire or Large Black or 75% upgraded pigs (Das *et al.*, 2005). Farmers mainly keep native breeds, as the local people prefer pork from native breeds to pork from imported (exotic) breeds. Moo Hmong and Moo Lath are the most common pig breeds in the North of Lao PDR (Sounthilath, 2005). These two native breeds are either completely black in colour or black with white spots.

The main challenge to improved pig productivity in Kenya and other developing countries is lack of organized breeding programmes to facilitate genetic improvement (Chimonyo and Dzama, 2007). This is mainly because the important components for design of breeding programmes such as definition of breeding objectives, choice of selection criteria, genetic evaluations, selection and design of appropriate mating systems and strategies for the dissemination of genetic superiority are missing (Kahi *et al.*, 2006).

#### **2.4. Socio-Economic Characteristics of Pig Production**

Pigs were owned by individuals as well as groups of producers organized into cooperatives mainly in Northern Ethiopia (Tekle *et al.*, 2013). According to the same author, the age of pig producers ranged from 19 to 54 and the mean family size was  $4.0 \pm 0.4$ . Seventy eight percent of the pig producing households were having elementary school and above educational background.

Majority of pig producers were educated. This provides potential opportunity to acquire and adopt agricultural knowledge and innovations. Education has thus been demonstrated

as an important socio-economic factor enhancing the capability of farmers to adopt new agricultural innovations and consequently improving productivity. The mean age of household heads was within the active age group for carrying out effective agricultural enterprises.

According to Mekuriaw and Asmare, (2014) the majority of pig keepers in Northwestern Ethiopia were males (86.7%) with small proportion of females (13.3%) with average land size of a pig keeper was 0.33 ha. According to the same authors, most pig farmers were engaged in a variety of off-farm activities with livestock fattening being the highest (33.2%) followed by trade (20%) and office work (13.4%).

## **2.5. Challenges and Opportunities of Pig Production**

Lack of market, high feed cost, lack of basic knowledge and skill on pig management, poor extension services, lack of skilled veterinarians on pig diseases and poor preventive healthcare are major constraints of pig production in Ethiopia (Tekle *et al.*, 2013; Birhan *et al.*, 2015). Similarly, lack of organized market channel, limited market information and lack of guaranteed prices were the most pressing challenges to pig production (Sovann and San, 2002).

Similarly, Dennies *et al.* (2012) stated that the major factors limiting pig production were; diseases and parasites mainly helminthosis and African swine fever (ASF). Others included; high costs of inputs, lack of capital, unstable availability of feed resources, inadequate advisory services and feed price fluctuation, lack of good quality breeding stock, poor and unorganized marketing, lack of enough land, high costs of veterinary medicines and inability to keep records. Additionally, lack of enough water and uncontrolled pig movement grossly limited the pig production.

The major challenges to the pig industry are inadequate slaughter facilities, unorganized marketing, and inadequate supply of breeding stock, high price of feeds, as well as, low quality feeds (John and Hezlet, 2011). To improve pig production and reduce animal

protein deficit, knowledge on constraints to pig production is important to inform pig sector promotion stakeholders.

The supply of pig breeding stock is grossly inadequate, indicating that an opportunity exists in breeding (Berihu and Tamir, 2015). There is no farmer that focuses solely on breeding pigs for sale to other farmers. There are imports of pig meat and processed pork products thus creating an opportunity to either establish new pig enterprises or expand existing ones. According to Samuel (2013) the main opportunities of pig production were increased pork consumption, increased prices of other meats (beef scarce), new outlets (butcheries), fragmentation of land, homemade rations and use of forage supplements, expanding export markets, short production cycle, formation of pig farmers groups, technical support from international bodies.

## **2.6. Pig Marketing Practices**

Marketing includes moving products from producers to consumers and comprises exchange activities of buying and selling and dissemination of information to participants in the marketing process (Jabbar *et al.*, 1997). Livestock marketing involves the sale, purchase or exchange of products (ILCA, 1990). Farmers need to be aware of the preferred characteristics of animals as well as price patterns so that they can plan breeding and fattening program and breed selection consistent with the best seasonal prices and consumers' preferences (Ehui *et al.*, 2000). Alleviating constraints to the export market, domestic trade and market structure increases the welfare of smallholder producers and urban consumers (Ayele *et al.*, 2003).

In most African livestock markets, evidence suggests that information flows relatively freely through traditional information systems (ILRI, 1995). However, the free flow of information does not necessarily imply the effectiveness of the information system. Consumers get meat through purchase of the animals from terminal markets and slaughters at home or they may get meat from markets or they may access from butchers who process the meat via abattoirs. Marketing channels refer to a sequence of enterprises and markets by which produce is moved from producer to consumer. Where the distance

between the production and the consumption points is small, the channel is correspondingly simple.

The absence of regular market information on prices and supplies and formalized grades and standards of livestock are the marketing constraints (Ayele *et al.*, 2003). Livestock are traded by eye ball estimation and strong negotiation between buyer and seller (EARO, 2000). Most farmers of semi-arid Zimbabwe cited market-related constraints such as difficulties to contact buyers, lack of price and grade information, high transport cost, and tedious legal procedures (Sabine *et al.*, 2007). Livestock markets are generally under the control of local authorities. Markets are usually not fenced. There are no permanent animal routes and no feed and watering infrastructures. Yet buyers and sellers are subjected to various service charges by the local authorities as well as other bodies (Ayele *et al.*, 2003).

Livestock are generally traded by 'eye-ball' pricing, and weighing livestock is uncommon. Animals are sold on a per-head basis and price agreement reached by a long one-on-one bargaining between a seller and a buyer. Under such circumstances, prices paid will reflect buyers' preference for various animal characteristics (weight, sex, age, condition, breed, and color), the purpose of animals purchased (for resale, slaughter, fattening or reproduction), the season of the year (occurrence of religious and cultural festivals) and the bargaining skills of buyers and sellers (Kebede, 1992; Ehui *et al.*, 2000; Ayele *et al.*, 2003).

## **2.7. Concept of Value Chain**

A value chain (VC) can be defined as the full range of activities that are required to bring a product or service from conception, through the different phases of production (involving a combination of physical transformation and the input of various producer services); delivery to final customers; and final disposal after use (Bammann, 2007). According to Issa (2010), in the context of food production, these activities include farm production, trade and support to get food commodities to the end consumer (e.g. transport, processing). Business dictionary also defined value chain as linked value

adding activities that convert inputs into outputs which, in turn, add to the bottom-line and help create competitive advantage.

Agricultural value chains can include three or more of the following: producers, processors, distributors, brokers, wholesalers, retailers and consumers (Bammann, 2007). Moreover, the value chain concept has proven particularly useful for the identification and formulation of projects as well as in the development of strategies for improved agricultural and rural development.

A value chain is the full range of activities required to bring a product from conception, through the different phases of production and transformation, and delivery to final consumer (Kaplinsky and Morris, 2001). As stated by Mengistu (2010), without having well established coordination among the value chain actors and convenient marketing systems, the potential increment in productivity, rural incomes and foreign exchange earnings resulting from dispersed efforts and introduction of improved production technologies alone could not be effective.

Thus, a well-established pig product marketing system would be a very valuable tool for producers, collectors and processors to plan and take advantage of the products' seasonal flow (Mengistu, 2010). An improvement in marketing efficiency, thus, attracts the attention of many governmental and NGOs and viewed as an important national development strategy.

### 3. MATERIALS AND METHODS

#### 3.1. Description of the Study Area

The study was undertaken in three major cities in East Shewa of central Ethiopia, namely: Addis Ababa, Bishoftu and Adama representing highland, midland and lowland agro-ecologies, respectively. The selection of towns was based on their proximity, pig population, pig fattening, feed production, marketing and pork utilization.

Addis Ababa is located at 9°1'48"N latitude 38°44'24"E longitude and average altitude of 2355 meters above sea level. The area receives a bimodal rainfall with a long rainy season occurring from June to September and annual rainfall of 1184 millimeter and average temperature of 12.2°C (Addis Ababa Bureau of Finance and Economic Development, 2013).

Bishoftu is found at 9°N latitude and 40°E longitude and at an altitude of 1850 meters above sea level. It is located in Oromia region, East Shewa Zone about 47.9 km Southeast of Addis Ababa, the capital city of Ethiopia with a bimodal rainfall pattern, having a main rainy season from June to September. The annual average rainfall and temperature are 866 mm and 20 C° respectively (NMSA, 2010). Bishoftu is also a town, where College of Veterinary Medicine and Agriculture, the National Veterinary Institute, the Pan-Africa Veterinary Vaccine Centre, and Ethiopian Institute of Agricultural Research are located (Mekonnen *et al.*, 2012). Hence, this area has greater potential for access to veterinary and production expertise and materials to support production than anywhere else in the country.

Adama is located at 8°32'24"N latitude and 39°16'12"E longitude about 99 km Southeast of Addis Ababa. It is situated at an altitude ranging from 1300 to 1500 meters above sea level. The area receives an average annual rainfall ranging from about 600 to 1150 mm which is erratic in nature. There is a significant seasonal variation in the amount of rainfall. More than 67% of the mean annual rainfall occurs in the four rainy months: June,

July, August and September. Some additional rains (about 23%) occur in the remaining dry months with mean monthly values of rainfall as low as zero mm. The minimum and maximum daily temperatures of the area are 12 and 33°C, respectively (NMSA, 2010). The map of East Shewa is described in Figure 1.

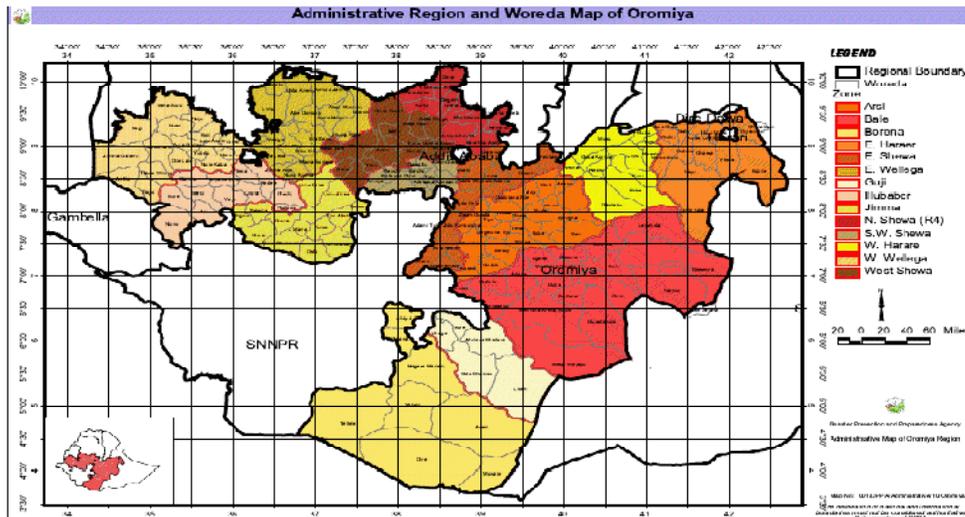


Figure 1: Map of East Shewa, Oromia Region

Source: (ILRI, 2005).

### 3.2. Sampling and Data Collection Procedure

In achieving the research project objectives different data collection techniques (questionnaire interview, focus group discussion, body condition scoring and weighing amount of feed offered and refused) were employed.

#### 3.2.1. Determination of the sample size

The sample size (N) was determined using the formula recommended by Arsham (2005) as  $N = 0.25/SE^2$ , where N is sample size, and SE is the standard error. Thus, 105 household pig farmers were sampled. A multistage sampling technique was employed to select study sites and pig farmers. In the first stage three cities namely Addis Ababa, Bishoftu and Adama were selected based on the availability of pig farms. In the second stage, two sub cities namely Akaki kaliti and Yeka from Addis Ababa and four Kebeles

each from Bishoftu and Adama were selected purposively. A total of 105 household pig farmers were randomly selected from the three cities. Accordingly, 35 (33.3%), 40 (38.3%) and 30 (28.3%) pig keepers were selected from each city, respectively. Then, the sample size for Yeka (16; 45%), Akakai Kaliti (19; 55%), and the four kebeles of Bishoftu (10; 26%, 10; 24%, 9; 22%, 11; 28%) and Adama (7; 23.5%, 11; 35%, 7; 23.5%, 5; 17.6%) were selected based on proportion. The pig farmers were randomly selected from the registered list of pig farmers of each selected sub-city in Addis, and from each Kebele in Bishoftu and Adama.

### ***3.2.2. Cross-sectional survey***

A cross-sectional survey was employed to explore information on small scale intensive pig production system in East Shewa with special emphasis on management practices, production and reproduction performances, marketing practices and challenges. Preliminary survey was conducted to have an overall view of the the pig farming system. With the assistance of local agricultural staff in the towns, preliminary information was observed in the following areas: pig farming systems, number of pig farms, average size of the pig herd per farm and how long farmers involved in pig farming?

### ***3.2.3. Data collection procedure***

The data were collected using structured and semi-structured questionnaire. The questionnaire was translated into local language and pre-tested before the actual data collection process to prove the appropriateness and clarity of the questions. The questions were re-framed in such a way that pig farmers can understand and respond easily. The questionnaire was administered to the pig producers by enumerators, selected from the study area, recruited and trained for this purpose with close supervision by the researcher. Based on the questionnaire interview, the following major information were gathered.

**Socioeconomic profile** pertaining to age, sex, family size, land size, educational level, farming experience in years, source of income and wealth status were accessed.

**Farm characteristics** with regard to type of breed, sources of labour, working hour, herd size and source of foundation stock were collected.

**Healthcare practices** with respect to maintain health records, contact of veterinarian in the last 12 months, purpose of veterinary contact and disposal of dead pigs, prevalent diseases bio-security practices (have controlled entry, overalls/boots for workers and visitors, perimeter fence around the farm, use of feet bath, use of wheel bath, cleaning and disinfecting trucks, quarantine practices, for new pigs, isolation areas for sick pigs, number of days quarantined, distance from the main herd (m), and factors affecting pig production were gathered.

**Feed** regarding feed types, feed sources, amount of feed offered, feed chemical composition and body condition scores of pigs were gathered.

**Watering** practices in relation to sources of water and watering frequency were collected.

**Housing** practices regarding individual and group housing were collected.

**Pig performance parameters** concerning age at first mating, conception rate, age at first farrowing, farrowing interval, birth weight, litter size (at birth and weaning), weaning (weight and age), marketing weight, stillbirth, gestation period and body condition score were collected.

**Performance of fattening pigs** in relation to number and breed of fattener pigs, average fattening time (months) and average daily gain (g) and average selling weight (kg) were collected.

**Mortality** on the subject of pre- weaning mortality was collected.

**Marketing practices** in relation to types of buyers, main product sold ways of buying, sources of market information, reasons of buying, selling place, methods of price estimation, average selling price of live pig and pork, price change, pig value chain, marketing channels and marketing constraints were gathered.

