

**FACTORS INFLUENCING PIG PRODUCTION IN
EMBU WEST, EMBU COUNTY, KENYA**

BY

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DECLARATION AND APPROVAL

Declaration

This Thesis is my original work and has not been presented for any award in this or any other University.

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Approval

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DEDICATION

This thesis is dedicated to my loving wife Deborah Gaiti Kithinji for the unwavering support she gave during the entire period of this study.

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I wish to acknowledge all the staff of the Department of Range and Wildlife Sciences for their support since I enrolled for my studies. I also do thank all the Embu Sub-County livestock sector personnel for the cooperation and help they extended to me during this study. I particularly single out Joseph Chomba who coordinated my data collection exercise. I also thank all the respondents for the cooperation and agreeing to answer the questions that achieved these study objectives.

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ABSTRACT

Traditional/backyard pig production systems are found in the larger Western Kenya while commercial systems are predominant in Eastern and Central Kenya including Nairobi. The pig holdings in Coast and few in North-Eastern are commercial systems. The expansion and improvement of the market for pigs and pig products generally in Kenya may explain why pig-keeping is beginning to be found outside traditional pig-keeping areas.

The objectives of the study were: 1) To characterize pig production systems, 2) establish factors constraining production and, 3) find strategies that can enhance the performance of the industry. The sampling was done in seven Sub- Locations of Embu West Sub- County where there was a concentration of farmers keeping pigs. From the sampling frame of pig farmers (142) a sample of (104) pig farmers was generated using the formula: $n = N / \{1 + N (e)^2\}$; *Yamane (1967: 886)*.

The pig farmers were randomly selected using Random Integer Generator. Data was collected using structured questionnaire in face to face interview with the pig farmers and also included physical examination of the households and photography. The data included the demographic characteristics of households, pig production and management practices, constraints and opportunities of pig farming. The data collected was transferred into Statistical Package for Social Sciences (SPSS) and analyzed to determine simple means, frequencies and percentages. The results of the data analysis were presented in frequency tables and charts. Results showed that 92.6% of the pig farmers were males and 93.3% of the households were male headed. Over 60% of the pig farmers were in the age bracket of 45-60 years. All the pig farmers were literate with about 60% of them having attained primary level of education indicating that the farmers could easily adopt new introduced agriculture technologies. All the pig farmers were Christians with about 82% belonging to the Protestant faith. They owned parcels of land ranging from 0.25 acres to 25 acres with a mean land size of 2.9 acres. Both parents and children (85.5%) were involved in pig farming. All the households (100 %) kept pigs in small intensive production system and (63.3%) households kept 1 to 4 pigs. The pig breeds kept were Large White and Landrace. The feed resources used to feed the pigs were garden weeds, kitchen leftovers, market agricultural waste (99%), Sow and Weaner ration (97.1%), rice bran (96.2%), Cassava, Napier grass, Sweet potato tubers and vines, Pumpkins (95.2%). Only 4.8% of the households used Creep feed, Sow and Weaner and Pig finisher meal. Almost 90% of farmers housed their pigs on temporary structures roofed with iron sheets. Timber, wooden poles and off

cuts were used to construct the walls and floor. Worm infestation and fleas were reported as the major disease/pest management problem by 81% and 32% of pig farmers respectively.

The preferred pig production system is the intensive pig production system. The major constraints to pig production were; lack of high quality breeding stock (95.2%), high cost of commercial feeds (95.2%), poor pig housing (87.5%) and diseases and pest management (83.7%).

. Opportunities to enhance the pig industry in the Sub County include; planting feedstuffs for direct feeding to pigs (92.3%) and supply for feed manufacture (91.3 %), establishing feed manufacturing facilities and government subsidies on feed cost (15.4%). Other opportunities of improving the pig production system include sourcing credit from Agricultural Finance Corporation by 74% of the respondents and, other financial institutions by 33% of the respondents.

It is recommended that pig farmers be trained in basic aspects of pig farming.

It is also recommended that pig farmers be encouraged to form groups so that they can run pig farming as a viable enterprise. This will enable them to access credit to acquire inputs and also make it easier to disseminate information to the farmers to improve pig farming.

Due to the expansion and improvement of the market for pigs and pig products in Kenya, it is recommended that a country survey be carried out to establish the extent of pig production, consumption and the contribution of the contribution of the pig sub-sector to the economy.

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ABBREVIATIONS AND ACRONYMS

A.I	Artificial Insemination
ASF	African Swine Fever
ADB	African Development Bank
AWAS	Animal Welfare Approved Standards
COMESA	Common Market for Eastern and Southern Africa
DAO	District Agriculture Officer
DVO	District Veterinary Officer
EU	European Union
FADA	Focal Area Development Approach
FAO	Food and Agriculture Organization of the United Nations
FAOSTAT	Statistics wing of Food and Agriculture Organization
GDP	Gross Domestic Product
KARI	Kenya Agriculture Research Institute
KALRO	Kenya Agriculture and Livestock Research Organization
PRA	Rapid Rural Appraisal
PIB	Pig Industry Board
MOLD	Ministry of Livestock Development
NALEP	National Agriculture and Livestock Extension Programme
SEKU	South Eastern Kenya University
SPSS	Statistical Package for Social Sciences
UAE	United Arab Emirates
USA	United States of America

CHAPTER ONE

INTRODUCTION

1.1 Background of the study

Food security remains a major global challenge as the world population continues to increase and recent projections indicate a 32% increase in the world population between 1995 and 2020 (Bidiane and Delgado, 1995). Over 97% of the increase will be in the developing world and the relative increase will be greatest in Africa where the population will increase by 70% (Rose grant *et al.*, 1995). To feed this rapidly expanding human population, animal based products will continue to be in great demand due to their contribution to food security and nutrition. Population growth, urbanization, income growth, and changes in diets of people are predicted to fuel massive demand for food of animal origin (Delgado *et al.*, 1999; FAO, 2006; Steinfeld *et al.*, 2006; Costales *et al.*, 2007; Thorton, 2010). The livestock sector contributes 40% of the global agricultural output and employs about 1.3 billion people globally and directly supports the livelihoods of over 600 million poor smallholder farmers in the developing world (FAO, 2011; Thorton *et al.*, 2006).

Livestock products contribute 17% Kilocalorie consumption and 33% to protein consumption globally, though there are large differences between the rich and poor countries (Rose grant *et al.*, 2009). From 1979, pork became the most produced and consumed meat in the world (Schneider, 2011). Pig production is widely scattered across the world. Asia is the largest producer of pork in the world accounting for 56% of the global pork production, surpassing Europe (25%) and North America (17%). China alone accounts for 48% of the total world pork production (FAOSTAT, 2011).

Global pig production systems of the world are diverse, (Verhulst, 1990) across developing countries/ tropics to those of the industrialized countries. Those in the developing countries can be classified into extensive (traditional), semi-intensive and intensive pig farming systems (Verhulst, 1990). Extensive and semi-intensive production systems supply mainly the rural populations while the intensive sector supplies the urban centres.

1.1.1 Pig Production in developed countries.

In industrialized countries, intensive pig production systems are characterized by a high level of intensification and management. These are located in regions of high grain production such as the American Corn Belt States and Canadian Prairie Province and also major arable areas of Europe. Large concentrations of pig production can also develop around areas where cheap industrial by-products from human food processing are available for feed as seen in Netherlands. Challenges associated with intensive pig production include waste management and the risk of adverse environmental impact such as ground water pollution, gaseous emissions and odour. There are also public concerns about animal welfare in large scale intensive enterprises increasing legislative control in both Europe and North America.

In highly specialized systems, the production of pig meat involves breeding, nursery, weaning and finishing phases. These operations may all take place on the same farm (farrow-finish operations) or may be split between different farms each specializing in one or two phases. In such systems biosecurity and health management are major priorities. Typically, majority of pigs in industrialized countries are housed in buildings with fully or partially slatted floors and have liquid manure (slurry) handling systems. Pregnant sows are most commonly housed in individual crates, but animal welfare concerns have resulted phasing out of such systems in the EU from 2012. Similar consumer concerns on this legislation are growing in the major pig producing states of North America. In many European countries and to a lesser extent in North America, alternative, less intensive systems of production have been adopted and include the deep litter, bedded indoor systems, outdoor production systems for both sows and growing pigs (Sorensen *et al.*, 2006).

1.1.2 Pig production in developing countries/ Tropics

In both South and South-East Asia, small-scale pig rearing in the back yard is the most predominant practice. Pig production is also practiced integrated in fish production systems. The integrated system involving pig production, fish farming, duck keeping and vegetable production, or a combination of these is traditional and is widely practiced in South-East Asia and China (Devendra and Fuller, 1979).

Many pig farmers in developing countries/ Tropics allow pigs to forage on pasture and supplement with available farm waste (Rangoma, 2013). Most households have some kind of kitchen waste, which can be exploited by a pig; however, this is only enough for the partial feeding of a single pig per household. Other feedstuffs that are locally available like maize and sorghum are deficient in lysine and methionine, the most limiting amino acids in pig feeds. Amino acids can be divided into two groups: essential and non-essential amino acids. Non-essential amino acids are manufactured by pigs, while essential amino acids must be supplied in feed. Amino acids are combined to make protein in lean muscle, with each type of protein having a strict and specific arrangement of amino acids. In cereal based diets, the most common diet fed to pigs the essential amino acids lysine, methionine, tryptophan, threonine and isoleucine are the most deficient with lysine usually in the shortest supply (Nutrition basics for pigs, 2010). Under intensive production systems, nutrients must be provided by the farmer (Lekule and Kyvsgaard, 2003). In advanced systems pigs are totally confined and provided a-balanced diet. To provide a balanced diet the nutritional requirements of the different classes of pigs must be known and met. The different nutrients required by the pigs include water, energy, proteins, fat, vitamins, minerals and additives for optimal performance. In addition to daily nutrient required by the pig for maintenance, growth and reproduction, other nutrients requirements depend on the size and the physiological state of the pig. Formulating a feed ration is a complex procedure that ordinary farmers might not be able to do effectively. It is therefore prudent for pig farmers to purchase already prepared rations from reliable commercial sources (Rangoma, 2013). Leaves from shrubs such as cassava and mulberry, from vegetables such as sweet potato and cocoyam, together with water plants such as duckweed and water spinach can successfully be used in diets for pigs to replace at least the protein usually supplied as soybean and fishmeal (Preston, 2006).

1.1.3 Pig production in Kenya

Livestock contributes 3.3% of Kenyan GDP (Akiluet *al.*, 2002) with red meat, comprising beef, mutton, goat and camel meat, accounting for 80% of all the meat consumed locally. Kenya imports livestock from neighboring countries mainly through informal trade and is a hub for livestock trade especially live cattle (Akilu, 2015). White meat, which includes poultry and pig meat, accounts for about 19 % (Bettet *al.*, 2012), of the meat consumed in the country and trends in the consumption of white meat are on the increase. It has been estimated that there will be an increase of up to 155% in annual pork consumption from the 2000 to 2030 in Sub-Sahara Africa and an even higher increase of 167% in annual pork consumption globally in countries deemed to be of low income (FAO 2011).