#### ***3.2.4. Focus group discussion***

To triangulate the data obtained through interview three focus groups (one group in each site) were organized and conducted in the selected towns East Shewa of central Ethiopia namely: Addis Ababa, Bishoftu and Adama using guideline for discussion (Annex<sub>2</sub>). And,

the points of discussion were: identification and prioritization of pig production constraints, disease situations, feed resource, water resource and farming systems. Nomination of discussants was made together with the urban agricultural staff. A total of 6 participants were invited for a focus group discussion (FGD). The date for discussion was set jointly and a reminder invitation sent to them one week before the date. Discussions were held in one of the government halls of the towns in East Shewa. Discussions begun by general introduction lead by a senior town elder; the group identified one of the participants to lead the group. The researcher gave a brief overview of the research and summarized key expectations for the meeting. All participants were encouraged to participate and considered each answer as relevant. The researcher called for open discussions in any language that the participants be comfortable with. Refreshments were offered to the participants at the end of each discussion. Unique observations during the discussions were recorded in writing by the researcher during the discussions.

### **3.3. Feed Chemical Analysis**

Chemical compositions of feed samples were analyzed in National Veterinary Institute (NVI) nutrition laboratory. Collected pig feed samples were ground to pass through 1mm sieve to determine for dry matter (DM), ash, ether extract (EE), crude protein (CP) and crude fiber (CF) according to AOAC (1990) and calcium (Ca) was determined by Talapatra method (precipitation, filtration and titration) according to Mudgal (2012). The metabolizable energy (ME) values of each feed sample were calculated ultimately from EE, CF and ash according to Wiseman (1987) as:  $ME \text{ (kcal/kg DM)} = 3951 + 54.4 \times EE - 88.7 \times CF - 40.8 \times \text{Ash}$ .

The amount of feed offered per day for different pig classes were determined by weighing using a suspended balance of 5 kg capacity. The number of pigs assessed for body condition score was 30 for each pig category making a total size of 180. Piglets are young pigs, weaners are found in the nursery having been weaned away from mother, any pig between weaning, transfers to the breeding herd or sold for slaughter, boar is male pig

that is not castrated, and sow is female pig that has furrowed (Darren, 2010). A scale from 1 (emaciated) to 5 (obese) was used in the scoring system for body condition assessment which combines both visual appraisal and feel.

Table 1: Pig body condition scoring system

Score	Description	Assessment
0	Emaciated	Exposed, no cover on bones
1	Poor	Bones prominent, little cover
2	Moderate	Bones easily felt without palm pressure
3	Good	Bones only felt with firm palm pressure
4	Fat	Bones cannot be felt with firm palm pressure
5	Glossily fat	Further deposition of fat impossible

Source: Holness (1991).

### 3.4. Statistical Data Analysis

Data collected through questionnaire were analyzed by ANOVA, Chi-square, Fishers exact test and descriptive statistics of statistical package for social sciences (SPSS, 2006). One way ANOVA was employed to analyze age, sex, family size, land size, farming experience in years, working hour, number of days quarantined, distance from the main herd (m), age at first mating, conception rate, age at first farowing, farowing interval, birth weight, litter size (at birth and weaning), weaning (weight and age), marketing weight, stillbirth, gestation period, body condition score, average fattening time (months) and average daily gain (g), average selling weight (kg), pre-weaning mortality and average selling price of live pig. The statistical model used in the present study included:

$$Y_{ij} = \mu + T_i + \varepsilon_{ij}, \text{ Where,}$$

$Y_{ij}$  = Response variables

$\mu$  = Overall mean

$T_i$  = Effect of towns where  $i = 1$  is Addis Ababa,  $i = 2$  is Bishoftu and  $i = 3$  is Adama

$\epsilon_{ij}$  = is random errors with normal distribution,  $N(0, I)$ .

Chi-square was used to analyze the following parameters: sex, educational level, source of income, wealth status, sources of labour, source of foundation pig, maintain health records, contact veterinarian in the last 12 months, purpose of veterinary contact and disposal of dead pigs, have controlled entry, no overalls/boots provided to visitors, perimeter fence around the farm, use of feet bath, use of wheel bath, no clean and disinfect trucks, no new pigs introduced, new pigs quarantined, no quarantine practices, feed types, feed sources, sources of water and watering frequency, recommended, not recommended, individual and group housing, number of fattener, types of buyers, main product sold, ways of buying, sources of market information, reasons of buying, selling place, methods of price estimation and price change.

Purposes of pig rearing, types of pig operations, chemical composition of composite feeds, pig value chains and pig marketing channels were analyzed by descriptive statistics. The method of ranking was used for leveling types of diseases, production and marketing constraints in the study areas as described by Ebrahim and Hailemicheal (2012).

$$\text{Index} = R_n * C_1 + R_{n-1} * C_2 \dots + R_1 * C_n / \sum R_n * C_1 + R_{n-1} * C_2 \dots + R_1 * C_n$$
; Where,

$R_n$  = Value given for the least ranked level (example if the least rank is 8<sup>th</sup>, then  $R_n = 8$ ,  $R_{n-1} = 7$ ,  $R_{n-2} = 6$ ,  $R_{n-3} = 5$ ,  $R_{n-4} = 4$ ,  $R_{n-5} = 3$ ,  $R_{n-6} = 2$ ,  $R_{n-7} = 1$ ),  $C_n$  = Counts of the least ranked level (in the above example, the count of the 8<sup>th</sup> rank =  $C_n$ , and the count of the 1<sup>st</sup> rank =  $C_1$ ).

## 4. RESULTS

### 4.1. Socio-Economic Characteristics

The socio-economic characteristics of small scale intensive pig keepers in East Shewa are shown in Table 2. Sex of respondents was not associated with the towns ( $p>0.05$ ). Majority (97.1%) of the respondents were male headed households while 2.9% were female headed households.

The results of the analysis showed that age of pig farmers at the three towns were similar ( $p>0.05$ ). The average age of the pig farmers was  $39.78\pm 2.1$ . The mean family size across the towns was not different ( $p>0.05$ ) from each other. The overall mean family size per household in the studied towns was  $3.14\pm 0.352$  people.

Pig rearing experiences of farmers were different ( $P<0.05$ ) across the study sites. The mean farm experience of respondents was significantly higher in Bishoftu ( $10.3\pm 1.032$  years) compared to respondents in Addis Ababa ( $5.1\pm 0.494$  years) and Adama ( $3.3\pm 0.547$  years), respectively. There were differences ( $P<0.05$ ) in farmers land size along with the three towns. The mean farm size in ha was significantly larger ( $P<0.05$ ) in Bishoftu ( $4.5\pm 1.28$ ) than in Addis Ababa ( $1.2\pm 0.646$ ) and Adama ( $1.2\pm 0.568$ ).

Education level of respondents was not associated with the study sites ( $p>0.05$ ). As regards to total educational level, 47.6% were university graduates, 27.6% senior and 25.7% junior school levels. There was no relationship ( $p>0.05$ ) between source of income among the respondents. The intensive pig farmers considered various combinations (77.1%) as their main source of income followed by sell of livestock (10.5%), salary (7.6%) and pension (5.7%).

Wealth status of pig keepers was significantly associated with the study sites ( $p<0.05$ ). Significantly higher ( $p<0.05$ ) percentage of wealthy farmers was identified in Bishoftu

than in Addis Ababa and Adama. Significantly smaller ( $p < 0.05$ ) proportion of poor pig farmers was detected in Bishoftu compared to in Addis Ababa and Adama.

Table 2: Socio-economic characteristics of small scale intensive pig production in East Shewa

Characteristics	Towns			Total N (%)	Test	
	Addis Ababa N (%)	Bishoftu N (%)	Adama N (%)		X <sup>2</sup> -value	p-value
<b>Sex</b>						
Female	1(2.8) <sup>a</sup>	1(2.5) <sup>a</sup>	1(3.3) <sup>a</sup>	3(2.9)	0.043	0.979
Male	34(97.1) <sup>a</sup>	39(97.5) <sup>a</sup>	29(96.7) <sup>a</sup>	102(97.1)	0.043	0.979
<b>Educational level</b>						
Junior	9(25.7) <sup>a</sup>	10(25) <sup>a</sup>	8(26.7) <sup>a</sup>	27(25.7)	0.025	0.988
Senior	10(28.6) <sup>a</sup>	11(27.5) <sup>a</sup>	8(26.7) <sup>a</sup>	29(27.6)	0.030	0.985
University	17(48.6) <sup>a</sup>	19(47.5) <sup>a</sup>	14(46.7) <sup>a</sup>	50(47.6)	0.024	0.988
<b>Source of income</b>						
Salary	2(5.7) <sup>a</sup>	2(5) <sup>a</sup>	2(6.7) <sup>a</sup>	6(5.7)	0.888	0.957
Pension	3(5.7) <sup>a</sup>	3(7.5) <sup>a</sup>	2(6.7) <sup>a</sup>	8(7.6)	0.085	0.959
Sell of livestock	4(11.4) <sup>a</sup>	4(10) <sup>a</sup>	3(10) <sup>a</sup>	11(10.5)	0.051	0.975
Various combinations	27(77.1) <sup>a</sup>	31(77.5) <sup>a</sup>	23(76.7) <sup>a</sup>	81(77.1)	0.007	0.997
<b>Wealth status</b>						
Poor	11(31.4) <sup>a</sup>	3(7.5) <sup>b</sup>	18(60) <sup>a</sup>	32(30.5)	22.323	0.000
Medium	7(20) <sup>a</sup>	11(27.5) <sup>a</sup>	2(6.7) <sup>a</sup>	20(19)	4.856	0.088
Well-to-do	17(48.6) <sup>a</sup>	26(65) <sup>b</sup>	10(33.3) <sup>a</sup>	52(50.5)	6.953	0.031
	Mean ± SD	Mean ± SD	Mean ± SD	Mean ±SD	F-value	p-value
Age in years	39.63±1.72 <sup>a</sup>	39.85±2.1 <sup>a</sup>	39.87±2.0 <sup>a</sup>	39.78±2.1	0.16	0.850
Family size	3.14±0.355 <sup>a</sup>	3.13±0.4 <sup>a</sup>	3.17±0.4 <sup>a</sup>	3.14±0.352	0.118	0.889
Farm experience in years	5.1±0.494 <sup>a</sup>	10.3±1.032 <sup>b</sup>	3.3±0.547 <sup>c</sup>	6.6±3.079	809.04	0.000
Land size in hectares	1.2±0.646 <sup>a</sup>	4.5±1.28 <sup>b</sup>	1.2±0.568 <sup>a</sup>	2.5±1.85	156.6	0.000

N (%) depicts number or percent of respondents; SD refers to Standard Deviation; <sup>a,b,c</sup> numbers connected by different letters are statistically significant

## 4.2. Characteristics of Pig Farms

Table 3 depicts the characteristics of small scale intensive pig farms: breed, labor, working hours, herd size and source of parent stock. For all herds, the pigs were crossbred considering the total population size. Sources of labor and foundation stock were not associated with town ( $p>0.05$ ). Hired labor was the leading supply of labor in the studied areas.

The majority (85.7%) of respondents in the three surveyed towns acquired their foundation stock from neighbor's herds, while 14.3% of them obtained from other towns and country; however, none of the respondents procured pigs from local market place. Working hour was similar ( $p>0.05$ ) while pig herd size was different ( $p<0.05$ ) across the towns. The overall mean time spent on feeding and managing pigs was  $7.07\pm 0.251$  hours per day. The number of pigs reared per household in Bishoftu town was very much higher ( $P < 0.05$ ) than those in Addis Ababa and Adama towns.

Table 3: Characteristics of small scale intensive pig farms in East Shewa

Characteristics	Towns				Test	
	Addis Ababa N (%)	Bishoftu N (%)	Adama N (%)	Total N (%)	X <sup>2</sup> -value	p-value
<b>Breed</b>						
Cross	48(100)	57(100)	30(100)	105(100)	-	-
<b>Sources of labor</b>						
Mother	4(11.4) <sup>a</sup>	4(10) <sup>a</sup>	3(10) <sup>a</sup>	11(10.5)	0.051	0.975
Father	7(20) <sup>a</sup>	8(20) <sup>a</sup>	6(20) <sup>a</sup>	21(20)	0.000	1.000
Children	6(17.1) <sup>a</sup>	7(17.5) <sup>a</sup>	5(16.7) <sup>a</sup>	18(17.1)	0.008	0.996
Hired	18(51.4) <sup>a</sup>	21(52.5) <sup>a</sup>	16(53.3) <sup>a</sup>	55(52.4)	0.024	0.988
<b>Sources of parent stock</b>						
Neighbor	30(85.7) <sup>a</sup>	34(85) <sup>a</sup>	26(86.7) <sup>a</sup>	90(85.7)	0.039	0.981
Others	5(14.3) <sup>a</sup>	6(15) <sup>a</sup>	4(13.3) <sup>a</sup>	15(14.3)	0.039	0.981
	Mean± SD	Mean± SD	Mean± SD	Mean± SD	F-value	p-value
Working hour	7.06±0.236 <sup>a</sup>	7.1±0.304 <sup>a</sup>	7.07±0.3 <sup>a</sup>	7.07±0.3	0.64	0.529
Herd size	21.1±1.54 <sup>a</sup>	186.53±1.7 <sup>b</sup>	8.5±0.6 <sup>a</sup>	88.5±1.3	31.0	0.000

N (%) depicts number or percent of respondents; SD refer to Standard Deviation; <sup>a,b</sup> values with one superscript letter in common are not significantly separated.

### 4.3. Watering Practices

Watering practices for small scale intensive pig production are presented in Table 4. Frequency of watering and sources of water did not vary ( $p>0.05$ ) across different sites. All households in the three sites reported that water was supplied to the pigs using water troughs. A large number (73.3%) of farmers provided clean drinking water, meant for humans, twice a day. The farmers reported that tap water (93.33%) was the main source of water across the study sites.

Table 4: Water sources and watering frequency of small scale intensive pig production in East Shewa

Variables	Towns				Test	
	Addis Ababa N (%)	Bishoftu N (%)	Adama N (%)	Total N (%)	X <sup>2</sup> -value	p-value
Watering frequency						
Once/day	9(25.7) <sup>a</sup>	10(25) <sup>a</sup>	9(30) <sup>a</sup>	28(26.7)	0.244	0.885
Twice/day	26(74.3) <sup>a</sup>	30(75) <sup>a</sup>	21(70) <sup>a</sup>	77(73.3)	0.244	0.885
Source of water						
Tap water	33(94) <sup>a</sup>	37(92.5) <sup>a</sup>	28(93.3) <sup>a</sup>	98(93.3)	0.096	0.953
Water well	2(6) <sup>a</sup>	2(7.5) <sup>a</sup>	2(6.7) <sup>a</sup>	6(5.7)	0.088	0.957
Use of water trough	35(100)	40(100)	30(100)	105(100)	-	-

N (%) depicts number or percent of respondents.

#### 4.4. Housing Practices

Table 5 indicates housing practices for small scale intensive pig production in Addis Ababa, Bishoftu and Adama towns. A large number ( $p < 0.05$ ) of brick walled pig houses were observed in Bishoftu compared to in Addis Ababa and Adama. In addition, a large portion ( $p < 0.05$ ) of pig farmers in Bishoftu constructed pig houses based on the recommended housing system for pig production compared to in Addis Ababa and Adama. According to their ages and performances, farmers had separated fattening and maternity pens. The focus group discussions conducted across the three districts revealed that the space allowance per pig was inadequate.

Table 5: Housing practices for small scale intensive pig production in East Shewa

Variables	Towns				Test	
	Addis Ababa	Bishoftu	Adama	Total	X <sup>2</sup> -value	p-value
	N (%)	N (%)	N (%)	N (%)		
Wood walled	8(22.9) <sup>a</sup>	8(20) <sup>a</sup>	7(23.3) <sup>a</sup>	23(21.9)	0.139	0.933
Brick walled	4(11.4) <sup>a</sup>	12(30) <sup>b</sup>	3(10) <sup>a</sup>	19(18.1)	6.20	0.045
Wall made of soil and wood	23(65.7) <sup>a</sup>	23(57.5) <sup>a</sup>	20(66.7) <sup>a</sup>	61(62.9)	0.801	0.670
Recommended housing	2(5.7) <sup>a</sup>	9(22.5) <sup>b</sup>	2(6.7) <sup>a</sup>	13(12.4)	6.113	0.047
Not recommended housing	33(94.3) <sup>a</sup>	31(77.5) <sup>b</sup>	28(93.3) <sup>a</sup>	92(87.6)	6.113	0.047
Group housing	35(100)	40(100)	30(100)	105(100)	-	-

N (%) depicts number or percent of respondents; <sup>a,b</sup> values with one superscript letter in common are not significantly separated.

#### 4.5. Types of Pig Operations

Figure 2 indicates the types of pig operations of small scale intensive pig production in East Shewa of central Ethiopia. Based on the types of pig operation undertaken, the farmers were divided into two groups. The farmers reported that mixed (71.4%) was the dominant type of pig operation. Another category of farmers (29.6%) had sows and reared the pigs from farrowing to market weight.

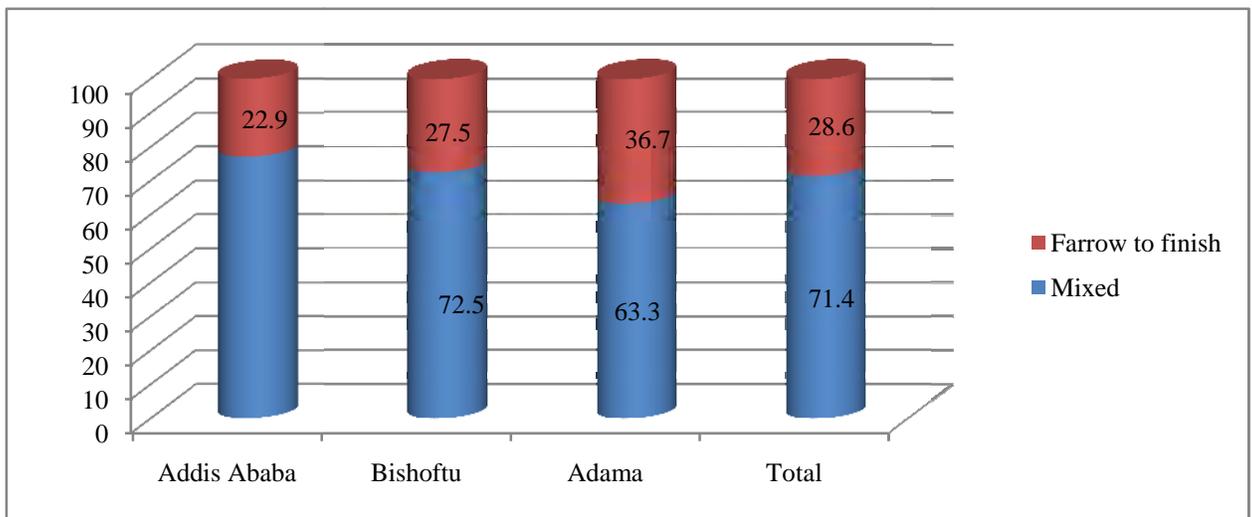


Figure 2: Types of operations of small scale intensive pig farming in East Shewa

#### 4.6. Feed Types and Sources

Table 6 shows feeding practices of small scale intensive pig production in East Shewa. Numerous feed types used in pig diets differed ( $p < 0.05$ ) with location. Significantly higher number of pig producers in Bishoftu town utilized commercial feed, (combination of concentrates, grains, forage and mineral) and (combination of concentrates, grains, poultry litter, forage and mineral), (combination of kitchen, concentrates, grains, forage and mineral) compared to Addis Ababa and Adama towns. However, combinations of (restaurant waste, concentrates, grains, poultry litter and mineral) and (concentrates, grains, kitchen, poultry litter and mineral) utilized by significantly lower ( $P < 0.05$ ) pig

keepers in Bishoftu than Addis Ababa and Adama towns. A small number of respondents in the three towns utilized abattoir wastes for pig production. The focus group discussions noticed that the poultry offal's were boiled and fed to pigs to protect disease transmission from poultry to pig.

Table 6: Feed types and sources for small scale intensive pig production in East Shewa

Feed characteristics	Addis Ababa N (%)	Bishoftu N (%)	Adama N (%)	Total N (%)	Test	
					X <sup>2</sup> -value	p-value
<b>Feed types</b>						
12	1(2.9) <sup>a</sup>	8(20) <sup>b</sup>	1(3.3) <sup>a</sup>	10(9.5)	8.023	0.016
6	2(5.7) <sup>a</sup>	1(2.5) <sup>a</sup>	2(6.7) <sup>a</sup>	5(4.8)	0.761	0.683
4	1(2.8) <sup>a</sup>	1(2.5) <sup>a</sup>	1(3.3) <sup>a</sup>	3(2.9)	0.043	0.979
3,5,10,11	2(5.7) <sup>a</sup>	9(22.5) <sup>b</sup>	2(6.7) <sup>a</sup>	13(12.4)	6.11	0.047
2,3, 5,9,10	18(51.4) <sup>a</sup>	1(2.5) <sup>b</sup>	14(46.7) <sup>a</sup>	24(31.4)	25.261	0.000
3,5,9, 10,11	1(2.9) <sup>a</sup>	9(22.5) <sup>b</sup>	1(3.3) <sup>a</sup>	11(10.5)	9.964	0.007
1,3,5,10,11	2(5.7) <sup>a</sup>	10(25) <sup>b</sup>	2(6.7) <sup>a</sup>	14(13.3)	7.624	0.022
1, 3,5,9,10	8(22.9) <sup>a</sup>	1(2.5) <sup>b</sup>	7(23.3) <sup>a</sup>	16(15.2)	8.120	0.017
<b>Feed sources</b>						
1,7	1(2.9) <sup>a</sup>	1(2.5) <sup>a</sup>	1(3.3) <sup>a</sup>	3(2.9)	0.043	0.979
1,7,8	3(8.6) <sup>a</sup>	3(7.5) <sup>a</sup>	2(6.7) <sup>a</sup>	8(7.6)	0.085	0.959
7,8	2(5.7) <sup>a</sup>	2(5) <sup>a</sup>	2(6.7) <sup>a</sup>	6(5.7)	0.088	0.957
1,8	4(11.4) <sup>a</sup>	4(10) <sup>a</sup>	3(10) <sup>a</sup>	11(10.5)	0.051	0.975
8,2	15(42.9) <sup>a</sup>	18(45) <sup>a</sup>	13(43.3) <sup>a</sup>	46(43.8)	0.039	0.981
7,8,4,2	4(11.4) <sup>a</sup>	5(12.5) <sup>a</sup>	4(13.3) <sup>a</sup>	13(12.4)	0.055	0.973
7,8,2	6(17.1) <sup>a</sup>	7(17.5) <sup>a</sup>	5(16.7) <sup>a</sup>	18(17.1)	0.008	0.996

N (%) depicts number or percent of respondents; <sup>a,b</sup> values with one superscript letter in common are not significantly separated; 1=Kitchen, 2= Restaurant, 3= Concentrates, 4=Abattoir waste, 5=Grains, 6=Vegetable and fruit waste, 7=Garden, 8=Market, 9= poultry litter, 10=mineral, 11=forage and 12=commercial feeds

#### 4.7. Feed Intake

Table 7 depicts the amount of feed intake for small scale intensive pig production in East Shewa of central Ethiopia. The quantity feed consumed by individual pig category, i.e. piglet, weaned, grower, sow, boar and fatterer was significantly higher ( $p < 0.01$ ) in Bishoftu compared to in Addis Ababa and Adama.

Table 7: Feed intake DM basis in small scale pig production in East Shewa

Pig class	Towns				Test	
	Addis Ababa	Bishoftu	Adama	Total	F-value	p-value
	Mean±SD	Mean±SD	Mean±SD	Mean±SD		
Piglets (kg)	0.17±0.02 <sup>a</sup>	0.2±0.00 <sup>b</sup>	0.16±0.01 <sup>a</sup>	0.18±0.02	118.317	.000
Weaned (kg)	0.41±0.06 <sup>a</sup>	0.63±0.05 <sup>b</sup>	0.42±0.05 <sup>a</sup>	0.49±0.12	188.006	.000
Growers (kg)	0.63±0.05 <sup>a</sup>	0.80±0.02 <sup>b</sup>	0.63±0.05 <sup>a</sup>	0.69±0.09	248.018	.000
Sows (kg)	1.1±0.10 <sup>a</sup>	1.51±0.11 <sup>b</sup>	1.10±0.10 <sup>a</sup>	1.26±0.22	187.159	.000
Boars (kg)	1.1±0.09 <sup>a</sup>	1.51±0.11 <sup>b</sup>	1.13±0.10 <sup>a</sup>	1.28±0.21	174.019	.000
Fatteners (kg)	1.7±0.04 <sup>a</sup>	1.96±0.095 <sup>b</sup>	1.73±0.045 <sup>a</sup>	1.81±0.14	158.828	.000

SD refers to Standard Deviation; <sup>a,b</sup> values with one superscript letter in common are not significantly separated.

#### 4.8. Chemical Composition of Composite Feeds

Chemical composition of composite pig feeds used in Addis Ababa, Bishoftu and Adama towns are shown in Table 8. The DM%, Ash%, Ca% contents of composite feeds was similar along the study sites. The EE% and ME% of composite feeds of Bishoftu were superior compared to Addis Ababa and Adama. The EE content of the feed sample in Bishoftu was very high compared in Addis Ababa and Adama.

Computed metabolizable energy values of composite feeds were also relatively lower for growing pigs in Addis Ababa and Adama than Bishoftu. The crude protein contents of the composite feeds of Adama were lower compared to composite feeds of Bishoftu and

Addis Ababa. The crude fiber content of the composite feeds in Bishoftu was smaller than in Addis Ababa and Adama.

Table 8: Chemical composition of feed samples of small scale pig production in East Shewa

Values	Towns											
	Addis Ababa				Bishoftu				Adama			
	Com <sub>1</sub>	Com <sub>2</sub>	Com <sub>3</sub>	Com <sub>4</sub>	Com <sub>1</sub>	Com <sub>2</sub>	Com <sub>3</sub>	Com <sub>4</sub>	Com <sub>1</sub>	Com <sub>2</sub>	Com <sub>3</sub>	Com <sub>4</sub>
DM%	89.7	89.5	90	89.9	89.9	89.8	90	89.9	89.7	89.7	90	90
Ash%	10.3	9.2	9.3	9.3	9.5	9.8	9.6	9.1	9.1	9.5	11.2	9.6
CF%	12.7	13.9	13	10.8	3.9	3.5	3.7	5.0	12.6	13.4	14	14.8
CP%	12.0	13.0	14.7	13.2	14.0	11.8	17.6	14.3	13.0	15.3	15.7	16.3
EE%	4.0	2.2	3.1	3.1	16.9	9	15.9	8.6	5.9	4.3	4.1	3.8
Ca%	2.4	2.8	2.2	2.8	3.2	3.0	3.0	2.9	2.9	2.6	3.0	2.6
ME%	2621.9	2462.4	2581.7	2776.8	4136.9	3558.4	4096.1	3604.1	2783.1	2608.7	2475.3	2453.3

Ca= Calcium; CF= Crude fiber; CP= Crude protein; Com=Composite feed; DM= Dry matter; EE= Ether extract; ME= Metabolizable energy

Addis Ababa: com<sub>1</sub> (2,3,5,9,10); com<sub>2</sub> (1,3,5,9,10); com<sub>3</sub> (1,3,5,10,11); com<sub>4</sub> (6)

Bishoftu: com<sub>1</sub> (1, 3, 5, 10, 11); com<sub>2</sub> (3, 5, 9, 10, 11); com<sub>3</sub> (3, 5, 10, 11); com<sub>4</sub> (12)

Adama: com<sub>1</sub> (2, 3, 5, 9, 10); com<sub>2</sub>(1, 3,5 , 9, 10); com<sub>3</sub>(1, 3, 5, 10, 11);com<sub>4</sub>(3, 5, 10, 11)

1=Kitchen, 2= Restaurant, 3= Concentrates, 4=Abattoir waste, 5=Grains, 6=Vegetable and fruit waste, 7=Garden, 8=Market, 9= poultry litter, 10=mineral, 11=forage and 12=commercial feeds,

#### 4.9. Body Condition Scores

Table 9 shows the body condition scores of pigs in Addis Ababa, Bishoftu and Adama towns. The body condition scores of pig categories were significantly different ( $p < 0.05$ ) among the study towns. The body condition scores of piglets, weaned, growers, boars and fatteners were significantly higher ( $P < 0.05$ ) in Bishoftu than in Addis Ababa and Adama.

Table 9: Body condition scores (BCS) of small scale intensive pig production in East Shewa

Pig class	Towns				Test	
	Addi Ababa Mean±SD	Bishoftu Mean±SD	Adama Mean±SD	Total Mean±SD	F-value	p-value
Piglets	2.06±.161 <sup>a</sup>	3.35±.483 <sup>b</sup>	2.13±.346 <sup>a</sup>	2.57±.712	148.848	0
Weaned	2.29±.667 <sup>a</sup>	3.53±.506 <sup>b</sup>	2.07±.450 <sup>a</sup>	2.70±.856	74.502	0
Growers	2.03±.453 <sup>a</sup>	2.73±.452 <sup>b</sup>	2.13±.571 <sup>a</sup>	2.32±.580	22.097	0
Sows	1.69±.530 <sup>a</sup>	2.70±.464 <sup>b</sup>	1.77±.568 <sup>a</sup>	2.10±.701	44.33	0
Boars	2.17±.514 <sup>a</sup>	3.40±.591 <sup>b</sup>	2.17±.379 <sup>a</sup>	2.64±.786	71.545	0
Fatteners	2.73±.450 <sup>a</sup>	3.80±.405 <sup>b</sup>	2.37±.490 <sup>c</sup>	3.02±.772	103.616	0

SD refers to Standard Deviation; <sup>abc</sup> values with one superscript letter in common are not significantly different.