Pig production in Kenya is relatively well developed (FAO, 2012) and has grown steadily in the last ten years despite some obstacles in the sector. These obstacles include the collapse of the tourist industry in 1998, suspension of activities at the KARI (KALRO) Pig Breeding Station in Naivasha since 2008, and the high cost of production. Pig production in Kenya has been in the hands of the private sector for many years, apart from the time when the Uplands Bacon Factory under the Pig Industry Board (PIB) had the monopoly. The factory collapsed and was wound up in 1987. After the collapse of the Factory, pig processing has largely remained under the Farmer's Choice Company which is also an export slaughter facility. There are three other major slaughter facilities in the country namely Ndumboini Farm Slaughter House and Lyntano Slaughter House located in Kiambu County. These two slaughter houses supply pork mainly to Nairobi and Kiambu. The third is Kabati Slaughter House in Muranga County whose main market for the carcasses is Thika Town which is thought to lead in Kenya in pork consumption and has many pork butcheries and eateries (FAO, 2012).

The Government of Kenya had in the 1990s tried to revive the pig sub sector through funding by the African Development Bank (ADB). The objective was to increase white meat availability in the market as well as increasing incomes of smallholder producers and processors in compliance with the Government policy of the sub sector (MoALD, 2002). The efforts failed because of problems of cash flow, procurement, technical assistance and extension. The pig industry has withstood periodic fluctuations moving from large scale to smallholder farming, the latter comprising about 70% of the industry. The industry relies mainly on tourism though consumption by the local population is on the increase (Bergevoet and Van Engelen, 2014).

The major challenges in pig production in Kenya include the high cost of feeds, limited access to credit, inadequate genetically high quality breeding boars, diseases, poor marketing opportunities,

lack of basic knowledge on pig management practices, poor extension services and lack of skilled veterinarians on pig diseases and preventive health (Kagira *et al.*, 2010; Wabacha *et al.*, 2004). Availability, accessibility and affordability of pig feed are some of the common challenges pig producers are facing in Kenya. For farmers to improve the pigs' productivity, weight, and make reasonable profits, they must feed the pigs on balanced commercial or homemade feeds. This is hardly so as most pig producers use agricultural wastes and other feedstuffs of low nutritional value to feed their pigs (FAO, 2012). Commercial feeds which include concentrates and protein sources such as fishmeal, soybeans, cotton seed cake, sunflower seed cake and meat and bone meal are bought by smallholders in varying amounts and with varying frequencies.

Smallholder production constitute up to 70 % of the total pig production in Kenya. Most farmers rely to a high degree on external sources such as the feed millers and other feed outlets to get feed for their pigs. Feeds and feeding constitute about 80% of the total production costs hence many producers are optioning for cheaper ways of feeding their animals. Some small-scale farmers have formed co-operative societies and opened feed mills (FAO, 2012), which manufacture cheaper and higher quality pig feeds. The cost of commercial feeds in Kenya has increased by 450% during the last the last three years (Githigia, 2013).

Proper housing which helps in maintaining high standard of hygiene (cleanliness of the pigsty), proper feeding, and some routine husbandry practices on piglets leads to prevention of diseases and pests. These practices include: tail docking (to avoid tail biting which prevents spinal abscesses), clipping needle teeth (to avoid injury to both sow and piglets) and iron injection/ paste (to prevent anemia), (Roese and Taylor, 2006). Most mortality of pigs occurs during the early life of the piglets (Ajala *et al.*, 2007; Kamuribo *et al.*, 2011). Several diseases have been mentioned that affect piglets such worm infestation, diarrhea and skin diseases by mites (mange), lice and deficiencies. Ocampo *et al.*, (2005) reported that at least two piglets die per litter because of worm infestation, diarrhea or being squashed by sows. In rural areas, *Taeniasolium* infestation is recognized as not only a health problem for pigs but also a public health problem (Vihena *et al.*, 1999; Veary and Manato, 2008; Kagira *et al.*, 2010; Eshitera *et al.*, 2012). Lack of meat inspectors and poor husbandry practices in rural areas makes worm infestation a serious public health problem (Veary and Monato, 2008). Public education and general awareness of *Taeniasolium* infections is vital in eradicating the parasite (Krecek *et al.*, 2012). Major pig diseases include; African Swine Fever (ASF), Porcine Cysticercosis, mange, pediculosis, worms, ticks and jigger

infestations (FAO, 2012; Wabacha *et al.*, 2004). Other studies show that diseases and pests are a major constraint in pig production (Muhanguzi *et al.*, 2012; Montsho and Moreki, 2012).

Health care of pigs in rural areas has been reported in several studies with no reference to biosecurity and worm infestation was reported as one of the health problems frequently mentioned by most farmers (Lekule and Kyvsagaard, 2003; Ajala *et al.*, 2007; Kamuribo *et al.*, 2011). Worms can be controlled but continuous inappropriate use of antihelmentics has resulted in resistance with worms affecting the productivity and profits (Steinfeld, 2003). In some studies farmers were not able to describe animal diseases and some said they did not experience any disease problems (Mutua *et al.*, 2010).

Another challenge to improved pig production in Kenya and other developing countries is lack of organized breeding programmes to facilitate genetic improvement (Kahia *et al.*, 2008). The limitation to genetic improvement programmes has been lack of sufficient reliable records and good pedigree structure. Most pigs in the country are highly inbred and there is an urgent need to address this challenge. There are no organized breeding programmes in Kenya. A boar is shared between several farmers and inbreeding is very common. A farmer buys a male and a female Weaner piglet from the same litter which becomes his starter stock. Neighbors' share boars and there is no support for the boar keeper. The owner can sell the boar anytime he needs money (FAO, 2012). Exotic breeding material for Kenyan pig farmers which are mainly breeds of Large White and Landrace Crosses are sourced from Farmers Choice, large commercial farms, Catholic Missions and other small-scale breeders (FAO, 2012).

There are no central markets for trading in live pigs in Kenya (FAO, 2012). This is most likely due to the limited volume of pigs and high cost of transporting pigs to urban centers and because most pigs from smallholder producers do not meet the standards of urban processing (Kagira *et al.*, 2010). Only 5% of pigs produced in rural areas are transported to larger city centres (Githigia *et al.*, 2005). About 80% of pigs produced in Kenya are raised by smallholder farmers who rely on farm gate sales which translate to low incomes (Lekule and Kyvsagaard, 2003; Kagira *et al.*, 2010, Mutua *et al.*, 2010). Pigs are sold to small scale pig butchers' enterprises that operate in rural and peri-urban market areas based on negotiated price between the farmer and the butcher (FAO, 2012).

1.1.4 Pig production in Embu West Sub County

Embu West Sub-County of Embu County has an estimated population of 2,900 pigs. In 2013, 792 pigs were slaughtered and consumed locally, 250 were moved out to Farmer's Choice for slaughter and 567 moved to other destinations for both breeding and slaughter purpose (DVO, 2013). Pigs contribute incomes to families of pig producers, processors and retailers thus creating employment. There are many pork eateries and outlets in Embu municipality and other market centres in the county dealing with fresh pork.

1.2 Statement of the problem

The increasing human population risks food insecurity especially food of animal origin if viable methods of producing it are not exploited. Pig production in the rural areas is poorly developed and does not meet community needs which include food and nutritional security and improved incomes. To transform the agricultural sector in general and the pig sub-sector specifically, data must be gathered on farming challenges. Studies done in other parts of Kenya (Wabacha et al., 2004; Karanja et al., 2005; Mutua et al., 2010 and Eshitera et al., 2012) have not addressed these challenges. No study has been conducted in Embu West Sub County to establish factors (variables) that affect pig production. This study was aimed at identifying constraints affecting pig production in Embu West Sub County, Embu County, Kenya and subsequently therefore identify strategies that may be used to improve pig production in the Sub County.

1.3 Purpose of the Study

The purpose of this study was to establish factors constraining the pig production in Embu West Sub-County and propose strategies that may be used to reduce the constraints and enhance the performance of the pig industry.

1.4 Objectives of the Study

- i. To characterize pig production systems in Embu West Sub County
- ii. To establish constrains in pig production in Embu West Sub County.
- iii. To identify strategies that can enhance the performance of the pig industry under the most preferred pig production system.

1.5 Research Questions

- i. Which pig production systems are practiced by pig farmers in Embu West Sub County?
- ii. What are the factors constraining pig production in Embu West Sub County?

- iii. What are the viable strategies for improving the most popular pig production systems in Embu West Sub County?

1.6 Significance/ justification of the Study

The findings from this study will provide useful insights for stakeholders and policy makers to formulate strategies and policies for enhanced pig production in Embu County.

1.7 Scope of the Study

The study was conducted among pig producing households in Embu West Sub-County. The study area was selected through recommendations by the local livestock extension personnel. This Sub-County had the highest concentration of households rearing pigs in Embu County.

1.8 Limitations of the Study

The key respondents were not necessarily the most knowledgeable and informed on pig production strategies, diseases and government policies.

1.9 Assumptions of the Study

This study assumed that the respondents were to answer questions correctly and truthfully so that the information gathered would enable the researcher to draw valid conclusions and make appropriate recommendations

1.10 Definitions of Terms and Terminologies

Koran: The holy book of Islamic religion, written in Arabic, containing the word of Allah as revealed to the Prophet Muhammad.

One Health Concept: The approach of managing human and animal health in relation to the environment as one entity.

Pig (*Susscrofadomesticus/ swine/hog*): Is a large domesticated, even toed ungulate.

Productivity: Means output from pig production and includes; number and weight of weaned piglets, piglets sold, number and weight of finished pigs sold, cash sources and manure.

Torah (in Judaism): The law of God as given to Moses and recorded in the first five books of the Bible.

Zoonosis: Are infectious diseases of animals that can be transmitted to humans

CHAPTER TWO

LITERATURE REVIEW

2.1 Pig Production Systems

Pig production systems are diverse, from the traditional method of rearing (other than being reared for food and incomes pigs are also reared for social and culture considerations) in large parts of the tropics which is the simplest and cheapest, to the industrialized integrated production systems around cities in the industrialized world, which involves considerable capital and specialized management skills. There are also integrated systems which involves the production of pigs with other enterprises like fish farming, production of algae, methane gas generation, ducks and vegetable production common in some parts of Asia (Devendra and Fuller, 1979). The pig production systems practiced in Kenya are; scavenging or backyard production, traditional free range system, small scale intensive production, small commercial pig farms and large commercial pig farms (FAO, 2012; Berge Voet and Van Engelen, 2014).

The free-range system 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 (FAO, 2012).

In the scavenging or backyard systems, pigs are left free to roam. A number of levels of free range and scavenging styles can be distinguished, depending on the periods for which they are free and whether there is any input/supplementation given to the pigs (FAO, 2012).

At one extreme is the free range system practiced in the slums of major cities and urban areas, in various garbage dumps. The pigs are kept by people who do not own land, and the pigs depend wholly on refuse and garbage deposited in these areas. This is a low or no-investment system.

Another type of free range production is where pigs are released in the morning to roam and scavenge throughout the day, returning in the evening for shelter and supplementation with kitchen leftovers and water, or confined during the day and released to scavenge overnight. They scavenge in garbage pits, sewage drainage channels, open fields and agriculture fields. This type of free range pig-rearing is a recipe for neighborhood conflict and is a menace and nuisance in many towns and urban areas (FAO, 2012).