#### 4.10. Purposes of Rearing Pigs

There was no difference in motives of rearing pigs among sites. The overall results indicated that the major reasons for keeping pigs across the towns were to generate secondary income followed by primary income (Figure 3). The focus group discussions in all towns put in plain words that pig owners were against the slaughtering of pigs for home consumption.

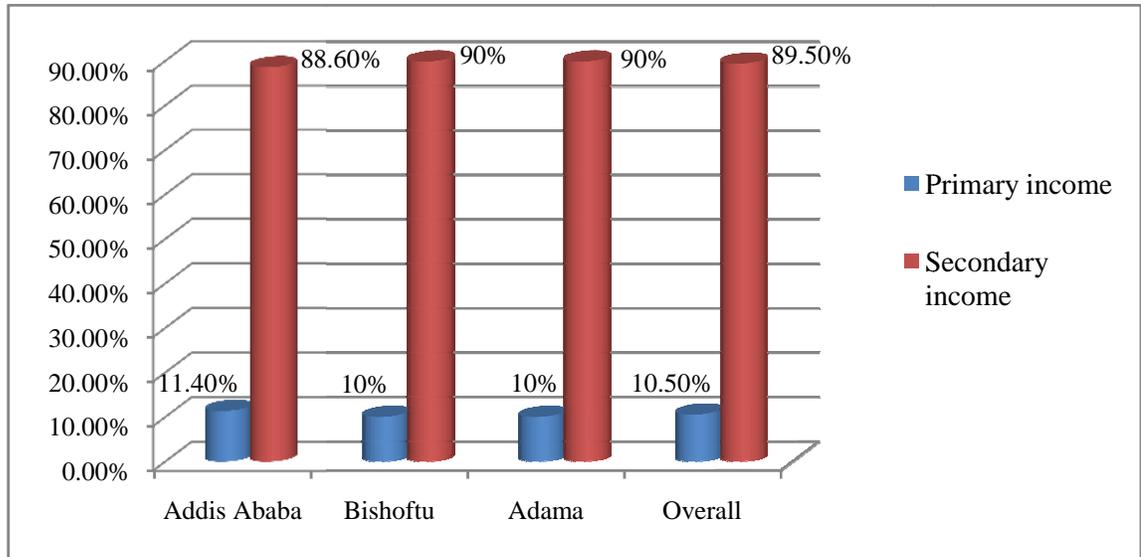


Figure 3: Purposes of rearing small scale intensive pig production in East Shewa

#### 4.11. Pig Healthcare Practices

Healthcare practices for small scale intensive pig production are presented in Table 10. Location had no effect ( $p > 0.05$ ) on health practices (maintain health records, contact veterinarian in the last 12 months, purpose of veterinary contact and disposal of dead pigs). The focus group discussions among the three sites noticed that all farmers did not regularly market pigs at public locations (abattoirs). Farmers in the three towns contacted veterinary professionals to get: advice on pig disease (40%), general pig information (37.1%) and antibiotics (32.4%). Almost all (97.1%) farmers across the study sites cited the last time veterinarian visited the pigs was in the last 12 months. Important practices for disposal of dead pigs revealed by respondents were burying (46.7%), burning (34.3%) and feeding to dogs (20%). The use of vaccine depended ( $p < 0.05$ ) on the investigated site. Significantly higher percentages of respondents in Bishoftu vaccinated their pigs than respondents in Addis Ababa and Adama towns.

Table 10: Healthcare practices of small scale intensive pig production in East Shewa

Health practices	Towns				Test	
	Addis Ababa N (%)	Bishoftu N (%)	Adama N (%)	Total N (%)	X <sup>2</sup> -value	p-value
Maintain herd health records	24(68.6) <sup>a</sup>	27(67.5) <sup>a</sup>	21(70) <sup>a</sup>	72(68.6)	0.05	0.975
Contact veterinarian in the past 12 months	34(97.5) <sup>a</sup>	39(97.5) <sup>a</sup>	29(96.7) <sup>a</sup>	102(97.1)	0.043	0.979
Use of vaccine	1(2.8) <sup>a</sup>	7(17.5) <sup>b</sup>	1(3.3) <sup>a</sup>	8(8.6)	6.578	0.037
Purpose of veterinary contact						
To get antibiotics	11(31.4) <sup>a</sup>	13(32.5) <sup>a</sup>	10(33.3) <sup>a</sup>	34(32.4)	0.027	0.986
To get disease advice	14(40) <sup>a</sup>	16(40) <sup>a</sup>	12(40) <sup>a</sup>	42(40)	0.00	1.00
For general pig information	10(28.6) <sup>a</sup>	11(27.5) <sup>a</sup>	8(26.7) <sup>a</sup>	39(37.1)	0.03	0.985
Disposal of dead pigs						
Bury	16(45.7) <sup>a</sup>	19(47.5) <sup>a</sup>	14(46.7) <sup>a</sup>	49(46.7)	1.58	0.454
Burn	12(34.3) <sup>a</sup>	14(32.5) <sup>a</sup>	10(33.3) <sup>a</sup>	36(34.3)	0.021	0.989
Feed to dogs	7(20) <sup>a</sup>	8(20) <sup>a</sup>	6(20) <sup>a</sup>	21(20)	0.00	1.00

N (%) depicts number or percent of respondents; <sup>a,b</sup> values with one superscript letter in common are not significantly different.

#### **4.12. Prevalent Pig Diseases**

The prevalent diseases of small scale intensive pig production in the study towns are described in Table 11. The study revealed that diarrhea had the highest incidence among the three towns. The focus group discussions emphasized that it was more common in piglets. FMD was leveled as the 2<sup>nd</sup> most important disease in Bishoftu town compared in Addis Ababa (4<sup>th</sup>) and Adama (4<sup>th</sup>) towns.

Swine fever was perceived as the 3<sup>rd</sup> important disease in Bishoftu while supposed as the 6<sup>th</sup> important disease in both (Addis Ababa and Adama) towns. Lice and swine fever were perceived as the 5<sup>th</sup> and 6<sup>th</sup> important diseases in Addis Ababa and Adama towns while the corresponding levels in Bishoftu town were 5<sup>th</sup> and 3<sup>th</sup>. Sun burn was perceived as the least important disease by respondents in all the three towns.

Table 11: Prevalent pig diseases of small scale intensive pig production in East Shewa

Diseases	Towns																	
	Addis Ababa						Bishoftu						Adama					
	1 <sup>st</sup>	2 <sup>nd</sup>	3 <sup>rd</sup>	4 <sup>th</sup>	Index	Rank	1 <sup>st</sup>	2 <sup>nd</sup>	3 <sup>rd</sup>	4 <sup>th</sup>	Index	Rank	1 <sup>st</sup>	2 <sup>nd</sup>	3 <sup>rd</sup>	4 <sup>th</sup>	Index	Rank
Diarrhea	20	15	0	0	0.24	1	25	15	0	0	0.25	1	25	5	0	0	0.21	1
Mastitis	20	0	15	0	0.2	2	0	0	12	28	0.09	6	10	10	10	0	0.16	3
Coughing	0	30	0	5	0.17	3	0	5	30	5	0.14	4	10	20	0	0	0.18	2
FMD	10	5	10	5	0.14	4	0	30	10	0	0.19	2	5	10	15	0	0.14	4
Lice	0	0	30	5	0.12	5	0	0	24	16	0.11	5	10	0	10	10	0.13	5
Swine fever	0	8	0	27	0.9	6	20	10	10	0	0.15	3	5	5	5	15	0.11	6
Sun burn	0	0	1	34	0.06	7	0	0	2	38	0.07	7	0	0	15	15	0.09	7

#### **4.13. On-Farm Bio-Security Practices**

Table 12 presents bio-security practices of the interviewed small scale intensive pig farmers in the study towns. In this survey, all farms in the three towns had perimeter fences. About 82.9% of the pig keepers in the three towns practiced entry control to visitors. While none of the farmers in all the three towns provided overalls/boots to guests and carried out wheel bath, cleaning and disinfecting for trucks.

The number of respondents declared to have no stock introductions was significantly higher ( $p<0.05$ ) in Bishoftu than Addis Ababa and Adama towns. The study highlighted that the number of farmer's quarantined new pigs were significantly higher ( $p<0.05$ ) in Bishoftu than that of in Addis Ababa and Adama towns. The pigs were quarantined at average distance of  $210\pm 10$  m from the main herd for average days of  $26\pm 8$  considering the total population.

Table 12: Bio-security practices of small scale intensive pig production in East Shewa

Practices	Towns				Test	
	Addis Ababa	Bishoftu	Adama	Total	X <sup>2</sup> -value	p-value
	N (%)	N (%)	N (%)	N (%)		
<b>On farm bio- security practices</b>						
Have controlled entry	29(82.9) <sup>a</sup>	33(82.5) <sup>a</sup>	25(83.3) <sup>a</sup>	87(82.9)	0.008	0.996
Overalls/boots not provided to visitors	35(100)	40(100)	30(100)	105(100)	-	-
Perimeter fence around the farm	35(100)	40(100)	30(100)	105(100)	-	-
Use of feet bath	7(20) <sup>a</sup>	34(85) <sup>b</sup>	6(20) <sup>a</sup>	47(44.8)	42.3	0.000
Use of wheel bath	1(2.9) <sup>a</sup>	9(22.5) <sup>b</sup>	1(3.3) <sup>a</sup>	11(10.5)	9.96	0.007
Trucks not cleaned and disinfected	35(100)	40(100)	30(100)	105(100)	-	-
<b>Quarantine practices</b>						
New pigs not introduced	5(14.3) <sup>a</sup>	28(70) <sup>b</sup>	4(13.3) <sup>a</sup>	35(33.3)	34.22	0.00
New pigs quarantined	2(5.7) <sup>a</sup>	10(25) <sup>b</sup>	2(6.7) <sup>a</sup>	14(13.3)	7.6	0.022
Quarantine not practiced	33(94.3) <sup>a</sup>	30(75) <sup>b</sup>	28(93.3) <sup>a</sup>	91(86.7)	7.6	0.022
	Mean ±SD	Mean ±SD	Mean ±SD	Mean ±SD	F-value	p-value
Number of days quarantined	26.3±0.95 <sup>a</sup>	26.9±2 <sup>a</sup>	26.6±2 <sup>a</sup>	26.6±2	1.67	0.193
Distance from the main herd (m)	210±0.00 <sup>a</sup>	210±0.00 <sup>a</sup>	210.3±1.8 <sup>a</sup>	210.3±1.8	1.26	0.289

N (%) depicts number or percent of respondents; SD refers to Standard Deviation; numbers connected by different letters are statistically significant

#### **4.14. Factors Affecting Pig Production**

Table 13 presents households' ranking of constraints to small scale intensive pig production in the study towns. Respondents in the three districts ranked market, disease and feed consecutively, as the most limiting factors to increasing pig production. The pig farms surveyed in all districts indicated that disease was the 2<sup>nd</sup> most important constraining factor for increased productivity.

The focus group discussions explained that losses due to disease in all the study sites ranged from 40 to 80%. Most farmers in the three districts had no explanation for these outbreaks, but 5% of interviewed households identified bringing pigs from other areas as a main cause of outbreak of disease. Feed was perceived as the 3<sup>rd</sup> most important constraint among all sites.

Scarcity of land was ranked 4<sup>th</sup> in Addis Ababa district while 7<sup>th</sup> and 8<sup>th</sup> in Adama and Bishoftu towns, respectively in terms of constraining productivity of the pig farms. Furthermore, the absence of municipal abattoir in Bishoftu and Adama was leveled as the 4<sup>th</sup> threat. The focus group discussions clarified that lack of local pork processing plant was thought to be one of the leading causes of the poor marketing. In Addition, they indicated that the leading pig processing plant (Bishoftu pig processing P.L.C.) failed to buy pigs from farmers due to less demand of pork in the local market.

Social tradition was perceived as the 5<sup>th</sup>, 6<sup>th</sup> and 7<sup>th</sup> constraint in Bishoftu, Adama and Addis Ababa towns, respectively. Respondents said there was less pork served in the local hotels because customers were not likely to enter hotels where pork is served. Inbreeding was cited as the 6<sup>th</sup> constraint to improving pig production in Bishoftu district while rated as 5<sup>th</sup> both in Addis Ababa and Adama towns. The focus group discussions highlighted that some of the breeders visited the neighboring provinces to procure quality breeding stock. In addition, pig keepers were unable to use artificial insemination to improve the quality of their pig herd.

Lack of know-how on pig production management was distinguished as 8<sup>th</sup> constraint in Addis Ababa and Adama towns while 7<sup>th</sup> in Bishoftu towns. The majority of respondents explained that feeding, healthcare and housing were issues inadequately experienced. The focus group discussions revealed that town pig category was provided with uniform feed supply and dose of drug. Similarly, the pigsty is constructed hardly according to the space requirement of different pig class and generally poorly constructed from local materials.

Table 13: Limiting factors of small scale intensive pig production in East Shewa

Factors	Towns																	
	Addis Ababa						Bishoftu						Adama					
	1 <sup>st</sup>	2 <sup>nd</sup>	3 <sup>rd</sup>	4 <sup>th</sup>	Index	Rank	1 <sup>st</sup>	2 <sup>nd</sup>	3 <sup>rd</sup>	4 <sup>th</sup>	Index	Rank	1 <sup>st</sup>	2 <sup>nd</sup>	3 <sup>rd</sup>	4 <sup>th</sup>	Index	Rank
Market	35	0	0	0	0.2	1	40	0	0	0	0.23	1	10	0	20	0	0.2	1
Disease	20	15	0	0	0.19	2	10	20	10	0	0.17	2	21	3	4	4	0.18	2
Feed	0	35	0	0	0.16	3	10	10	15	5	0.15	3	20	0	0	10	0.15	3
Land scarcity	10	0	20	5	0.13	4	0	0	0	40	0.06	8	0	0	0	14	0.08	7
Inbreeding	0	0	35	0	0.11	5	0	0	20	20	0.09	6	5	10	0	0	0.11	5
Slaughtering facilities	0	0	20	15	0.08	6	5	0	35	0	0.13	4	30	0	0	0	0.14	4
Social tradition	0	0	10	25	0.07	7	0	0	30	10	0.1	5	5	0	10	15	0.09	6
Technical know-how	0	0	0	0	0.05	8	0	0	10	30	0.06	7	0	0	0	30	0.05	8

#### **4.15. Economically Important Traits**

The performance traits of small scale intensive pigs in East Shewa are shown in Table 14. Age at first service, services per conception, age at first farrowing, farrowing interval, number of farrowing/sow/year, litter size at weaning, birth weight, weaning weight and pre-weaning mortality were different ( $p<0.05$ ) across the study sites.

The mean age at first service of pigs was significantly lower ( $p<0.05$ ) in Bishoftu compared to Addis Ababa and Adama towns. The mean services per conception of sows in Addis Ababa and Adama were greater than the value obtained in Bishoftu.