A third type of free range pig -keeping is practiced by small scale resource poor farmers in the larger Western Kenya. Farmers own two to five pigs. Some farmers specialize in producing piglets which are sold to other farmers at the age of two months. The pigs in this system are tethered around the homestead especially during the planting season. They are released during harvesting and post-harvesting to roam until the next planting season. They are not housed, and feed on pasture, kitchen leftovers and some crop by-products such as cassava, sweet potato tubers and vines. The pigs are usually small in size owing to prolonged underfeeding, and there is lack of genetic improvement because of inbreeding. The pigs take up two years to reach market weight of between 50 and 70 kg. This system may be referred to as traditional free range as it is entwined with the traditions of the local people. The free range system of Western Kenya has a great potential for development. The willingness of farmers and availability of local feed materials can be capitalized on to develop the free range pig sector in this area (FAO, 2012).

In some small scale commercial systems/ small scale intensive production systems in Central, Eastern Kenya, Central and North Rift Valley and the larger Western Kenya, pigs are fed on commercial feeds and supplemented with swill, kitchen leftovers, market by-products/waste and crop residues. Most farmers provide the pigs with crop residues as feed, bedding and also as a source of organic farmyard manure. The pig houses are not concreted and the pigs root in them. Piggeries are often established near official institutions due to the availability of swill. However, there are small scale farmers in these areas who feed their pigs exclusively on commercial feeds. The pigs are fed twice a day according to their age, production status and type of feed. The piglets are fed on starter (Pig Creep) pellets. The weaners, sows, boars, gilts and early fattening stage pig are fed on Sow and Weaner meal while the baconers/finishers are fed on Pig Finisher meal as on recommended feeding schedules. Some small scale farmers have formed cooperatives to manufacture cheaper and high quality pig feed (FAO, 2012).

In the large- scale commercial pig keeping systems common in Nairobi, Central Kenya, Central and North Rift Valley, the pigs are fed on commercial feeds according to age and production status. Piglets are fed with starter/Pig Creep pellets. The weaners, sows, boars, gilts and early fattening-stage pigs are fed Sow and Weaner feed meal while the baconers/finishers are fed Pig Finisher meal. Most farmers use Sow and Weaner feed across the board with the recommended amount given over the course of the day, usually morning and evening (FAO, 2012).

The largest commercial pig enterprise Famer's Choice makes its own feed for its farms, which also supplies to some of its commercial contract farmers. In these cases, its field officers monitor

and advise on feeding, to produce quality finished pigs (FAO, 2012; Berge Voet and Van Engelen, 2014).

In a pig production enterprise, it is often asked; which is the most economical production system among the three, namely; the farrow to Weaner; Weaner to slaughter and farrow to finish? As per Farmer's Choice Company Management (Muiruri, 2011) a Weaner to slaughter (fattening) unit would be economical if good weaners are sourced. A farrow to Weaner (breeding) unit would make good business but the management must be good. However, the selection of genetically sound sows and boars is a must because the weaners must weigh about eight kilograms when weaned at 40 days of age to attract a good price.

Most farmers are engaged in farrow to finish production system. As per Farmer's Choice Management, the economical number to start with is five sows and aim at producing a market ready pig of about 90 kg in about 180 days. Beyond 210 days, the venture starts becoming uneconomical. However, all the three pig production enterprises are profitable (Mbaso and Kamwana, 2013) evidenced by the positive gross and net profit margins across all the enterprises. From their results farrow to finish was more profitable than feeder pig production and pig finishing systems.

2.2 Feeds and Feeding Systems

Feed cost is the most important variable in pig production. Feed costs take 75-80% of total cost of rearing pigs (Smith, 2006; FAO, 2012). Grains make up between 55-70% of pig rations (Smith, 2006). However, in many developing countries, there is not enough grain to feed both humans and livestock hence a major limitation (Petrušet *al.*, 2011). Small- scale pig farmers in developing countries face problems of high feed costs and shortages as well (Peters, 2004).

To date, only a few farmers supplement pig diets with concentrates or commercial feeds because they are not willing or cannot afford (Kumaresanet *al.*, 2009; Kagiraet *al.*, 2010; Hossainet *al.*, 2011). Less than 2% of farmers used commercial feeds in Colombia, in India it was between 8-12% while in Laos; it was only 6% of the farmers that used commercial feeds (Ocampoet *al.*, 2007; Kumaresanet *al.*, 2007; Phengsavanhet *al.*, 2004).

In Namibia, Petrušet *al.*, (2011) found that 53% of farmers used brewer's grains while Ajalaet *al.*, (2007) reported that in Nigeria farmers used brewer's grain mixed with swill. It has been noted

that supplying pigs with the required protein under village conditions is very difficult mainly because of the cost involved (Lekule and Kyvsagaard, 2003).

Pigs under intensive systems in particular require a dietary intake of balanced diets as they cannot fend for themselves and should get all the required nutrients from the fed ration (Lekule and Kyvsagaard, 2003). In South and South East Asia smallholder farmers use locally available feedstuffs using family labour (Tuet *et al.*, 2010; Dekamet *et al.*, 2007). The pigs are fed mainly with kitchen waste and rice bran, and occasionally limited amounts of purchased concentrates. Pig feeds mainly depend on availability rather than on the nutritional requirements at different stages of the production cycle (Lemke *et al.*, 2007) which results in low productivity of pigs. In confined pig rearing systems, feed is mainly composed of kitchen waste, residue of rice beer, bran (maize, millet, wheat, and rice), jungle forages, pumpkins, yams and taro (Lemke *et al.*, 2007). In some South Eastern Asian countries smallholder pig farmers use a mixture of concentrate feed (maize, rice polish, wheat bran, soybean meal, oil cakes) and crop by-products like cassava leaves/meals, sweet potatoes, fresh sweet potato vines, small amount of salted fish, water hyacinth, water spinach, banana tree, soybean, cotton seed, coconut oil, fish meal and sea shells (Kunavongkrit and Heard, 2000). These feed ingredients are generally chopped, mixed and cooked before being offered to pigs. In Vietnam (the second largest world producer of sweet potato), 75% of sweet potato, mainly vines and roots, are used as pig feed (Peters, 2004). The Vietnamese potato-pig-system is also playing an important role in many other countries including China, Philippines, Korea, Taiwan and Indonesia. In both regions of South and South East Asia, pigs at smallholder level do not get adequate feed in terms of quantity and quality. The lack of protein in traditional diet restricts the growth of pigs, with the average daily weight gain being no more than 100gm per day (Thorne, 2005). The high cost of feed is the major problem of managing pigs purely on commercial feeds in both regions.

The amount of feed and the number of times fed is vague in most studies. The amount of feed depends mainly on age, physiological state of pigs (Hossain, 2011) and the availability of feed (Kagira, 2010). In India, Laos and Thailand, farmers reported that they fed their pigs twice a day (Kumaresan *et al.*, 2007; Phengsavanhet *et al.*, 2010; Nakai, 2012). Water is the most essential dietary component although often overlooked (Haynes, 2001). Farmers in rural areas often provide water mixed with feed only during feeding (Kumaresan *et al.*, 2007; Phengsavanhet *et al.*, 2010) and only a few farmers were found to provide additional water outside the feeding times. In his study,

Phengsavanh (2010) observed that only 7% of the farmers offered extra water during the day out of the feeding schedules. In Kenya, Carter *et al.*, (2013) found that farmers did not provide feed and water *ad libitum*.

In Kenya many pig producers are looking for cheaper ways of feeding their pigs. Most of the large-scale farmers are mixing their rations while the small-scale farmers forming co-operative societies and opening feed mills. The feed milled by the farmers or their co-operative societies has been found to be both superior in quality and cheaper in price than commercial feeds (FAO, 2012).

The fodder crops being grown by farmers can replace large part of the ration of compounded/commercial feeds. Food crops and by-products are also used in pig production. The crops include sweet potato vines, kales, cabbages, Napier grass, sugar cane cuttings, sugar cane tops, garden weeds, mangoes, tomatoes, oranges, avocados, peelings and market by-products/waste. The use of feeds such as cereal residues, cassava and potatoes has been shown to save up to 20% on feed costs for growing pigs and 50% for breeding pigs (FAO, 2012). Other by-products fed to pigs include brewers waste, rumen contents, and blood from slaughter slabs, the latter given as is, or cooked and mixed with kitchen left over. Sorghum and cassava are reported to offer a lot of hope as a source of energy for the growing poultry and pig industries (Berge Voet and Van Engelen, 2014).

Another feedstuff source for pigs is swill from schools, hotels, and government institutions with farmers around these institutions and some of these institutions especially schools and prisons feeding their pigs with the kitchen leftovers. The problem of feeding swill is the spread of diseases to pigs and from pigs to humans (Haynes, 2001). Cooking swill before feeding pigs is effective in controlling diseases (Kumaresan *et al.*, 2007; Phengsavanhet *et al.*, 2010). Feeding swill also poses another challenge because the diets are imbalanced and cannot supply all the nutrients for pigs (Kagira *et al.*, 2010).

2.2.1 Feeding Pigs on Nonconventional Feedstuffs

The most frequently used protein rich ingredients in pig and poultry diets are fish meal, soy bean meal, extracted sunflower seed and rape seed cakes (Wageningen UR Livestock Research, 2012). The global demand for animal protein for human consumption is increasing and with this also the price of the animal feed ingredients. These protein sources together with grain by-products from the milling industry constitute the traditional or conventional feed sources. Alternative feed sources especially protein rich raw materials for the livestock industry are required. Insect's larvae

can be a sustainable alternative protein rich ingredient particularly if they are reared on substrates of bio-wastes and organic side streams. Insects are cold blooded and can therefore efficiently turn low grade bio-waste into high quality proteins. However, the most important obstacles before insects can be used at a large scale as animal feed ingredients are in areas of legislation and the cost of production (Wageningen UR Livestock Research, 2012). The use of insects for feed is an area in which the application of the “One Health Concept” would be appropriate, although it requires more research (FAO forestry paper, 171). Sugar cane may also be used in intensive pig units. Pig fattening systems based on sugar cane juice were first developed in Mexico and in the Dominican Republic by (Fenandez, 1986), who showed that results obtained with sugar cane juice appear comparable or even superior, to those generally obtained with cereal based diets. It has further been demonstrated that sugar cane juice can replace in totality the cereal component of the diet (Mena, 1987). Trials in different regions of Colombia and Swaziland in Africa were carried out to validate the pig fattening systems based on sugar cane juice (Sarria *et al.*, 1990; Speedy, 1991).

2.3 Housing and Management Practices

Pig rearing can be done intensively or extensively (Nsosoet *et al.*, 2006; Kumaresanet *et al.*, 2009; Kagira *et al.*, 2010). Housing is very important because pre-weaning mortality in piglets is common due to piglets being exposed to bad weather conditions such as cold, rain and predators (Chiduwa *et al.*, 2008; Madzimureet *et al.*, 2013). The mortality of young pigs can be avoided by providing adequate and secure housing (Madzimureet *et al.*, 2013). In Central Uganda, Muhanguziet *et al.*, (2012) observed that pigs were housed in local mud and wattle houses under grass thatch, tree shades, conventional tropical houses with half solid wall made of bricks, sand and cement with upper part made of wire mesh and roofed with corrugated iron sheets. Mud brick houses were observed by Ajala *et al.*, (2007) used by most farmers in Kaduna District, Nigeria. Kagira (2010) observed that in Kenya, 96% of the shelters had mud floors and only 4% were made of concrete. Nissen *et al.*, (2011) found that only 16% of houses had soil floors in Uganda. Floors raised above the ground in some pig houses were observed in Uganda where 59% of the pens were slatted and raised above the ground. The materials used for building rural pig houses vary according to their affordability and availability locally (Ajala *et al.*, 2007; Kumaresanet *et al.*, 2009). These materials include mud bricks, cement bricks, bamboo, concrete, wood and iron sheets (Ajala *et al.*, 2007; Nsosoet *et al.*, 2006; Nakai, 2012).

High housing costs may make overhead expenses so high that pig production cannot be ran profitably. Adult pigs are hardy animals that may be kept in simple inexpensive houses if such houses protect the pigs from wind, rain and sun (Gikonyo, 2010). Good housing makes management easier and helps the farmer to successfully rear 85% of all the live born piglets to market weight in the shortest possible time (Gikonyo, 2010).Pigs at different stages of growth need different environments (temperatures) but piglets need special protection against low temperatures while growing and reproducing pigs must be protected from high temperatures.

Animal welfare practitioners believe outdoor pig farming may be more suitable for pigs as it addresses the welfare of the animals (Bellaver and Bellaver, 1999). Concerns in respect to pig housing from the welfare point of view, floor types, stocking density, feeding management and restraining devices tend to affect pigs negatively. The opposing view is that confinement of pigs makes production more manageable in terms of supplementation and disease control which leads to faster growth and higher performance (Madzimureet *al.*, 2013).

2.4 Capital Input/ Credit Services

Access to financial services is one of the obstacles that many farmers have to overcome to be able to engage in commercial livestock farming. An estimated 36% of rural Kenyans have no access to any form of financial services (Rangoma, 2013). Inability of small-scale farmers to provide collateral for their loans has resulted in farmers getting the lowest levels of credit compared to other sectors in the economy. To attract funding, farmers must provide good records, provide a clear growth path and demonstrate that the business has potential to be profitable. In addition, farmers especially in the rural areas are not aware of the agricultural loans available to them. However, there are banks that have facilities for the small-scale farmers and advise them on the various ways of investing in their farm enterprise (Mutambara, 2013).

2.5Health Management Systems

Disease and pest management, control/ eradication provide key support to livestock production and particularly pig production. Unlike other livestock, there are no disease control programmes in Kenya for pigs. However, the Farmer's Choice Limited has a vaccination regime for all its pigs

against Erysipelas, Escherichia coli, Porcine Parvo virus and Clostridium (FAO, 2012). Ajala *et al.*, (2007) noted that over 60% of respondents in Kaduna, Nigeria vaccinated their pigs against diseases. Kumaresan *et al.*, (2009) also found that 37.7% of farmers in India vaccinated pigs against common notifiable diseases. Selling of diseased pigs in the market or feeding leftover meat to pigs is common in many parts of South-East and South Asia both of which are important contributors to transmission of diseases (Northoff, 2006). In both regions, farmers tend to take care of diseased pigs by themselves during initial stages. Only in severe cases do they ask the assistance of veterinarians. In Vietnam sick pigs were presented for treatment by 80% of households (the nearer to town, the higher the percentage), dewormed by 71% of households and presented for vaccination by 88% of households (Lemke, 2007) although these figures significantly vary from place to place. In South Asia, only a small section of households treat sick pigs, but 67% of these households treat the pigs by themselves using pharmaceutical products or traditional medicines (Bernard *et al.*, 2012).

2.6 Advisory/ Extension Services

The least expensive input for improved rural agricultural development is adequate access to knowledge and information in areas of new agricultural technologies (Blait, 1996). There have been short-comings of traditional print and library based methods in providing such agricultural information to rural farmers who are generally illiterate and relatively remote from formal sources of information. Farmers would benefit from global information if centres are sited in rural areas (Aina, 2007). For easy access and effective utilization of agricultural information in this digital age, there is need for establishment of information centres in all rural communities. Such information centres would be able to provide the rural farmers with the desired agricultural information in a format that would be comprehensible to them, taking into cognizance the prevailing illiteracy rate, cultural differences and limited technology.

Rural farmers are noted to have low agricultural productivity due to constraints that lead to lack of access to timely and up to date information which would enable them to achieve optimal production. Such information is highly desired by these farmers and can only be made available to them via extension workers, community libraries, email or World Wide Web (WWW) in a tele-centre. Information technology in tele-centres provide the rural farmers with prompt and reliable information about what is happening in new and improved agricultural technologies including new advances in livestock production and disease control. According to Munyua (2000) where rural

farmers are faced with constraints in accessing agricultural information, traditional media such as radio has been used. Other ways of delivering information to rural farmers include print, video, television, films, slides, pictures, drama, dance, folklore, group discussions, meetings, exhibitions and demonstrations.

Extension and rural advisory services occupy a strategic position in the agricultural production cycle. They link farmers to information about appropriate farming practices, when and what to do, and how to use new technologies developed by researchers. Extension service providers also pass feedback from farmers to policy makers and help to ensure that government policies are effectively meeting the needs of the farmers. Agriculture extension is a powerful tool with a rich potential to empower and support rural livelihoods (Anon, 1999; Rolaet *al.*, 2002) but it has been observed that the current system in Kenya is ineffective and not able to meet the needs of the local farmer (Munyanga and Jayne, 2006).

2.7 Breeds and Breeding

2.7.1 Breeds

The main breeds of pigs in Kenya are the Large White, Landrace, Duroc and Hampshire (Rangoma, 2012). The Large White is the main breed kept due to its desirable growth potential and high fecundity (Wanjaiya, 1999; Githinjet *al.*, 2007).

Plates 2.1.1 to 2.4.2 below represent the main pig breeds in Kenya (source: internet)



PLATE 2.1.1
Large White Male

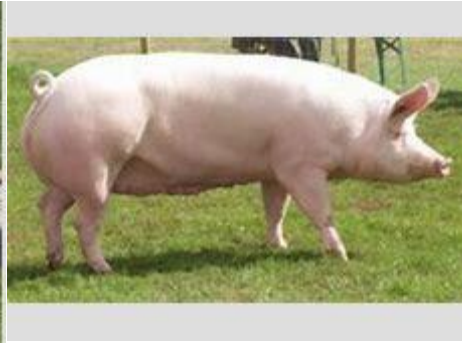


PLATE 2.1.2
Large White Female



PLATE 2.2.1
Landrace Female

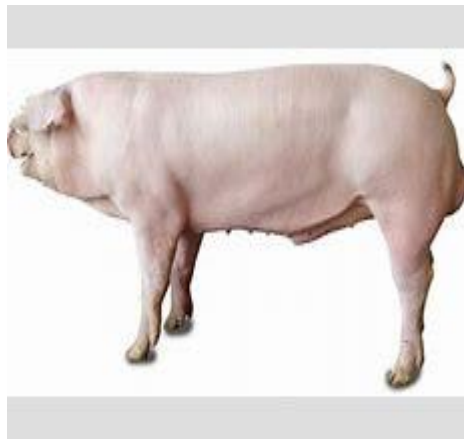


PLATE 2.2.2
Landrace Male



PLATE 2.3.1
Duroc Male

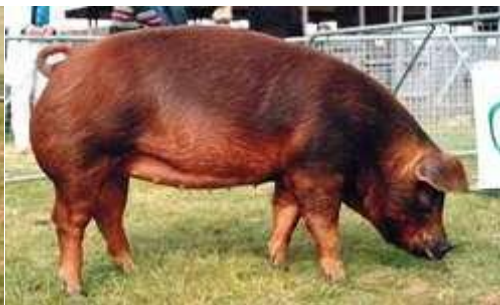


PLATE 2.3.2
Duroc Female



PLATE 2.4.1

Hampshire Male



PLATE 2.4.2

Hampshire Female

2.7.2 Characteristics of the main pig breeds in Kenya

Large White is hardy, long-bodied, white skin with fine white hair, erect ears with slightly dished face and moderately long head. It has longer legs compared to other pig breeds. The sows have large litter sizes (10-12). It is a late maturing breed with excellent maternal instincts. Lack of pigment on the skin makes it very prone to sunburn. It is commonly used in crossbreeding programmes.

Landrace has a white skin free from black hair, straight snout with ears drooping and slanting forward. Sows produce and rear large litters of piglets. It has high lean meat production and good for both pork and bacon production. It is also prone to sunburn due to lack of skin pigment. It has early rapid growth and weight at weaning is higher than other breeds.

Duroc is small sized, of medium length and quite muscular with slightly drooping small lop ears. It is a late maturing breed. It has a thick coat and a hard skin. It has a solid red colour varying from gold to a deep, brick red with the face slightly dished. The litter size is lower than other breeds and boars are aggressive compared to other breeds.

Hampshire is hardy and has black and white markings. The head, ears, shoulders, rear legs and tail are usually black. It has large upright ears. It has excellent mothering ability. It has fast growth rate and farrows 8-14 piglets. It produces more lean meat than the Large White or Landrace (Rangoma, 2012).

Most smallholder pig producers pay no attention to selection of pigs on desirable traits. Under good management, crossbred dams are used because they farrow and wean more pigs. On average, crossbred pigs gain more weight and are more efficient than pure breeds. However, lack of good quality breeding stock is still an impediment in small-scale pig production (Rangoma, 2011; Petruset *al.*, 2011; Morekiet *al.*, 2011; Montsho and Moreki, 2012).

2.7.3 Pig Mating Systems

Three commonly used pig mating systems are the pen mating, hand mating and artificial insemination services. Pen mating means that a group of females are brought into the boar's pen for mating. The pigs are left to mate naturally and is therefore the least labour-intensive mating system. Disadvantages associated with this system are that the boar is not used efficiently. In hand mating, the boar and one sow/gilt at a time are brought together for servicing. The producer exercises mate choice and collaterally also eliminates social competition. It also allows for better timing of the servicing allowing the boar's fertility to be kept at its peak with each subsequent mating. Hand mating requires more labour than pen mating. Artificial insemination (A.I) is the most efficient mating system (Pitcher and Springer, 1999).

2.8 Pig Marketing Systems

Establishment of a reliable market is a very important aspect in any production system and more so in pig production (Levy, 2014). This ensures maximum returns on investment. Failure to secure a reliable market may make investments a loss making venture. Pig butchers are central to the coordination of activities required in connecting pig farmers to pork consumers in rural areas. There are no proper pig slaughter facilities available (Levy, 2014), and although the pig meat is usually inspected, slaughter is done in the backyard and in informal and sub-standard structures.

Lack of pig slaughter facilities is a major constraint in pig production (Moreki and Mphinyane, 2011; Motsho and Moreki, 2012; Mutambara, 2013).

Most of the marketing of rural pigs occur within the rural communities where pigs are sold live or as meat (Nsosoet *al.*, 2006). For example, 95% of pigs were sold within the community in Busia District in Kenya (Kagiraet *al.*, 2010). In Namibia and India 90% of farmers reportedly sold their pigs to neighbours within their communities (Petruset *al.*, 2011; Kumaresanet *al.*, (2009). According to Lemke (2007), throughout South East and South Asia weaners were sold to other farmers or traders while fatteners were mainly sold to traders or slaughterers. Insufficient market information, coupled with lack of guaranteed prices are major obstacles for small scale farmers (Sovann and San, 2002). In monetary terms, it is not clear how much money is made from pigs in rural areas, because rural markets are considered inefficient (Petruset *al.*, 2011). The markets are not well defined because pigs are sold at different ages and sizes through informal poorly structured marketing systems (Ajalaet *al.*, 2007; Petruset *al.*, 2011).