The mean age at first farrowing and farrowing interval of pigs was significantly lower ( $p<0.05$ ) in Bishoftu compared to in Addis Ababa and Adama. The mean number of farrowing/sow/year was significantly greater in Bishoftu compared to in Addis Ababa and Adama. The mean gestation period was similar ( $p<0.05$ ) across the study sites.

The mean litter size at weaning of pigs was significantly lower in Addis Ababa and Adama than in Bishoftu. The mean values of live weights at birth and at weaning were significantly higher ( $p<0.05$ ) in Bishoftu than in Addis Ababa and Adama. Weaning age was not associated ( $p<0.05$ ) with location. The overall weaning age was  $23.4\pm 1.5$  day. Pre-weaning piglet mortality was higher ( $p<0.05$ ) in Addis Ababa and Adama than Bishoftu.

Table 14: Reproductive performance traits of small scale intensive pig production in East Shewa

Traits	Towns				Test	
	Addis Ababa	Bishoftu	Adama	Total	F-value	p-value
	Mean± SD	Mean± SD	Mean± SD	Mean± SD		
Age at first service (month)	4.6±0.6 <sup>a</sup>	4.2±0.45 <sup>b</sup>	5.1±0.51 <sup>c</sup>	4.6±0.6	30.999	0.0
Service per conception	1.6±0.5 <sup>a</sup>	1.2±0.4 <sup>b</sup>	1.5±0.5 <sup>a</sup>	1.4±0.5	8.42	0.0
Age at first farrowing (month)	8.7±0.5 <sup>a</sup>	8.2±0.4 <sup>b</sup>	8.7±0.5 <sup>a</sup>	8.5±0.5	12.79	0.0
Farrowing interval (month)	2.3±0.4 <sup>a</sup>	2.0±0.0 <sup>b</sup>	2.9±0.4 <sup>c</sup>	2.3±0.5	66.21	0.0
Number of farrowing/sow/year	1.9±0.4 <sup>a</sup>	2.4±0.6 <sup>b</sup>	2.0±0.4 <sup>c</sup>	2.1±0.5	8.3	0.0
Gestation period (day)	113.9±0.3 <sup>a</sup>	113.8±0.5 <sup>a</sup>	113.9±0.3 <sup>a</sup>	113.9±0.4	0.75	0.48
Litter size at birth	8.0±1.4 <sup>a</sup>	8.9±2.7 <sup>a</sup>	8.6±2.2 <sup>a</sup>	8.5±2.2	1.37	0.26
Still birth	1.57±0.5 <sup>a</sup>	1.63±0.49 <sup>a</sup>	1.57±0.5 <sup>a</sup>	1.59±0.49	0.156	0.86
Litter size at weaning	3.3±0.7 <sup>a</sup>	8.8±1.1 <sup>b</sup>	2.9±0.3 <sup>a</sup>	4.8±2.3	352.68	0.0
Birth weight (kg)	0.61±0.1 <sup>a</sup>	0.8±0.1 <sup>b</sup>	0.7±0.1 <sup>c</sup>	0.71±0.1	26.99	0.0
Weaning weight (kg)	5.5±0.6 <sup>a</sup>	7.5±0.6 <sup>b</sup>	5.3±0.5 <sup>a</sup>	6.2±1.1	208.96	0.0
Weaning age (day)	23.6±1.5 <sup>a</sup>	23.6±1.5 <sup>a</sup>	23.5±1.5 <sup>a</sup>	23.4±1.5	0.186	0.83
Pre weaning mortality	3.86±0.55 <sup>a</sup>	2.18±0.71 <sup>b</sup>	4.17±0.65 <sup>a</sup>	3.3±1.1	101.48	0.00

SD refers to Standard Deviation; <sup>a, b, c</sup> values with one superscript letter in common are not significantly separated.

#### 4.16. Growth Performance of Fattening Pigs

The study revealed that all respondents practiced pig fattening across the study sites (Table 15) . There was significantly shorter ( $p<0.05$ ) fattening period and higher ( $p<0.05$ ) average daily gain and market weight of pig farming in Bishoftu than in Addis Ababa and Adama.

Table 15: Growth performance of fattening pigs under small scale intensive production in East Shewa

Parameters	Towns				Test	
	Addis Ababa	Bishoftu	Adama	Total	F-value	F-value
	Mean± SD	Mean± SD	Mean± SD	Mean± SD		
Number of fattener	35(100)	40(100)	30(100)	105(100)	-	-
Fattening period (month)	5.9±0.3 <sup>a</sup>	5.1±0.2 <sup>b</sup>	5.9±0.3 <sup>a</sup>	5.6±0.5	110.7	0.00
Average daily gain (g/day)	333.3±0.43 <sup>a</sup>	487.5±1.0 <sup>b</sup>	306.2±0.4 <sup>c</sup>	384.3±82.1	66940	0.00
Final weight (kg)	60.3±9.9 <sup>a</sup>	72.8±6.0 <sup>b</sup>	55.3±7.8 <sup>a</sup>	63.6±10.8	45.8	0.0
Finishing period (month)	9.1±0.85 <sup>a</sup>	7.6±0.5 <sup>b</sup>	9.4±0.68 <sup>a</sup>	8.6±1.06	75.2	0.0

SD refers to Standard Deviation; <sup>a,b,c</sup> values with one superscript letter in common are not significantly separated.

#### **4.17. Marketing Practices**

Table 16 presents the types of buyers, main product sold, ways of buying, sources of market information, reasons of buying, selling place and methods of price estimation in small scale intensive pig production in East Shewa. In the market, the largest number of buyers comprised of traders followed by neighbors. The primary reason to buy pigs was to sell to others followed by for production. Majority of the respondents reported that the selling place for pigs was in the slaughter house followed by farm gate.

The farmers reported that the principal mode of marketing was the negotiation among sellers and buyers while brokers were also used by minimal number of respondents. A large proportion of households obtained market information from neighboring farmers followed by friends. The results indicated that live pig was the main product sold while selling pork was experienced by small number of pig farmers. The respondents explained that the characteristics that determine the price of pigs were body size, color, body conformation, age and sex in that order.

The method of weight estimation was associated with location. The number of respondents utilized weight balance to measure body size of pigs was significantly higher ( $p < 0.05$ ) in Addis Ababa and Bishoftu than in Adama. The traits that determine the price of pigs were body weight, color, age, body conformation and sex in that order.

Table 16: Marketing characteristics of small scale pig production in East Shewa

Characteristics	Towns				Test	
	Addis Ababa N (%)	Bishoftu N (%)	Adama N (%)	Total N (%)	X <sup>2</sup> -value	p-value
<b>Types of buyers</b>						
Traders	29(82.9) <sup>a</sup>	33(82.5) <sup>a</sup>	25(83.3) <sup>a</sup>	87(82.9)	0.008	0.996
Neighbors	6(17.1) <sup>a</sup>	7(17.5) <sup>a</sup>	5(16.5) <sup>a</sup>	18(17.1)	0.008	0.996
<b>Reasons of buying</b>						
Selling to others	27(77.1) <sup>a</sup>	31(77.5) <sup>a</sup>	24(80) <sup>a</sup>	82(78.1)	0.90	0.956
For production	8(22.9) <sup>a</sup>	9(22.5) <sup>a</sup>	6(20) <sup>a</sup>	23(21.9)	0.90	0.956
<b>Ways of selling</b>						
Negotiation	11(31.4) <sup>a</sup>	12(30) <sup>a</sup>	11(36.7) <sup>a</sup>	34(32.4)	0.37	0.831
Brokers	24(68.6) <sup>a</sup>	28(70) <sup>a</sup>	19(63.3) <sup>a</sup>	71(67.6)	0.37	0.831
<b>Method of weight estimation</b>						
Weight balance	30(85.7) <sup>a</sup>	35(87.5) <sup>a</sup>	6(20) <sup>b</sup>	71(67.6)	43.5	0.00
Visual estimation	5(14.3) <sup>a</sup>	5(12.5) <sup>a</sup>	24(80) <sup>b</sup>	34(32.4)	43.5	0.00
<b>Selling place</b>						
Producers house	15(42.9) <sup>a</sup>	18(45) <sup>a</sup>	12(40) <sup>a</sup>	45(42.9)	0.175	0.916
Slaughter house	20(33.3) <sup>a</sup>	22(36.7) <sup>a</sup>	18(30) <sup>a</sup>	60(57.1)	0.175	0.916
<b>Source of market information</b>						
Neighbor	17(32.1) <sup>a</sup>	21(52.5) <sup>a</sup>	15(50) <sup>a</sup>	53(50.5)	0.119	0.942
Friend	18(51.4) <sup>a</sup>	19(47.5) <sup>a</sup>	15(50) <sup>a</sup>	52(49.5)	0.119	0.942
<b>Main product sold</b>						
Live pig	24(68.6) <sup>a</sup>	15(37.5) <sup>b</sup>	24(80) <sup>c</sup>	63(60)	14.51	0.001
Pork	11(34.4) <sup>a</sup>	25(62.5) <sup>b</sup>	6(20) <sup>c</sup>	42(40)	14.51	0.001
<b>Price estimation</b>						
Body size	12(34.3) <sup>a</sup>	15(37.5) <sup>a</sup>	10(33.3) <sup>a</sup>	37(35.2)	0.151	0.927
Color	10(28.6) <sup>a</sup>	12(30) <sup>a</sup>	8(26.7) <sup>a</sup>	30(28.6)	0.093	0.954
Body conformation	6(17.1) <sup>a</sup>	4(10) <sup>a</sup>	4(13.3) <sup>a</sup>	14(13.3)	0.824	0.662
Sex	1(2.9) <sup>a</sup>	2(5) <sup>a</sup>	1(3.3) <sup>a</sup>	4 (3.8)	0.260	0.878
Age	6(17.1) <sup>a</sup>	7(23.3) <sup>a</sup>	7(23.3) <sup>a</sup>	20(19)	0.502	0.778

N (%) depicts number or percent of respondents; SD refers to Standard Deviation; <sup>a,b</sup> numbers connected by different letters are statistically significant

#### 4.17.1. Selling price of live pig and pork

The mean selling price of live pig and pork per kg across the study sites is presented in table 17. The price per kg of live pig and pork was significantly higher ( $p < 0.05$ ) in Addis Ababa and Bishoftu than Adama in relation to current, 5 years back and 10 years back.

Table 17: Average selling price of live pig and pork in small scale intensive pig production in East Shewa

Commodity	Period	Towns				Test	
		Addis Ababa Mean $\pm$ SD	Bishoftu Mean $\pm$ SD	Adama Mean $\pm$ SD	Total Mean $\pm$ SD	F-value	p-value
Live pig							
	Current	89.86 $\pm$ 1.91 <sup>a</sup>	89.25 $\pm$ 2.67 <sup>a</sup>	69.3 $\pm$ 4.5 <sup>b</sup>	83.76 $\pm$ 9.7	4451.5	0.00
	5 years back	39 $\pm$ 1.2 <sup>a</sup>	39 $\pm$ 3.0 <sup>a</sup>	30 $\pm$ 2.3 <sup>b</sup>	36.6 $\pm$ 4.8	167.96	0.00
	10 years back	29 $\pm$ 2.0 <sup>a</sup>	29 $\pm$ 2 <sup>a</sup>	19.3 $\pm$ 1.7 <sup>b</sup>	26.3 $\pm$ 4.8	279.1	0.00
Pork							
	Current	119 $\pm$ 2.8 <sup>a</sup>	119.3 $\pm$ 2.7 <sup>a</sup>	98.3 $\pm$ 3.8 <sup>b</sup>	113.2 $\pm$ 10	491.4	0.00
	5 years back	99.4 $\pm$ 2.4 <sup>a</sup>	99.3 $\pm$ 2.7 <sup>a</sup>	48.7 $\pm$ 3.5 <sup>b</sup>	84.9 $\pm$ 23.2	3451.9	0.00
	10 years back	49.6 $\pm$ 1.4 <sup>a</sup>	49.4 $\pm$ 1.7 <sup>a</sup>	29.7 $\pm$ 1 <sup>b</sup>	43.8 $\pm$ 9.1	2050.6	0.00

SD refers to Standard Deviation; <sup>a,b</sup> numbers connected by different letters are statistically significant

#### 4.17.2. Price change of pig marketing

The level of price change of the pig marketing practices is presented in Table 18. The majority of the respondents stated that the change in price of live pig or pork was three fold, with small number of respondents said two fold increase in price.

Table 18: Price change of pig marketing under small scale intensive farming in East Shewa

Price change	Towns				Test	
	Addis Ababa	Bishoftu	Adama	Total	X <sup>2</sup> -value	p-value
	N (%)	N (%)	N (%)	N (%)		
Slightly	1(2.9) <sup>a</sup>	2(5) <sup>a</sup>	2(6.7) <sup>a</sup>	5(4.8)	0.53	0.77
One fold	5(14.3) <sup>a</sup>	5(12.5) <sup>a</sup>	4(13.3) <sup>a</sup>	14(13.3)	0.05	0.98
Two fold	7(20) <sup>a</sup>	8(22.5) <sup>a</sup>	5(13.3) <sup>a</sup>	20(19)	0.97	0.62
Three fold	22(62.9) <sup>a</sup>	25(62.5) <sup>a</sup>	19(63.3) <sup>a</sup>	66(62.9)	0.005	0.997

N (%) depicts number or percent of respondents; <sup>a,b</sup> numbers connected by different letters are statistically significant

#### 4.17.3. Marketing constraints

Table 19 indicates the constraints of pig marketing in small scale intensive production in East Shewa. The dominant obstacle of pig marketing in Addis Ababa was price fluctuation. Lack of market channel was the second important marketing impediment followed by lack of price information, lack of functioning abattoir and high cost of transportation. While the main pig marketing constraint in Bishoftu and Adama was lack of functioning abattoir followed by, price fluctuation, lack of price information and lack of market channel, respectively.

Table 19: Marketing constraints of small scale intensive pig production in East Shewa

Factors	Towns					
	Addis Ababa		Bishoftu		Adama	
	<b>Index</b>	Rank	Index	Rank	<b>Index</b>	Rank
Price fluctuation	0.31	1	0.31	2	0.33	2
Lack of market channel	0.29	2	0.02	5	0.02	5
Lack of price information	0.28	3	0.05	4	0.07	4
Lack of functioning abattoir	0.02	4	0.34	1	0.34	1
High cost of transportation	0.1	5	0.27	3	0.24	3

#### ***4.17.4. Pig value chain***

Figure 3 indicates the value chain of pig marketing in small scale intensive pig production in East Shewa. Smallholders produced pigs under intensive feeding management. Farmers also utilized veterinary service for their pigs. Traders were the dominant pig suppliers from different towns to the market areas. The supplied pigs were ultimately consumed by dwellers of different towns and partly exit to Mega projects of Ethiopia through official routes by the traders to obtain better price.