2.9 Opportunities in the Pig Industry

There are an increasing number of people who have an interest in consuming pork (Bett et al.,2014). The price of other meats is rising compared to pork and an increase in the number of outlets such as local butcheries, small scale processors, means that farmers have a wider choice of markets for their products. As farm sizes continue to decrease owing to high human population and fragmentation of land, land intensive livestock such pigs gain advantage over the livestock that require more land such as cattle. Farmers can enhance their profit margins by making their own feeds. Export markets for Kenya pork already exist in COMESA countries and Non-COMESA Countries such as United Arab Emirates (UAE), Bahrain, Ghana, Nigeria, Indian Subcontinent, Oman and the Netherlands also increase the market base.

The short production cycle for pigs gives them an advantage over other livestock such as cattle. The formation of pig farmers' interest groups has been championing the interests of pig farmers (FAO, 2012). There is also need for slaughter houses to reduce the monopoly of Farmer's Choice in Kenya as the main producer and distributor of pork and pork products in Kenya. An enhanced pig industry also offers the establishment of pig value chains for fresh pork which offers better returns to producers because of value addition (Berge Voet and Engelen, 2014)

Pig production increases the availability of high value animal protein, minerals, vitamins and trace elements in diets and therefore contributes to a balanced diet. In food insecure areas this can be significant especially for children and pregnant or breast feeding women. Few inputs are needed to start a small scale pig production enterprise. It has the potential to add value of farm resources that have little commercial value such as agricultural wastes. It also offers a potential for marginalized and underprivileged people to improve their livelihoods. Pig production also offers diversification through different types of production (Dietze, 2011). For example, small scale farmers can produce their own piglets, fatten them and sell them. Small scale farmers can leave breeding to more specialized farmers and/ or commercial firms and provide fattening services. In harmonious village communities, a more socially oriented community level diversification can be done as a cooperative effort. Keeping boars used for mating can be a separate activity of one group of community members, reproductive sows and their offspring can be handled by a second group and a third group can raise the animals until they reach market/ slaughter weight. Pig production can also perform very well in enterprise integration especially in pig-aquaculture combinations, a very common practice in some parts of Asia (Devendra and Fuller, 1979). This optimizes nutrient flow within a farming system to increase its productivity. A small number of pigs are kept near a fish pond and the manure is used to either directly feed the fish kept in the pond or to fertilize the pond and increase the growth of algae that fish can feed on. Pig production is also suitable for landless production systems in peri-urban areas where the producer can be linked to larger markets (Dietze, 2011).

The processing of primary livestock products brings in a series of benefits to the producer. It extends shelf-life and makes protein available beyond slaughter. This also adds value to the commodity and can raise profit margins significantly. Processing contributes to the integration of animal tissues that would otherwise not enter the food chain (bristles for use in shaving and paint brushes, intestines for use as sausage casings, blood for human food or animal feed, slaughter house by-products for animal feed and hoofs for gelatin or glue products). Pig breeding is a profitable cottage industry that enjoys both high demand and good prices (Muiruri, 2011). The imports of pork and pork products are greater than local production in Kenya, indicating that opportunities exist to start new pig farms or to expand existing ones (Moreki, 2011).

2.10 Perceptions and Beliefs in pig production

In Western Kenya, Mutua *et al.*, (2010) observed that pigs were kept as a business for income generation. Pigs were reared by women but men do the selling. Some families keep pigs for security purposes at night because they can differentiate between strangers such as thieves. Local anecdotal evidence indicates that pigs are believed to offer protection and acted as charm to protect against evil persons in the neighborhood. These thoughts have an impact on the price of pork with some specific pork sections costing more. Some farmers believe that pigs are dirty and can eat anything when hungry. Some denominations such as the Seventh Day Adventist (SDA) do not even touch the flesh of pigs. Negative beliefs might have had a negative effect on pig farming and therefore if farmers must view pigs as an escape route from poverty, they need to be educated away from such mythical considered views. In some religions and denominations such as Judaism and Islam, pork is a taboo food. Jews and Muslims abstain from eating pork without knowing why, except that it is forbidden by the Torah and Koran (Hesse, 1990).

Animal Welfare is an increasingly important factor in the purchasing decisions of consumers (Napolitano *et al.*, 2010). This is especially so in the developed world, (USA and Europe) and particularly in the European Union. Pigs have been identified amongst the three animal systems most in need of animal welfare improvements by the EU citizens (European Commission, 2005). Consumers often perceive meat produced in outdoor systems as safer and more nutritious (Edwards, 2005). Eighty five percent of German pork consumers said they considered organic production to be an important indicator of product safety (Becker *et al.*, 2000). Increasingly, Africa is recognizing Animal Welfare as an important production factor as evidenced by development of a Animal Welfare Strategy for Africa by AU-IBAR.

2.11 Benefits of Pig production

At the household level, pig production provides access to animal protein for farm families contributing to an improved diet for family members when pigs are slaughtered at their homes. Pig production in a farming system is also beneficial to a series of agricultural activities. Pigs feed on by-products from crop production/ kitchen leftovers and therefore add value to nutrients that would otherwise have been lost to the farming system. Pig manure is a valuable fertilizer that can contribute to increased agricultural productivity and/ or it can be used as a source of fuel when processed in a bio-digester (Dietze, 2011). Pig plays an important role in household income in all

production systems (FAO, 2012; Dietze, 2011). Due to the pig’s short breeding cycle, many farmers take the view that pig-keeping is the livestock equivalent to cash crops and has the potential to improve rural livelihoods. The sale of pigs provides money needed to pay school fees, hospital bills, buy clothes, food and build better houses.

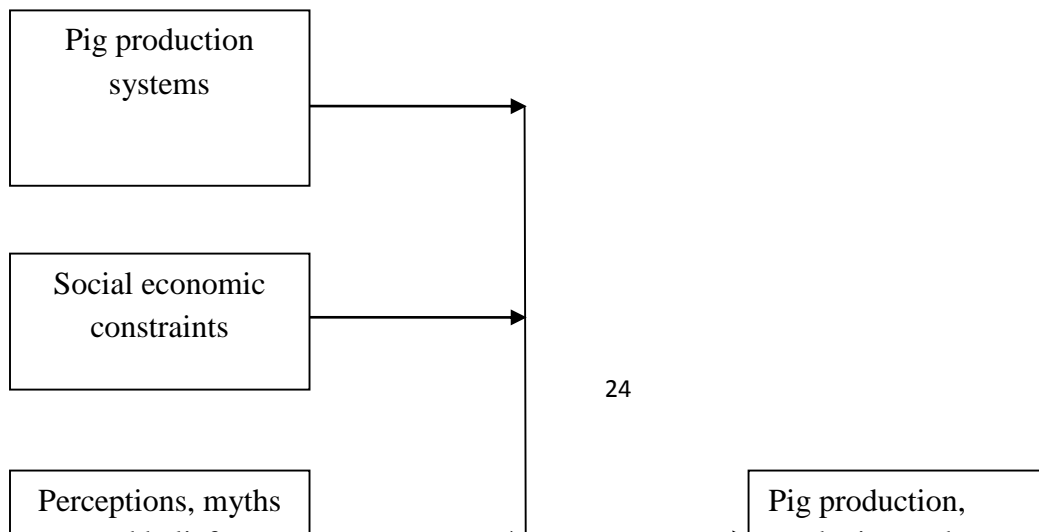
2.12 Policies and Legislation in Pig Production

Policies and legislation support pig production by recommending and enforcing the minimum conditions of rearing pigs for increased production, welfare of the animal as well as consumer protection. Policy framework also enhances farming systems that combines efficient rearing methods that are acceptable to most of the public (*European Commission-DG Health and Consumer Protection, 2001*).

In Kenya, the key weaknesses in policies and legislation include; implementation gap of existing laws and regulations, inadequate regulation and facilitation of services such as animal breeding services, feed production, regulation of veterinary pharmaceuticals, resolution of livestock/wildlife conflicts, quality assurance of livestock inputs and products, conflicting legislations, inadequate coordination of research and extension, proliferation of quacks in veterinary practice, information as well as monitoring, and evaluation of projects and Programme (National Livestock Policy, 2008). Worldwide most governments do not have clear policies on the development of the pig sub-sector. But in China, pig and pork production are so important economically, culturally and politically that the government has created a strategic pork reserve. The reserve is the only one of its type in the world, was created in 2007 with an official mandate to stabilize pork prices (Kemp, 2013). The Government supports increased pork production and consumption through subsidies, investments and favorable policies for medium to large scale industrial operations.

2.13 Conceptual /theoretical framework

The conceptual frame work of the study is represented in figure 2.1 below



Variables

“Framework”

Figure 2.1: The conceptual frame work is based on related literature.

The conceptual framework shows the various variables that interact and contribute to pig production, marketing and consumption in Embu West Sub County, Kenya.

CHAPTER THREE

METHODOLOGY

3.1 Location of the Study Area

Embu West Sub County is one of five (5) Sub Counties in Embu County. Together with Manyatta Sub County, it constitutes Manyatta Constituency. It lies approximately on latitudes $0^{\circ} 8'$ South and longitudes and $37^{\circ} 42'$ East. The sub county covers a total area of 637.7 square Km.

It borders Mbeere North and South to the East and South East, Manyatta and Embu East Sub Counties to the North and Kirinyaga County to the West. Embu town is the main urban centre within the Sub County and the headquarters of the whole County. It has two (2) administrative

divisions namely Nembure and Central division with five (5) locations and fifteen (15) Sub-locations. Nembure Division falls in between the high potential and the transition zone area where the main land uses are dairying, coffee and horticultural crops farming. The Central division is in transitional zone with dairy farming, cash and food crops as main enterprises in upper parts while lower parts are under beef cattle, sheep, goats and food crop production (DAO Annual Report, 2013).

MAP OF KENYA SHOWING EMBU WEST SUB-COUNTY

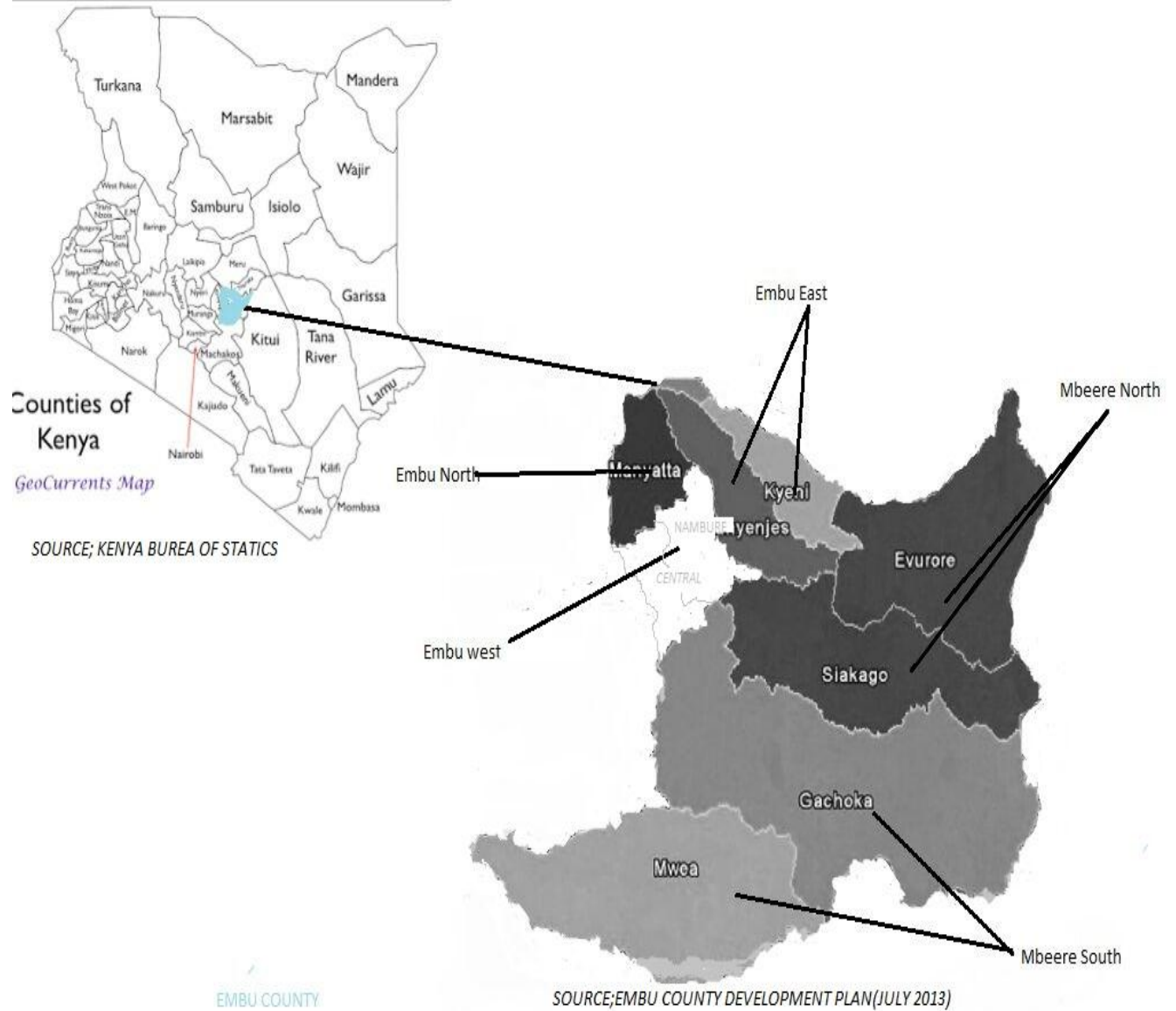


Figure 3.1: Map of Kenya showing Embu West Sub County

3.1.1 Topography

It rises from 910 metres in the lowlands of the Tana basin in the east to about 5,000 metres in the North-West forming part of the Mount Kenya Forest.

The Sub County is drained by two main rivers, namely Kii, Rupingazi (with Kapingazi as a tributary). The Kapingazi and the Rupingazi are intensely used for domestic water and for irrigation. The Sub County has six (6) Agro-Ecological Zones which include Highlands (H), Upper midlands 1 (UM1), Upper midlands 2 (UM2), Upper midlands 3 (UM3), Upper midlands 4 (UM4), and Upper midland 5 (UM5) starting at the top of Mt. Kenya that cover the forest

3.1.2 Climate

It has an average rainfall of 1,495 mm per annum. The rainfall is bi-modal with long rains falling in between March to June and short rains falling in October to December. The temperatures range from 12⁰ Centigrade July to 30⁰ Centigrade in March with a mean of 21⁰ Centigrade (DAO Annual Report, 2013).

3.1.3 Livestock Population

The Sub County has an estimated human population of 105, 189 with 51,763 males and 53,426 females. The total number of households is 29,996 (Kenya Census, 2009).

The estimated livestock population is as tabulated below:

Table 3.1 Estimated Livestock Population in the Study Area

Type of livestock	No.
Dairy cattle	30,000
Beef cattle	26,000
Goats	23,000
Sheep	17,000
Pigs	2,900
Poultry (mainly indigenous chicken)	46,000

Source: DVO Annual Report, 2013

3.1.4 Markets

Most of the pigs are sold locally within the sub county for fattening, slaughter or breeding. A few famers are contracted by Farmer’s Choice where they sell their finished pigs for slaughter.

3.2 Research Design

The research utilized descriptive survey design. Descriptive survey was chosen because it allows the researchers to study phenomena that do not include the manipulation of variables (Kombo and Tromp, 2006). The researcher collected information on the factors influencing pig production in Embu West sub-county. The researcher collected information on factors influencing pig production in Embu West Sub County.

3.3 Target Population

The list of farmers keeping pigs was sourced from the local administration in collaboration with the Sub County livestock personnel. The researcher randomly selected households to participate in the survey from list of households keeping pigs. The questionnaire for data collection was administered in Kithegi (17), Kithimu (14), Kamiu (16), Kangaru (18), Itabua (17), Rukira (10) and Gatituri(10) Sub Locations of Embu West Sub County.

3.4 Sampling Design/ Procedure

From the sampling frame of targeted households, a sample of households (respondents) was generated using the formula below:

$$n = N / \{1 + N (e)^2\}; \text{ Yamane (1967: 886)}$$

$$n = 142 / \{1 + 142 (0.05)^2\}; n = 104$$

A 95% confidence level and variability of 0.5 is assumed. The sample, $n = N / (1 + N (e)^2)$ where n = sample size; N = target population; e = precision or error limit.

Random Integer Generator was used to get the representative sample. From the sampling frame of 142 households, 104 households were randomly selected as the representative sample. The first representative sample household was No. 10 and the last, 104th representative sample household was No. 141(Appendix 3).

In addition, a purposive sampling procedure was used to interview six (6) service providers and five (5) traders/butchers. This provided data to enrich information given by the pig producers in

the questionnaire. All the six service providers were personnel trained as animal health and production assistants.

Sampling matrix			
Category	Population	Sampling procedure	Sample size
Households	142	Simple random sampling	104
Service providers	6	Purposive sampling	6
Traders/butchers	5	Purposive sampling	5

3.5 Data collection procedures

The study employed two types of data collection instruments; a questionnaire and key informants' interviews. A questionnaire was used to collect data from sample household heads that were requested to respond to structured interview with question manual and the responses recorded for analysis. The questionnaire requested information on household characteristics, social economics and pig productivity. Interview schedules for the service providers (animal health assistants) and traders/butchers were administered by the researcher.

Piloting of the questionnaire was conducted by administering the questionnaire to a sample of 10 respondents who were not to take part in the main study but who have similar characteristics to those to be used in the actual study. After research instruments were piloted through pre-testing and received back by the researcher, they were scrutinized for mistakes on procedure. Vague questions were identified and improved.

The researcher booked appointments with Sub County administrators at sub location level and planned on how and when he would personally visit the selected households. The delivery and collection method was adopted to ensure high response rate. This approach is better compared to the impersonal, mailing approach in terms of encouraging the respondents to fill the questionnaires and allowing the researcher to respond immediately to the respondents need for clarification. The

researcher also personally interviewed the service providers and traders/butchers. The data collection exercise took one and a half months.

3.6 Data analysis

Data collected from the field was analyzed using Statistical Package for Social Sciences (SPSS) version 15.0 for windows. Descriptive statistic, including frequency counts, means and percentages were used to analyze the data obtained. The results of the data analysis were presented in frequency tables and charts.

CHAPTER FOUR

4.1 Socio-economic characteristics of households in Embu West Sub County

The socio-economic characteristics of households keeping pigs are presented in Table 4.1 below

Table 4.1; Socio-economic characteristics of households

Descriptors	Percentage
Gender of respondents	
Male	96.2
Female	3.8
Family head	
Male headed	93.3
Female headed	6.7
Child headed < 18 years	0
Educational level of family head	
Primary level	59.6
Secondary level	38.5
Tertiary level	1.9
Informal	0
Religion/Sect	
Catholic	18.3
Protestant	81.7
Islam	0
Farm Size in acres of households	
0.25-2.0	47.2
2.25-4.0	31.7
4.24-7.0	19.2
>12	1.9
Those involved in farming activities	
Parents only	8.7
Both parents and children	85.5
Children	0
Hired Workers	5.8

The data in Table 4. 1 shows that a large proportion (96.2%) of the respondents was males while females comprised of only 3.8%. Most of the households are headed by males of between the ages of 45 to 65years. Labour is provided by both the parents and the children.

The age distribution of family heads among pig farmers is presented in figure 4. 1 below

All the family heads were older than twenty-five years with the age bracket 45-64 years having the largest number of farmers. All the household heads were literate with (59.6%) having attained primary level of education, 38.5% secondary level of education and 1.9% tertiary level of education.

Data in Table 4.1 also shows that majority of the respondents were Protestants (81.7%) and 18.3% were Catholics. Majority of the pig farmers (78.9%) owned parcels of land ranging between 0.25 acres to 4.0 acres. The mean land size was 2.9 acres. Both parents and children (85.5%) were involved in farming activities while parents only contributed 8.7%, and hired workers 5.8% of the labour force.

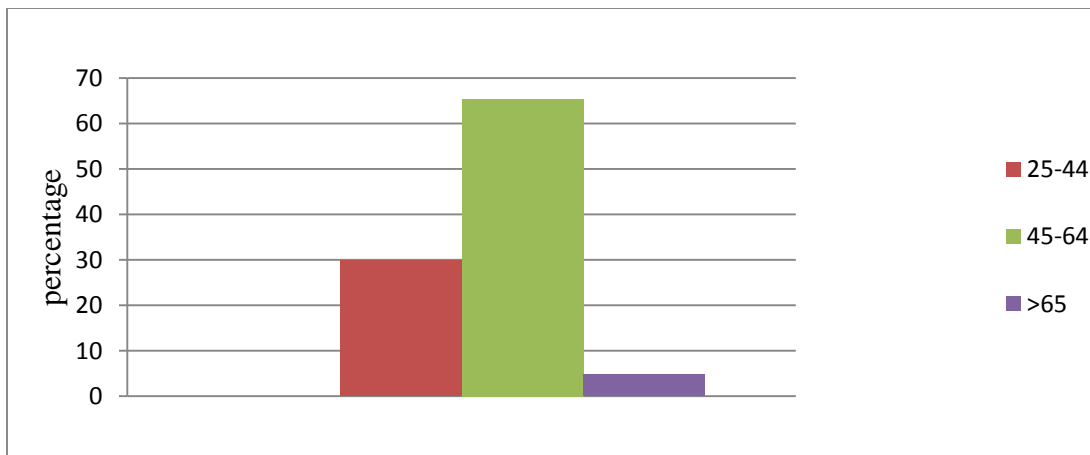


Figure 4.1: Age distribution among pig farmers

The family size distribution among pig farmers is presented in figure 4. 2 below.

Most households had a family size of between 2 and 5 members (69. 2%)

The household sizes are shown in figure 2. Most households (69.2%) had 2 to 5 family members.