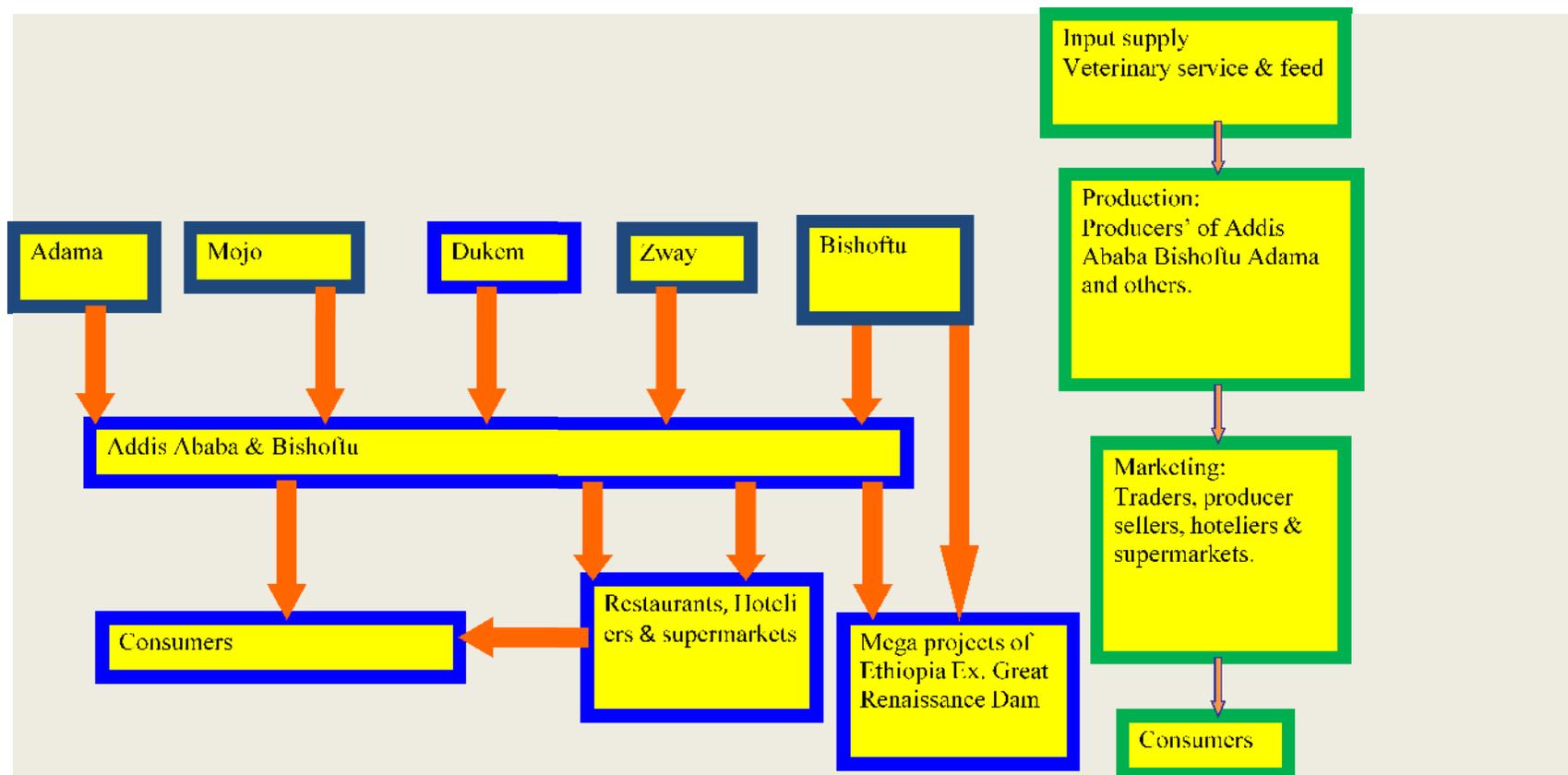


Figure 4: Pig value chain of small scale intensive pig production in East Shewa

#### 4.17.5. Pig marketing channels

In the study area, five different marketing agents participated in the operation of pig marketing. These included producers, traders, supermarket owners, restaurant owners/hoteliars as well as ultimate consumers. Traders were the main suppliers of pigs to the market. Small scale producers sell their pigs to restaurants, hotels, traders, supermarkets and direct consumers. Traders sold their pigs to restaurants, hotels, supermarkets and consumers. The consumers were local people and foreigners (tourists, investors and ambassadors). The main marketing channel was producer-trader-supermarket-hotel/restaurant-consumer.

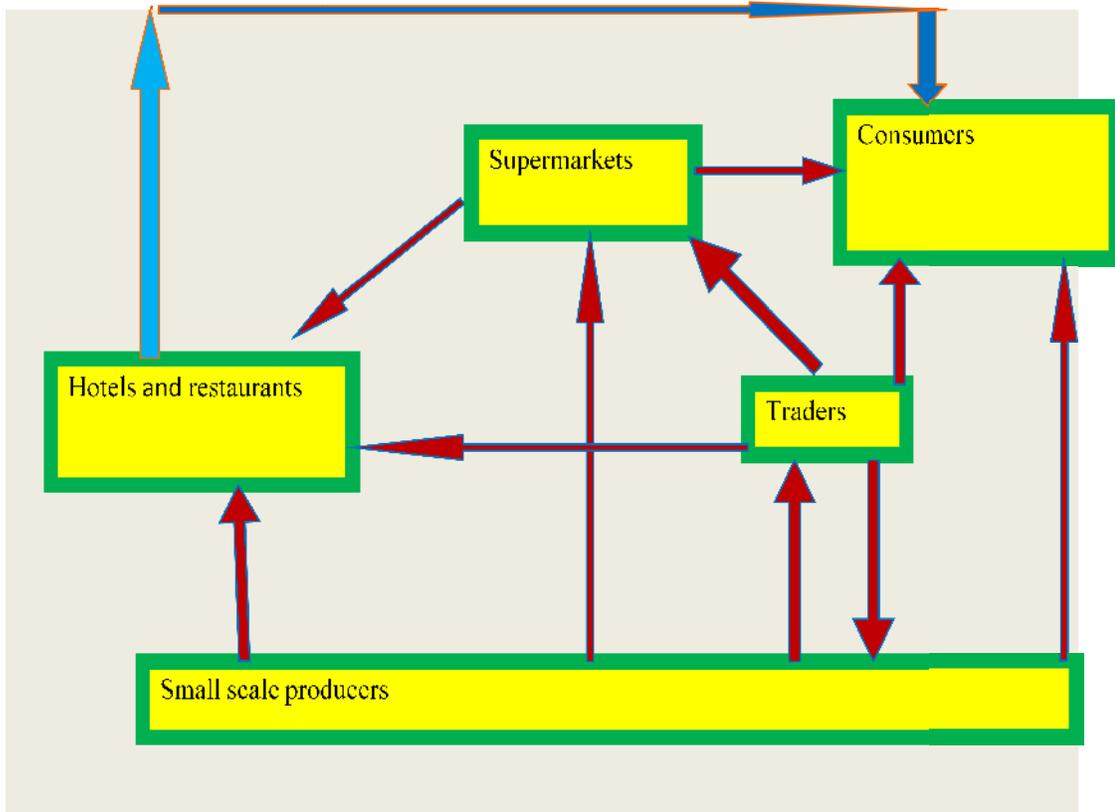


Figure 5: Marketing channels of small intensive farming in East Shewa

## 5. DISCUSSION

The current research indicates that the participation of female farmers in raising pigs was low. The low percentage of women involved in pig production than men could be as a result of drudgery, physical and energy demanding as well as capital-intensive nature of investment required by pig production, which discourages women. The predominance of men in swine production observed in this study was in agreement with the findings of Fualefac *et al.* (2014), who clarified that men are capable of doing more tedious work which is usually associated with pig farming than the females.

The average age of pig producers was under 40 years old. The mean age along with farmers may suggest high level of vitality for agricultural activities and play central role in productive enterprises (Kimbi *et al.*, 2015). Furthermore, it was in agreement with earlier findings of Ajala *et al.* (2006); Duniya *et al.* (2013), who reported that farmers were within an economic active age (under 40 years old), making positive contribution to agricultural production. The mean family size in the present research was lesser than the average family size (4.7 people) of Ethiopia (2007). The smaller family size of the current study might be related to the high educational status the pig farmers.

It seems that Bishoftu farmers commenced raising pigs earlier than Addis Ababa and Adama. Most farmers had experience in pig production which might improve their productivity and expand their activities. Farming experience could generally be correlated with attainment of improved skills in agriculture. Accumulated field experiences may tend to tailor farmers choices of feedstuffs, feeding standard and breed of pigs among others away from official standards approved for tropical environment. The overall farming experience for the present study agreed with the findings of Adesehinwa *et al.* (2003). The present variation in land size might be related to the nature and land allocation system of the three sites.

Educational status indicates that majority of the respondents were found in a better level of education. The high level of education may be attributed to the quick expansion and

development of schools and universities and colleges in Ethiopia that could be important to the farming community. This could also ease the acquisition of scientific information and uptake of new technologies on pig husbandry and production aspects. The relative high level of literacy among the towns might enhance innovativeness of the farmers. Additionally, it may assist to extension officers for easy communication and understanding of extension message, especially for application of new technology in swine production and management. This conformed to previous reports of Zanu *et al.* (2012), who indicated that there was high level of education among the pig producers in Ghana. However, the current results disagreed with reports of Birhan *et al.* (2015), who stated that majority of the pig farmers in Gonder, Ethiopia were illiterate.

Pig farmers that regarded various combinations as their source of earning conducted diverse tasks such as dairying, gardening, meat processing, import and export of different commodities. The diversity in sources of income mirrored the global economic activities of the pig farmers. The current results were in line with the reports of Nsoso *et al.* (2003).

The difference in wealth status might be related to the variation in start of pig farming across the study towns. The results were in accordance with reports of Iyai (2012), who noted that large number of farmers had well off livelihood of farming pigs. Respondents might prefer crossbred pigs for better growth performance, higher weight gain, larger litter size and greater back fat thickness, which agreed the reports of Rahman *et al.* (2008). The utilization of more hired laborer in the study towns might indicate profitability of the pig production. Similar results were reported by Okoli *et al.* (2009), where most pig farmers utilized hired labors in their pig farms.

The results of the current study in relation to sources of foundation stock disagreed with reports of Ironkwe and Amefule (2008), who stated that pigs were mostly (84%) procured from local market and only 16% of the respondents collected the pigs from any organized farm. The present variation may be due to the difference in social tradition of pig farming in central Ethiopia. Working hour of farmers of the current study agreed with the reports

of Klooster and Wingelaar (2011), who mentioned that intensive pig production system required significant inputs of time.

The higher number of pigs in Bishoftu could be attributed to better adaptation, relatively adequate feed production and allocation of more land for livestock farming. This agreed with reports of Kimbi *et al.* (2015), who stated that land size owned by pig farmers had positive association with pig herd size. The housing practices might indicate that the pig farmers in Bishoftu reinvested the cash obtained from sell of pigs on constructing brick walled houses. The insufficient floor spacing might be a stressor to pigs, speed up the spread of contagious diseases especially where animals have been over-crowded in a place thus leading to high piglet mortality and poor performance.

The leading type of pig operation in the study sties was a combination of the three systems (farrow to weaned, farrow to finisher, and weaned to finisher). The other pig operations namely, Farrow to weaned (sows and reared piglets up to weaning) and weaned to finisher (fattened the pigs before selling for slaughter) were hardly practiced by the farmers of the study area. The complete cycle of pig production model was not available because of poor linkage among the pig enterprises. However, each pig operations could have the potential to create extensive employment opportunities for the youth group of Ethiopia. This implied that the pig production in the current study was not organized in such a way that it could offer better job opportunity and economic benefit to the country. The present results disagreed with reports of Kagira *et al.* (2010), who classified pig operations in to four groups (mixed, farrow to finish, weaned to finish, farrow to wean).

The abattoir waste included poultry offal's mainly intestines which were paralleled with reports of Iyai (2012); Iyai *et al.* (2013) on pig rearing. The focus group discussions elaborated that decisions to include particular feed ingredients in the diet were related to palatability, availability and price in the market which agreed with reports of Losada *et al.* (1995). The feeding of home mixed kitchen, restaurant, associated with concentrates and grains to pigs of all categories could be considered as a mechanism of saving feed cost

and recycle of locally available resources which might lead to sustainable utilization. The price of own-mixed feeds was less than the feed mill factories, because feed manufacturers raised the price of their feeds in order to be able to pay their workers, maintain the feed mill and also make a profit, which was not the case when farmers mix their own feeds (Apantaku *et al.*, 2006). However, these home-mixed feeds have been reported to be nutritionally insufficient (Kasule, 2012), hence, resulting in decreased production efficiencies. Major reasons for the poor nutritional quality were the use of inappropriate feed formulae (Ferris and Laker-Ojok, 2006; Nabukeera, 2011) and adulterated feed components (MAAIF, 2005; UNBS, 2012).

The present variation in feed offer might be caused by the availability of wider farm size in Bishoftu which might support better feed production and supply to pigs. It was observed that farmers determined the amount of feed allowed to different pig classes without understanding the chemical composition of feedstuff and nutrient requirement of the pigs. However, such practice may be insufficient to satisfy to the nutrient requirement of pigs. Sex split feeding was not observed across the study towns throughout the study period. This could suggest that farmers were unable to monitor Nitrogen and Phosphorus wastage in their pig production units. To improve the quality of feeding pigs, it is needed that farmers first know the feed value and requirements of the pigs. Therefore, it will be instrumental to teach the pig keepers on this feature of pig husbandry.

The higher EE content of the feed samples would be of benefit to the pigs in Bishoftu. High fat content can also predispose feedstuff to rancidity. The lower ME may have contributed to the lower growth performance obtained in Addis Ababa and Adama. The CP content of the current results was relatively similar compared with previous reports of Okoli *et al.* (2009). The CF content of composite feeds in Addis Ababa and Adama seems higher for monogastric animals like pigs, which means that the proteins were probably locked up in these fiber materials of the feeds and can only be released with the aid of appropriate additive enzymes (Okoli, 2005). However, CF contents of all composite feeds in all study sites were smaller (25%) which disagreed with reports of Carter *et al.* (2015). The current variation in feed value of composite feeds across the study sites might be due

to the inclusion of diverse feed ingredients during formulation of rations for pig production. The feed values of the present study were similar with reports of Ermias *et al.* (2015), who studied the chemical composition of composite feeds for chicken production in central Oromia, Ethiopia.

The higher body condition scores of pigs in Bishoftu than Addis Ababa and Adama might be associated with the greater amount of feed offered and better feed quality. This in turn explained that there was more appropriate feed and effective delivery system in Bishoftu than in Addis Ababa and Adama. However, the overall results in relation to body condition scores of sows were lower which could increase the number of stillborn piglets in the study towns. Sows with lower body condition scores (less than 3) or amounts of back fat at the end of gestation experienced a significantly higher percentage of stillborn piglets (Maes *et al.*, 2004). So, monitoring the body condition scores of sows through phase feeding might help to decrease stillbirth in the pig herd.

In the surveyed towns, the majority of farmers involved in pig production used it as a source of additional income, probably due to its high rate of profitability which was inconformity with reports of Florence *et al.* (2010); Dennis *et al.* (2012); Nath *et al.* (2013), who stated that the majority of farmers involved in pig production started it as a source of secondary income. None of the pig keepers reared pigs for home consumption which might indicate that religion, culture and traditions played an important role in the pig sector of Ethiopia (MoARD, 2007). The purpose of keeping pigs in the current study was in contrast to the situation in Namibia, Uganda and Kenya, where pig keeping is primarily for income and pork consumption (Petrus *et al.*, 2011; Muhanguzi *et al.*, 2012). Failure to monitor health status on-farm may result in a disease invasion going undetected. The current results in relation to removal of dead pigs were inconsonance with the findings of Schembri *et al.* (2010). The current variation in use of vaccine for pig production might be due to difference in awareness, access to veterinary service and paying ability of the farmers in the three towns.

Diarrhea was leveled as the first important pig disease affecting mainly piglets which agreed with reports of Halpin (1975), who pointed out that the age of the animal had a great effect on its ability to withstand attack by both physical and biological agents. In addition, it was observed to be probably responsible for piglet mortalities. The death of piglets can affect the ability of future breeding practices to respond to changing consumer needs (Halimani *et al.*, 2010).

The occurrence of diarrhea may be related to the observed poor hygiene, and lack of disease preventive measures as well as poor nutrition of sow during gestation and lactation (Phengsavanh *et al.*, 2010). Furthermore, this finding agreed with observations by (Hong *et al.* 2006), who reported that the poor quality of feed and nutrient supply may be a contributory factor to the high incidence of diarrhea in piglets. The problem of diarrhea in piglets might cause considerable economic loss to pig farmers which was in harmony with study of Tuyen *et al.* (2005). It is suggested that improving the quality of pig feed could play an important role in reducing diarrhea in piglets, particularly in the pre-weaning period.

The types of pig diseases differed across the study sites. The noted diseases were identified by farmers or by a veterinarian according to the symptoms, seldom by sample analysis in a laboratory. The bio-security practices of pig farmers varied with location. These variations of bio-security implied that measures must be improved in towns with low practices in order to minimize chances of infection by diseases (Dijkhuizen *et al.*, 1999).

The average distance and time in relation to quarantine practices of the present study agreed with reports of Schembri *et al.* (2010). However, the results disagreed with reports of Okello *et al.* (2015), who stated that replacement stock often come from a variety of sources of unknown health status with no quarantine before entry. None of the pig producers found in all the three study sites met the recommendations for pig quarantine sketched by APL (2002). Inadequate quarantine procedures can increase the potential for disease introduction and spread into a naive herd.

Inadequate market access was similarly leveled in all the studied towns which limit pig farming. The results concurred with reports of Tekle *et al.* (2013). This might be related to lack of organized market channel, limited market information and lack of guaranteed prices (Sovann and San, 2002). This implied that alleviating constraints to marketing, improving marketing and market information and upgrading marketing infrastructures could potentially increase the welfare of producers and urban consumers.

The prevalence of pig diseases might be related to poor awareness of farmers, high cost of drugs and veterinary services. Similar results have been reported by Banta *et al.* (2012). This suggested that farmers were not alert and responsive to pig diseases which might have caused reduced productivity and income. There is need to increase producer awareness on healthy husbandry practices through strengthened extension services. These coupled with additional research would promote healthy pork production to meet the requirement of the increasing human population.

Pig keepers initially concerned on the ability to provide enough feed sooner than quality feed for pigs to consume. While farmers in all locations contended that many feed materials were available nonetheless, they were unable to utilize in their feeding program. This might be due to the high prices of feed ingredients. This agreed with reports of Mutua *et al.* (2011) who emphasized that inadequate feeding as a major challenge in pig production.

The scarcity of farm land in the study areas might hamper pig farm expansion, own feed/forage production and development. Land size had a positive influence on pig herd size; in that herd size increased with increased land size (Kimbi *et al.*, 2015). In addition, the absence of municipal abattoir in Bishoftu and Adama might result in small-scale producers slaughtering their pigs either on farms under unhygienic conditions or in Addis Ababa, about 40 km away. The slaughtering of pigs in Addis Ababa might contribute to farmers incurring high transportation costs which could render pig farming unprofitable. The inadequacy of slaughter facilities might contribute to low off take in the study towns.

This confirmed reports of Moreki and Mphinyane (2011), who stated that lack of slaughtering facility was the main challenge of pig farming.

Social tradition could demonstrate the cultural belief of the community i.e. pigs were considered unclean animals and have demons. This could in turn affect the selling price of pork in the market centers. This implied that awareness creation practices conducted by different stakeholders were too slow. The present condition could hamper the development of the sector to its full potential. Similar traditions have been reported by Florence *et al.* (2010).

Inbreeding was leveled differently among the study sites. This might be related to the use of same source of pig stock in Addis Ababa and Adama towns while in Bishoftu there is infrequent use of pig breeds imported from Holland. Inbreeding might cause a loss in heterozygosity and increases homozygosity which can result in increased lethal genes that increase embryonic death, mummified fetuses and stillbirths. Furthermore, inbreeding might cause a decrease in production/reproductive performance and fitness (inbreeding depression), low birth weights, increased mortality and poor fertility (Nicholas, 2003).

The lack of expertise on pig husbandry might have contributed to poor profitability of pig farms which agreed with reports of Phiri, (2012) stated that low profit levels were achieved in piggeries due to inadequate knowledge of farmers. The housing condition might lead to fighting, stress and decreased productivity.

The constraints to pig production as perceived by the farmers in the current study sites were largely in accordance with the findings in other pig production systems of Ethiopia (Tekle *et al.*, 2013; Mekuriaw and Asmare, 2014). The production constraints might hinder improvement of productivity of pigs (Wabacha *et al.*, 2004). These constraints were a major concern in the sustainability of the pig industry which needs to be addressed for complete realization of the sectors potential. If limitations to pig production in East Shewa were reduced, the enterprise could be source of employment and livelihood to

many dwellers of central Ethiopia. In general, the rank values for many limiting factors of small scale intensive pig production were unlike to towns. This implied that pig production constraints were different for Addis Ababa, Bishoftu and Adama towns.

The shorter age at first service of pig production in Bishoftu could be explained by increased furrowing rate. Sows with long age at first service often have decreased furrowing rates and litter sizes compared to sows with shorter age at first mating (Karveliēne *et al.*, 2008). Numerous studies have found that an inadequate intake of energy or protein during lactation affects body fat and protein reserves and prolongs the age at first service (Karveliēne *et al.*, 2008). The average age at first service could be determined by many factors including season, environmental temperature, photoperiod, nutrition, stress, facility design, lactation length, and management practices (Karveliēne *et al.*, 2008). The results in relation to age at first service were lower than reports of Okello *et al.* (2015). Services per conception were associated with location. The results might demonstrate that there were larger numbers of repeat breeders in pig production of Addis Ababa and Adama than in Bishoftu. The present results were concurrent with reports of Losada *et al.* (1995).

The lower mean age at first furrowing in Bishoftu implied that the pigs were matured earlier than pigs in Addis Ababa and Adama. The mean age at first furrowing of the current results were smaller than reports of Ate and Oyedipe (2011). In addition, this was a shorter period compared to age at first furrowing values of 319-417 days reported for other pig breeds including indigenous pigs (Stasiak *et al.*, 2008). Likewise, the average ages at first furrowing recorded in the present study was relatively lower than reports of Subalini *et al.* (2010) and Kadirvel *et al.* (2013).

The higher mean furrowing interval in Addis Ababa and Adama might be associated with the extended suckling period of pig production. This might have contributed to the delayed heat and invariably long furrowing intervals. Sows with long furrowing interval could influence the prolonging of the duration of reproductive cycle of sows in the herd and reduction of the number of parities per sow per year. The mean furrowing interval of

the current results were shorter than reports of Okello *et al.* (2015); Mutua *et al.* (2011); Petrovic *et al.* (2013).

The mean Number of farrowing/sow/year illustrated that the sows in Bishoftu conceive earlier than pigs in Addis Ababa and Adama after farrowing. A higher farrowing rate could result in more pigs born alive per bred sow per year. This could be associated with the diversity in early separation of sows from their piglets and put them close to a boar, in a way that could make direct contact (hear, see, smell) possible to stimulate regular heat across the study sites. The present results were higher than reports of Wabacha *et al.* (2004); Kumaresan *et al.* (2007); Lemke and Zarate (2008); Lemke *et al.* (2008); Roessler *et al.* (2008); Iyai *et al.* (2012). The results implied that pigs had shorter pregnancy period that could make fast investment return of pig production that confirmed reports of Nath *et al.* (2013). This in turn explained that the gestation period of pigs was lower than shoats and cattle.

The overall litter size at birth was comparable with reports of Ikwap *et al.* (2014). The mean litter size of the current study was higher than that of Taiwanese pigs, Tanzanian native pigs and Zimbabwean native pigs reported by Chiduwa *et al.* (2008). It was however lower than 11 piglets at birth reported for northern Ethiopia (Tekle *et al.*, 2013). Similarly, larger litter size at birth was reported (Engblom *et al.*, 2007). Differences in both nutrition and management practices probably accounted for the disparity in values.

The mean high stillbirths in pig production across the study sites might be associated with lack of farrowing supervision and timely intervention as needed which might reduce sow discomfort and increase piglet death during parturition (Vladimir *et al.*, 2005). The present results were lower than reports of Okello *et al.* (2015). Farrowing season, farrowing length and parity had highly significant effects on both number of stillborn piglets per litter and percentage born alive (Chu, 2005). Thus, identification of risk factors associated with stillbirths could help to optimize reproductive efficiency of pig production.

The mean litter size at weaning could indicate that there was better care and survival of piglets and profitability in Bishoftu than Addis Ababa and Adama towns. The profitability of pig farm largely depended on the survival of litters up to weaning besides other closely related factors such as weight of piglets at birth (Chu, 2005). The current results were smaller than reports of Rekwot *et al.* (2003).

The lighter live weight at weaning of pigs in Addis Ababa and Adama compared to Bishoftu might demonstrate that pigs had lower growth rates post-weaning and were slower to reach a common slaughter weight. This could be attributed to greater feed intake of pigs in Bishoftu that had larger weight at weaning. Similarly, pigs that were heavier at weaning performed better than those that were light (Dunshea *et al.*, 2003). Pigs weighing less than 5kg at weaning (21 days) require 12 additional days to reach market weight when compared to pigs weighing greater than 7 kg (Azain *et al.*, 1996). This implies that maximizing weaning weight would help to ensure rapid post weaning growth.

Weaning age was not associated ( $p > 0.05$ ) with location. The overall weaning age of pigs was  $23.4 \pm 1.5$  days. Comparable values were also reported in northern part Ethiopia (Birhan *et al.*, 2015). Conversely, the current result was smaller than reports of Mota *et al.* (2002); Phengsavanh *et al.* (2010). The current age at weaning could accelerate the growth performance of pigs. This agreed with reports of Smith *et al.* (2008), who stated that increasing weaning age from 12 to 21.5 days improved wean-to-finish growth performance in a multisite swine production system.

The variation in pre-weaning mortality of pigs could be affected by numerous factors such as litter size, birth weight and order, farrowing duration, housing, flooring, and management practices (Roy *et al.*, 2014). The present results of pre-weaning mortality were higher than reports of Pedersen *et al.* (2011); Li *et al.* (2010). The death of piglets might adversely affect the productivity of farms; therefore, implementing an effective management regime after birth could decrease the occurrence of piglet deaths.

The reduced growth rate of pigs in Addis Ababa and Adama could be associated with the lower feed resource, feed quality and feed allowance. The results of the current study were relatively better than reports of Phengsavanh *et al.* (2010), who found that pigs generally took nearly 2 years to reach a marketable weight of 60 to 70 kg. This equated to an average of daily weight gain ranging from 100 to 140 g, which disagreed with the present results. However, the performance of pigs in small scale intensive farming system was generally very poor, as it might be affected negatively by nutritionally imbalanced diets and underfeeding. This might diminish the number of pigs supplied to the market that in turn reduced the income of farmers.

Traders were the dominant types of buyers where they sold their commodities to others. This agreed with reports of Alemayehu and Getu (2015). The action of traders is to buy animals from markets where prices were low and sell in markets where prices are high.

Weight balance was utilized by greater number of respondents to measure body size of pigs in Addis Ababa and Bishoftu. This could imply that farmers in those sites were better equipped and could keep away from under pricing of their commodities. The current results were inconsistent with reports of Ebrahim and Hailemicheal (2009) in North Ethiopia and Tsedeke (2007), who in Southern Ethiopia explained the majority of the producers market their animals on eye-ball estimation and agreement to prices reached after a long one-to-one bargaining between buyers and sellers and sometimes brokers.

Slaughter house was the dominant place where marketing conducted; farm gate marketing was also utilized by considerable number of pig farmers. Selling pigs at farm gate may enable the farmers to save on transportation costs and avoid losses of pigs due to stress during transport. However, prices they receive could be lower which agreed with reports of Rubzen *et al.* (2002). The frequent random farm gate selling to mobile trader's pointed to the farmers' disadvantage in comparison to middlemen (Riedel *et al.*, 2012). Samkol *et al.* (2006) explained such farmers as rather being price takers than price makers. The arrangement of cooperatives and similar clusters or prevention of middlemen by creating straight trade linkage with retailers would reinforce small-scale farmers.

Sources of market information were not associated with location. The current market information sources indicated that there was no regular market information on prices and supplies, nor formalized grades and standards of pigs across the study sites which agreed with reports of Ayele *et al.* (2003). This could hinder producers to make timely and sound decisions on pig marketing. Accordingly, farmers may supply surplus pigs further than the demands in several periods. The more mobile trader could be well up to dated on market prices which combined with excess supply places where the trader might be in a better situation during price negotiation.

In general, farmers did not have control over prices. Prices were mainly dictated by the middlemen. Problems expressed by farmers include low commodity prices, unreliable weighing scale used by buyers, few buyers and lack of information on prices and alternative markets. The absence of market services such as animal weighing scale, grades and standards might have encouraged the activities of the brokers. Farmers expressed the need for timely information on prices and potential alternative markets. There could be disruption of dissemination efforts by traders and brokers targeted on preventing producers from accessing market information. This might put producers at a disadvantage as it could limit their ability to negotiate prices received. Quality and timeliness of information could be important. Improving price information systems in the area could have a positive effect in livestock production and marketing. This may be an area where government intervention or facilitation would be useful.

The main products sold in the current study concurred with reports of Rubzen *et al.* (2002), who stated that live pig and pork were the foremost commodities sold by pig farmers. The characteristics that determine the price of pigs in the current results coincided with reports of Ayalew *et al.* (2013). These preferred traits influenced the price of pigs, where buyers paid more for the desirable qualitative and quantitative traits. Pig production that tailored to the interests and preferences of customers would improve the income and livelihood of small scale farmers.