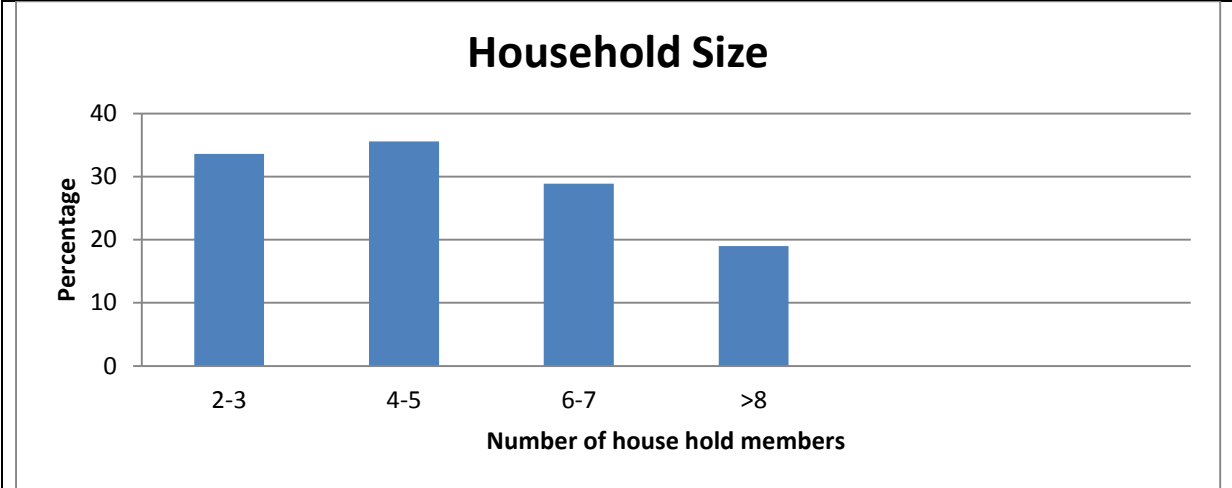


Figure 4.2; House hold sizes of the respondents

Figure 4.2: Distribution of family size among pig farmers

The different type of crops grown by the pig farmers is presented in figure 4.3 below.

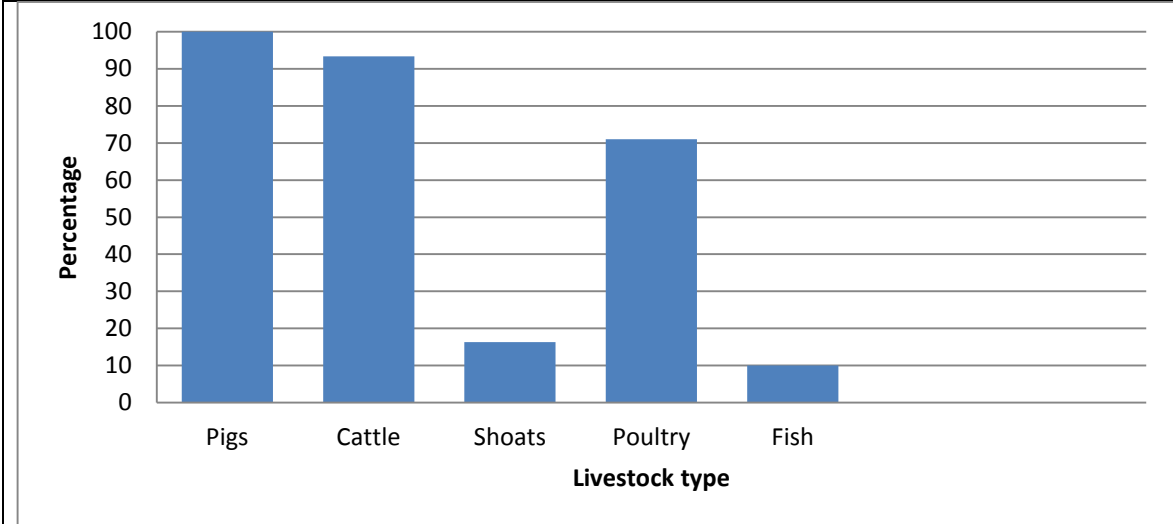


Figure 4.3; Livestock types kept by the respondents

The proportion of pig farmers keeping other type of livestock is presented in figure.4. 4 below. Most farmers kept dairy cattle (93.3%) and poultry (97.1%).

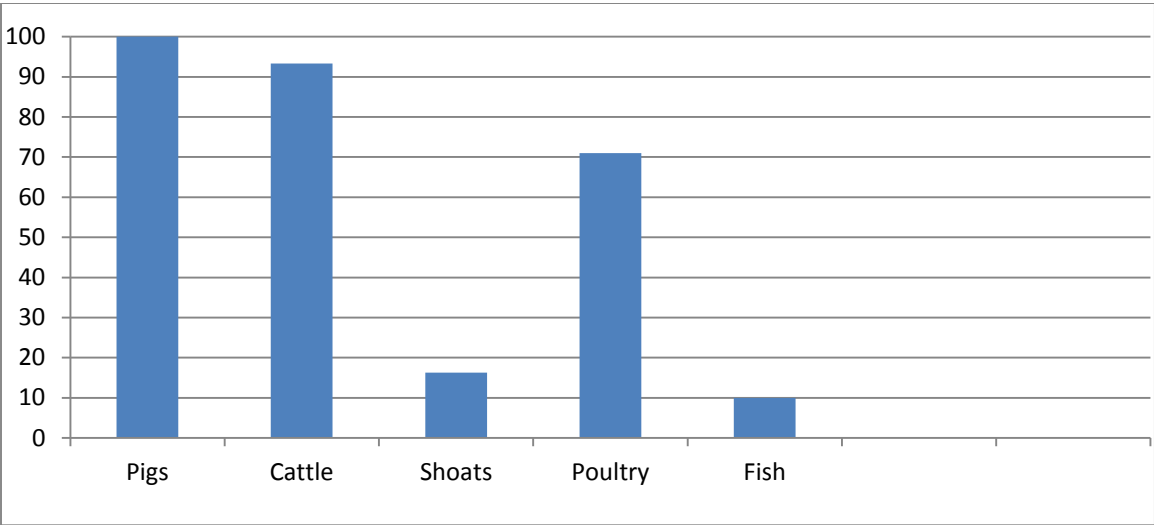


Figure 4.4; Pig farmers keeping other type of livestock

4.2 Characterization of the Pig Production Systems in Embu West Sub-county in Table 4. 2 below

Table 4. 2. Pig Production and Management in Embu West Sub-county	
Descriptors	Percentage
Breeds of pigs kept by households	
Large White	51.9
Landrace	33.7
Both Large White and Landrace	14.4
Source of breeding stock	
Locally from other farmers within the sub county	95.2
Farmers Choice	4.8
Breeds valued most	
Large White	65.4
Landrace	34.6
Production systems practiced by households	
Intensive production system	100
Households with problems feeding their pigs	95.2
Households with problems housing their pigs	87.5
Households with disease/pest management problems	83.7

From the data presented in Table 4. 2, the Large White was the breed that was most kept (51.9%) followed by Landrace (33.7%). Some households (14.4%) kept both the Large White and Landrace. Most farmers (95.2%) sourced their breeding stock locally while the rest (4.8%) got their stock from Farmers Choice. The most valued pig breed was Large White (65.4%) followed by Landrace (34.6%). All the farmers (100%) practiced intensive pig production system. Most households had problems of feeding (95.2%), housing (87.5%) and disease and pest management (83.7%) in their pig enterprises. All the farmers (100%) castrated male piglets not intended for breeding, (16%) administered iron injection/paste, (12%) clipped the teeth of the piglets and none practiced tail docking.

Animal health services were provided by Para-veterinary professionals (100%) either at farm level or through Agro-vet outlets. These were mainly in private practice but occasionally pig farmers

were attended by those employed by the government. Extension services to the pig farmers were provided through farmer to farmer consultation, (76.9%), FM Radio (55.8%), Television (42.3%), Para-veterinary professionals (23.1%) and Internet (15.4%). Only a few pig farmers (6.7%) had problems marketing their pigs. There are no live pig markets in the Sub County. Most farmers (92.3%) slaughtered and sold pork locally, several farmers (31.6%) sold their pigs to traders (farm gate sales) while a few (6.6%) were contracted by Farmers Choice. Only 1.9% sold their pigs through middlemen. Most of the pig farmers (98.1%) kept some form of record for their pig enterprises. The recorded information was used to estimate the farrowing date by 32.7% of the farmers, date due for deworming (63.5%), date due for second iron injection (5.8%), and when finished pigs were due for the market (5.8%). About 51% of pig farmers belonged to an association such as a group or Sacco. About 40.4% of the pig farmers belonged to Saccos while 10.6% belonged to Table banking groups. Sacco members received services in form of cash (85.7%) and inputs (14.3%). Table banking group members received cash contributions during their meetings (100%). Most of the Sacco members (64.4%) were satisfied with the services offered while all the table banking group members were satisfied with their cash contributions. The Saccos were of a general nature, where the respondents had accounts from the sale of various farm products including Macadamia nuts, Coffee, milk and sale of pigs. Most farmers kept some sort of record. Less than two percent (1.9%) kept no record at all.

Pig ownership by households is presented in Table 4.3 below. Over 60% of households kept between one and four pigs.

Table 4. 3; Pig ownership by households					
					Total
No. of pigs (groups)	1-4	5-10	11-21	>22	
Percentage	63.3	19.2	12.6	1.9	100

The reasons for valuing the Large White pig breed as the top ranked breed by households are presented in Table 4. 4 below. Over 60% of households preferred Large White because it produced more piglets than other pig breeds.

Table 4.4 Reasons for valuing Large White as the top ranked breed.

S/No	Reason	Percentage	Rank
1	Prolific	64.4	1
2	Locally available	45.2	2
3	Fast growth rate	32.7	3
4	Good mothering ability	25.0	4

Feed resources used by households to feed their pigs are presented in Table 5. Only less than 5% of the pig farmers could afford to feed their pigs on commercial feeds fulltime.

Table 4. 5 Feed Resources used in Feeding Pigs

S/No	Feed resource	Percentage	Rank
1	Garden weeds, kitchen left overs, market agricultural waste	99	1
2	Sow and Weaner ration	97.1	2
3	Bran (rice)	96.2	3
4	Cassava, Napier grass, sweet potato tubers and vines, pumpkins	95.2	4
5	Creep feed, Sow and Weaner ration, pig finisher	4.8	5

Most pig farmers especially in the rural areas use locally available feed resources to feed their pigs. They occasionally supplement them with commercial feeds.

4.3 Factors Constraining Pig Production

The constraints identified in the study were; Lack of high quality breeding stock, high cost of feeds, housing- (related to lack of credit/inputs), diseases and pests, and marketing.

4.3.1. Breeding stock

About 95.2% of households sourced their breeding stock locally from other famers within the Sub County. The rest (4.8%) of the households sourced their breeding stock from local breeders or Farmer's Choice.

4.3.2 Cost of feeds

The common feeds were garden weeds, kitchen left over, market agricultural waste (99%) and Cassava, Napier grass, Sweet Potato vines/tubers and pumpkins (95.2%). Sow and Weaner Meal

and Bran were fed to pigs that were pregnant or had farrowed to provide piglets with enough milk. The pigs were usually feed twice daily and water was available all the time.

About ninety six percent of the pig farmers (95.2%) had problems feeding their pigs on commercial feeds. The problems are listed, ranked and presented in Table 6 below

S/No	Problem	Percentage	Rank
1	High feed cost	95.2	1
2	Feed not locally available	92.3	2
3	High transportation costs	90.4	3

4.3.3 Housing (related to lack of credit/inputs)

Most of the households had problems housing their pigs. The problems were: Lack of capital to build suitable pig structures (87.5%), and constant repairs of temporary structures in which the pigs were housed.