The average price per kg of pig and pork was associated with the study sites. The higher average price per kg of live pig in Addis Ababa and Bishoftu might be connected with the presence of greater number human population. This agreed with reports of Lampheuy (2012), who stated that there is a trend for increasing pig production in commercial systems close to densely populated areas to meet the consumer demand for pork. Furthermore, the difference in price at diverse areas could be associated with elevated participation of trader, accessibility and proximity of the market (Ayalew *et al.*, 2013).

The level of price increase of live pig and pork in the last ten years was threefold which might be caused by increased number of urban consumers (Ebrahim and Hailemicheal, 2009). The increase in sale price may motivate local farmers to sale as many animals as possible; that could affect household flock production through the removal of young breeding flocks. The results of the present study were in conformity with reports of Workneh (2006), who suggested that market prices may offer greater incentives for rising off-take animals among smallholders that could place serious concern to the replacement of breeding stock.

The marketing constraints varied with location. The difference in pig marketing constraints among the study sites might be due to the variation in market infrastructures. Pig slaughtering house was the least important impediment in Addis Ababa while it was the most pronounced obstacle in Bishoftu and Adama. This implied that the markets were poorly developed. However, markets could be a powerful vehicle for farmer's development (Dixon *et al.*, 2001). The poor terms of trade of farmers at times might act as a disincentive to increase pig production. The marketing channels of the present study were consistent with reports of Ayalew *et al.* (2013).

## 6. CONCLUSIONS AND RECOMMENDATIONS

### 6.1. Conclusions

Male headed households were dominant in the small scale pig production system across the study sites. Socioeconomic characteristics, farm profile, housing practices were associated with the study sites since variation was detected along with the towns, mainly in relation to wealth status, farm experience, land size, herd size, housing practices (brick walled, recommended and non-recommended housing). Future development endeavors in pig production in East Shewa of central Ethiopia should take into account the diverse socio-economic characteristics, farm profile and housing practices of the towns.

Two types of pig operations were identified in East Shewa namely: mixed and farrow to finish operations. The Feed resources, amount of feed offered, nutritional composition of feeds and body condition scores of different pig categories varied across the study towns. Therefore, context specific development interventions could improve the income of pig producers.

The small scale pig production system in the three towns can be characterized as intensive pig production aimed mainly at income generation. Health management and challenges of pig husbandry differed across the towns, particularly in terms of use of vaccine, disease types, bio safety (use of feet and wheel bath) and quarantine practices (no new pigs introduced, new pigs quarantined and no quarantine practices).

Pig mortality and stillbirth were serious problems that need due attention in order to produce more animal protein for the community. The pig production performance in relation to reproduction and growth were affected by study areas, specially issues linked with age at first service, age at first farrowing, farrowing interval, number of farrowing/sow/year, litter sizes at weaning and birth, live weight at weaning, pre-weaning piglet mortality, average daily gain, fattening period and market weight.

The characteristics that determine the price of pigs were body size, color, body conformation, age and sex in that order. The principal marketing channel was producer-trader-supermarket-hotel/restaurant-consumer. Pig marketing practices were influenced by study sites, as dissimilarity were scrutinized among towns, specifically in terms of methods of weight estimation, main product sold, price of live pig and price of pork.

Lack of pig slaughtering facility was the foremost obstruction in Bishoftu and Adama while it was the least important barrier in Addis Ababa town. Therefore, prospective improvement actions in pig production in East Shewa of central Ethiopia should bear in mind the variation in performance traits, miscellaneous marketing practices and constraints of the towns.

## **6.2. Recommendations**

Any further actions to improve pig production in East Shewa of central Ethiopia should consider differences in socioeconomic factors, farm profile, feed resource, health management practices, performance, marketing practices and challenges of the towns. Such actions were articulated in seven major pillars that were identified in this survey as the most critical.

- Creating awareness on bio-security and quarantine measures should be conducted to advance the pig herd performance and profitability.
- Animal disease control strategies associated with the background of the current towns should be intensified to improve the health status and performance of pigs.
- The government should consider the possibility of establishing pig breeding center, pork processing units and creating market linkage which can motivate pig producers. It could be more promising to support innovative community-based systems and encouraging other private-sector investment to better meet the unsatisfied demand.
- Allocation of land to the community for pig rearing would be a key intervention for supporting their livelihoods and for increasing number of producers participating in piggery.

- Future research and development endeavors should focus on estimating body weights of pigs using linear body measurements that could be extremely beneficial for purposes of treating animals with the appropriate doses of drugs and vaccine.
- The government should work on cultural and behavioral change of the people and formulate an appropriate policy regarding swine production and incorporate in the national livestock development program.
- Future research should focus on conducting experiment to determine the feed intake, nutrient utilization and performance of pigs.

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## 8. APPENDIX

### Appendix1: Questionnaire 1

#### Socio-economic characteristics of pig farmers

**1. Sex**

A. Male

B. Female

**2. Age:**\_\_\_\_\_

**3. Family size:**\_\_\_\_\_

**4. Education level**

A. No education

B. Basic

C. Junior

D. Senior

E. University

**5. Land size:**\_\_\_\_\_

**6. Experience for pig husbandry (year):**\_\_\_\_\_

**7. Source of income**

A. Salary

B. Pension

C. Business

D. Sale of livestock

E. Various combinations

**8. Wealth status**

- A. Poor
  - B. Medium
  - C. Well off
- 9. Sources of labour**
- A. Mother
  - B. Father
  - C. Children
  - D. Hired

**Questioning route: - For pig production systems**

**10. Type of pig operation**

- A. Farrow to finish
- B. Farrow to wean operation
- C. Grower to finishing operation
- D. Mixed operation

**11. Pig production system**

- A. Free-range
- B. Semi-intensive
- C. Intensive

**12. Breed**

- A. Local
- B. Cross breed

**13. Herd size:\_\_\_\_\_**

**14. Manager**

- A. Owner

- B. Owner and male relative
- C. Owner and female relative
- D. Female relative
- E. Worker
- F. Friend

**15. Record keeping**

- A. Yes
- B. No

**16. Daily time devoted to pig management**

- A. Less than one hour
- B. One hour
- C. Three hours
- D. Four hours
- E. Five hours
- F. Six hours
- G. Seven hours

**17. Purpose of pig keeping**

- A. Primary income
- B. Extra income
- C. Family tradition
- D. Cultural tradition
- E. Food for home consumption (home kill)
- F. Hobby

**18. Interviewed farmer was trained on pig husbandry**

A. Yes

B. No

**19. Sources of parent stock**

A. Market

B. Inherited

C. Neighbors

D. Bred

E. Government farm

F. Borrowed

G. Others

**20. Herd composition**

A. Sow

B. Boar

C. Gilt

D. Male

**21. Other livestock species kept by pig farmers**

A. Cattle

B. Sheep

C. Goats

D. Chickens

E. Donkey

F. Horses

**22. Body condition score**

- A. Piglets
- B. Weaners
- C. Growers
- D. Sows
- E. Boars

**23. Pig performance traits**

- A. Age at first service
- B. Services per conception
- C. Age at first farrowing (months)
- D. Farrowing interval (months)
- E. Number of farrowing/sow/year
- F. Gestation period (months)
- G. Litter size at birth
- H. Litter size at weaning
- I. Birth weight (kg)
- J. Weaning weight (kg)
- K. Pre-weaning average daily gain (gm)
- L. Post-weaning average daily gain (gm)
- M. Slaughter weight (kg)
- N. Slaughter age (month)
- O. Range of lactation period Days

**Questioning route: - For pig feed characteristics**

**24. Feed source**

- A. Kitchen
- B. Garden
- C. Restaurant
- D. Disposal
- E. Market

**25. Feed type**

- A. Kitchen
- B. Restaurant
- C. Forages
- D. Grains
- E. Concentrates
- F. Abattoir Waste
- G. Poultry Feaces
- H. Mineral

**26. Feed sources**

- A. Kitchen
- B. Restaurant
- C. Market
- D. Grains
- E. Garden

**27. Number of meals fed to pigs**

- A. Once a day

- B. Twice a day
- C. Three times a day
- D. Several times a day

**28. Amount of feed offered to pigs**

- A. Piglets
- B. Weaned
- C. Growers
- D. Boars
- E. Sows
- F. Fatteners

**29. Who feeds pigs?**

- A. Farmer
- B. Member of family
- C. Workers

**30. Source of water for pig**

- A. Tap water
- B. Tap and rain water
- C. River
- D. Well

**31. Frequency of watering**

- A. Once a day
- B. Twice a day
- C. Three times a day
- D. Several times a day

**32. Use of water trough**

- A. Yes
- B. No

**33. Pig housing type**

- A. Wood walled sty
- B. Brick walled sty
- C. Stone walled sty
- D. Wall made of soil
- E. Fence/Kraal/Paddock
- F. Asbestos pipe
- E. None

**34. Housing frequency**

- A. All year round
- B. Occasional

**35. Is pig housing based on recommendation?**

- A. Yes
- B. No

**36. Pigs are housed**

- A. Individually
- B. In group

**37. Prevalent diseases in the study areas**

- A. Diarrhea

- B. Cough
- C. Lice
- D. Sunburn
- E. ASF
- F. FMD
- G. Mastitis

**38. Pig health practice**

- A. Maintain herd health records
- B. Contact veterinarian in past 12 months

**39. Purpose of veterinary contact**

- A. To get antibiotics
- B. To get disease advice
- C. For general pig information

**40. Last time veterinarian visited the pigs**

- A. <12 months
- B. 1–5 years ago
- C. >5 years ago
- D. Never

**41. Treatment of sick pigs**

- A. Try and treat yourself
- B. Seek advice
- C. Destroy affected pig

**42. Disposal of dead pigs**

- A. Bury
- B. Burn
- C. Compost
- D. Feed to dogs

**43. On-farm bio-security practices**

- A. On-farm bio-security practices
- B. Have a controlled entry
- C. Overalls/boots provided to visitors
- D. Perimeter fence around the farm
- E. Seen feral pigs on the property

**44. Quarantine practices**

- A. No new pigs introduced (closed herd)
- B. New pigs quarantined from the main herd
- C. No quarantine practices for new pigs
- D. Number of days quarantined
- E. Distance from the main herd (m)

**45. The performance of fattening pigs**

- A. Number of fatteners
- B. Average starter's weight (kg)
- C. Average fattening time (months)
- D. Average selling weight (kg)
- E. Average daily gain (g/d)

**46. Pig identification practices and movement requirements**

- A. Ear tag
- B. Ear tattoo
- C. No identification practices

**47. What are the buyers of your pigs?**

- A. Consumers
- B. Neighbor
- C. Trader
- D. Butcher/restaurant
- E. Others

**48. What are the major reasons for selling pigs?**

**49. What are the major reasons for buying pigs?**

- A. For home consumption
- B. For production
- C. For selling to others
- D. Others( specify)

**50. How do you sell pig in the market?**

- A. Through negotiation
- B. Through brokers
- C. Others (specify)

**51. Where do you sell your pigs?**

- A. At producers house
- B. At butchers house
- C. Slaughter house
- D. Local markets

E. Others (specify)

**52. Is pig marketing dependent on season?**

A. Yes

B. No

**53. What is your source of market information?**

A. Neighbor

B. Friend

C. Radio

D. Others (specify)

**54. What is the main product sold?**

A. Live pig

B. Pork

**55. How do you estimate price of pigs?**

A. Body Size

B. Color

C. Body conformation

D. Sex

E. Age

F. Others(specify)

**56. Indicate current, the past 5 and 10 year's average price for pig.**

Period	Piglet	Weaner	Grower	Sow	Boar
Current					
5 years back					
10 years back					

**57. What do you think is the level of change/increase in the price of pig?**

- A. Only slightly
- B. One fold increase
- C. Two fold increase
- D. Three fold increase
- E. Four fold increase

**58. What are the major problems related to pig marketing?**

- A. Price fluctuation
- B. Lack of market channel
- C. High cost of transportation
- D. Limited capital
- E. Lack of functioning abattoir
- F. Lack of price information
- G. Mistrust and cheating
- H. Others (Specify)

**59. What are the major problems related to pig production?**

- A. Lack of market to sell pigs and their products
- B. Lack of pork processing units

- C. Lack of feed
- D. Lack of land
- E. Lack of government policy
- F. Transportation problem
- G. Less acceptance of pig production and pork consumption
- H. Lack of other inputs, equipment and farm resources
- I. Lack of extension service and technical support
- J. Unfavorable climatic factors
- K. Lack of knowhow on pig management and other aspects
- L. Others (specify)

**60. What do you suggest to solve your problems on pig production and marketing?**

**61. Origin of Slaughter animals**

- A. Within district
- B. Other districts

## Appendix2: Guideline for FGD 0-1

Guidelines
Identification and Prioritization of Pig Production Constraints
Disease Situations
Feed Resources and Feeding
Water Resources
Name of the Pig Breed
Distribution of Pigs

## Appendix3: Amount of feed offered 0-1

Pig class

Piglets (kg)
Weaned (kg)
Growers (kg)
Sows (kg)
Boars (kg)
Fatteners (kg)

**Appendix4: Body condition scoring 1**



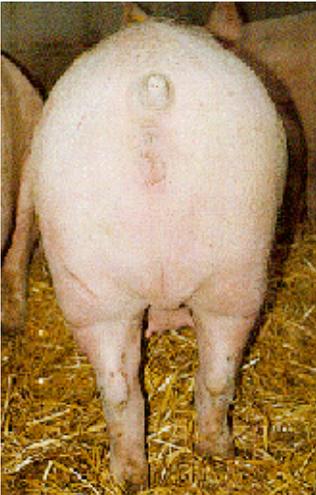
**Score 1**



**Score 2**



**Score 3**



**Score 4**



**Score 5**

## Publications

This thesis is based on the issues contained in published articles, numerically listed from roman number I to V.

- I. Berihu, M and B. Tamir, 2015. Socioeconomic and Farm Characteristics of Small Scale Intensive Pig Production in East Shewa of Central Oromia, Ethiopia. *World Applied Sciences Journal*, 33 (12): 1827-1833.
- II. Berihu, M., B. Tamir and N. Lundeheim, 2015. Health Management and Factors Affecting Small Scale Intensive Pig Production in East Shewa of Central Ethiopia. *Advances in Biological Research*, 9(5): 373-380.
- III. Berihu, M. and B. Tamir, 2015. Characterization of Feed Resources and Body Condition Scores of Pigs under Small Scale Intensive Production in East Shewa, Ethiopia. *Academic Journal of Nutrition*, 4 (3): 106-112.
- IV. Berihu, M. and B. Tamir, 2015. Analysis of Reproduction and Fattening Performances of Pigs under Small Scale Intensive Farming in East Shewa, Ethiopia. *Journal of Reproduction and Infertility*, 7(1). 1-7.
- V. Berihu, M. and B. Tamir, 2015. Marketing practices and constraints of pig production under small scale intensive farming in East Shewa, Ethiopia. *Global Veterinaria*, 16(2):261-267.