4.3.4. Diseases and Pests

About 84 % of households reported disease and pest problems. The problems are listed and ranked in Table 4.7 below.

S/No	Problem	Percentage	Rank
1	Worm infestation	80.8	1
2	Fleas	31.7	2
3	Mange	13.5	3
4	Pneumonia	4.8	4

4.3.5. Marketing

There are no markets for trading in live pigs. There is lack of standard slaughter facilities in the locality. There is lack of volumes of pigs and high cost of transport of pigs to urban centres. Most of the pigs are from smallholder producers and do not meet the standards of urban processing. However a few farmers (4.8%) were contracted by Farmers' Choice Company.

6.7% of pig farmers had problems marketing their pigs. They sold their pigs directly to traders or through middlemen.

4.4. Constraints to pig production in Embu West Sub-County

Major constraints affecting pig production in Embu West Sub County are presented in figure 4.5 below. High feed costs (95.2%) and lack of high quality breeding stock (95.2%) are the top ranked constraints followed by lack of suitable pig housing (87.5%).

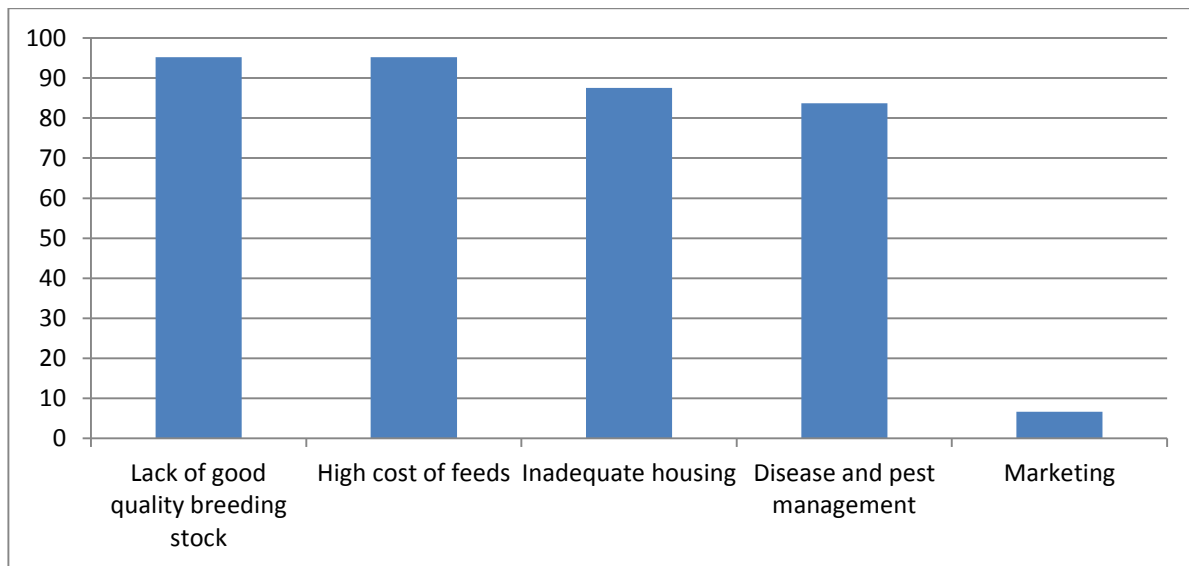


Figure 4.5 Ranking the major constraints affecting pig production in Embu West Sub-County.

4.5. Strategies that may enhance the performance of the pig industry under the intensive pig production system.

This objective sought to identify strategies that may be used to enhance the performance of the pig industry under the intensive pig production system practiced in Embu West Sub County. The suggested solutions are presented in Table 4. 8. Planting suitable forage species was the top ranked strategy.

Table 4. 8 Suggested solutions to top ranked problem (pig feeding)

S/No	Suggested Solutions	Percentage	Rank
1	Planting suitable materials for pig feed (sorghum, cassava)	92.3	1
2	Locally investing in animal feed manufacture	91.3	2

3	Government to subsidize feed cost	15.4	3
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The suggested strategies for pig housing problems were: Sourcing loans from the Agricultural Finance Corporation (74%) and sourcing credit from financial and microfinance institutions (32.7%). [This data was obtained after analysis: Housing Solution1 77/104=74%; Housing Solution2 34/104=32.7%].

The suggested strategies to manage top ranked pests are presented in Table 4.9. Regular deworming was the top ranked strategy for pests (worms).

The only disease problem reported was pneumonia (4.8%) mainly in piglets. In all cases treatment was sought from qualified personnel.

Table 4. 9.Suggested solutions to top ranked pest management problem (Worm infestation)

S/No	Solutions	Percentage	Rank
1	Regular deworming	79.8	1
2	Regular deworming and cleaning the pig house	61.5	2
3	Removing waste/ Cleaning pig house	37.5	3

Most respondents (73.1%) Treated fleas by spraying with acaricides and controlled mange infestation (75%) using old engine oil while 25% of the respondents controlled mange by spraying with acaricides. Over half of the respondents (51%) of the respondents believed that good shelter could control pneumonia, 18% believed in treating their piglets for pneumonia while 30.8% believed in both good shelter and treatment in combating pneumonia in their piglets.

The suggested strategies to top ranked marketing problem are contract farming (6.7%) and creating marketing groups (3.8%). The suggested strategy to top ranked group/ Sacco members' problem is diversifying services provision to include inputs, health, breeding and marketing of pigs.

CHAPTER FIVE

5.1 Socio-economic characteristics of households

Most of the pig farmers (96.2%) were males as shown in Table 4.1. This depicts gender disparity in pig ownership. This differs with most studies elsewhere whose review suggested that rural pig farming is mainly done by women and girls in the Republic of South Africa, Botswana, Zimbabwe, Namibia and Tanzania (Nsosoet *al.*, 2006; Chiduwaet *al.*, 2008; Kamuriboet *al.*, 2011; Petruset *al.*, 2011; Halimamiet *al.*, 2012). In Zimbabwe and Botswana, Nsosoet *al.*, (2006) reported that 75% of females and 69.7% of girls were involved with pig husbandry.

In Embu West Sub County, the age range of pig farmers was 31-70 years with a mean age of 49 years. Nsosoet *al.*,(2006) found that 62.5% of respondents in Botswana who kept pigs were over 41 years old. In Tanzania those who kept pigs had a mean age of 38 years (Kamuriboet *al.*, 2011). Landholdings of the households ranged from 0.25 – 25 acres with a mean landholding of 2.9 acres and over 60% of the households kept 1-4 pigs. In India where many farmers have less than 2 acres of land (Kumaresanet *al.*, 2009), and in Bangladesh where 52.8% of pig owners are landless (Hossainet *al.*, 2011) farmers can rear many pigs under intensive production systems.

In Embu West Sub County all the participating households kept pigs in small intensive production system. These are smallholder households with over 60% of the households owning 1 - 4 pig (Table4.3). The pigs are kept in a mixed farming enterprise involving crops, other livestock and poultry (Figure 3 and 4). Resource poor people should not have their income or food security deriving from a single source; they need a number of safety nets or livelihood diversifications (Dietze, 2011). It has been observed that most of the rural people planted different crops and kept different types of livestock (de Villiers, 2005). The proportions of livestock kept per household varied as reported by different authors (Nsosoet *al.*, 2006; Ajalaet *al.*, 2007; Chiduwaet *al.*, 2008; Kamuriboet *al.*, 2011; Halimamiet *al.*, 2012). Therefore, in Embu West Sub County, pigs are kept under intensive system in varied integrated crop-livestock production systems.

The family size is the most important determinant of labour investment for family farms (Barlett, 1980). Activities in small-scale pig production often require additional labour. Family members participate in the enterprise and this provides more employment opportunities for the farm family

(Dietze, 2011; Tu, *et al.*, 2010; Dekaet *al.*, 2007). All the household heads were literate (Table 4.1). This suggests that the pig farmers can easily adopt new farming technologies (Nyangito, 1986).

In other countries where pig farming has been investigated, different authors found that pig farmers had a low level of education. Nsosoet *al.* (2006) in Botswana found that only 25% of respondents had secondary education, while Kamuriboet *al.* (2011) in Tanzania reported that only 14% had secondary education. In Bangladesh, Hossainet *al.* (2011) found that only 20.8% of pig farmers had secondary or post-secondary education.

5.2 Pig production and management

It was been noted that a high percentage of replacement stock for breeding were purchased within the community in rural areas (Kagiraet *al.*, 2010; Madzimureet *al.*, 2013). This leads to inbreeding creating a pig population with low production, reproductive rate and health status. Furthermore, the price of good breeding stock even when available is beyond the reach most of the smallholder pig farmers. Lack of good quality breeding stock has also been reported in Kenya (Mutua, 2010; Rangoma, 2011; FAO, 2012). Lack of good quality breeding stock has also been observed as an impediment in small-scale pig production (Petruset *al.*, 2011; Morekiet *al.*, 2011; Montsho and Moreki, 2012).

In Colombia, Ocampoet *al.*, (2005) reported that farmers did not control breeding at all and that led to farmers being unable to know the performance potential of individual pigs.

The most popular pig breed kept is the Large White (Table 4.4). This breed has desirable growth potential and high fecundity. This is in agreement with (Wanjaiya, 1999) and (Githinjiet *al.*, 2007). Pigs were fed on kitchen leftovers, food crops and crop by-products (cassava, sweet potatoes tubers and vines, pumpkins, pastures and fodder) - Table 4.5. The time taken for pigs to reach slaughter weight for most farmers was a problem because of poor feeds and underfeeding and therefore it took a long time before pigs attained slaughter weight. According to Dekaet *al.*, (2007) in India, poor feeds that lacked enough protein was a major contributor to the length of time it took pigs to reach slaughter weight. In the study area, pig farmers fed their sows on sow and Weaner ration and rice bran in addition to other available local feedstuffs when they farrowed or were about to farrow. These are fed for about two months when the piglets are weaned. Water was provided *ad libitum* at one corner of the piggery usually in recycled plastic containers. For most of the time the pigs were fed on locally available feedstuffs. These findings are similar to those observed by Lemke

(2007) that that pig feeds mainly depend on availability rather than on nutritional requirement at different stages of the production cycle.

The high cost of pig feed remains prohibitive in Kenya (Githigia, 2013) as elsewhere (Smith, 2006). Sorghum and cassava have been reported to offer a lot of hope as a source of energy for the growing pig industry in Kenya (Berge Voet and Van Engelen, 2014).

The most common type of floor was raised wooden platform usually made of off cuts as shown in Plates 4.3, 4.4, 4.5 and 4.6. This observation is like that of Nissen *et al.* (2011), in Uganda where 59% of pig pens were slatted and raised above the ground. Several respondents reported problems in managing their piggeries as they had to repair pig houses constantly because as pigs got older, they broke down their pens and run out. There were no mud brick houses as observed by Ajala *et al.* (2007) in Nigeria nor were there houses with mud floors as observed by Kagira (2010) in Western Kenya.

Most of the financial lending commercial institutions regard farming as a very high risk business making it hard for farmers to access loans for farming inputs (Rangoma, 2013; Mutambara, 2013). However, most microfinance institutions are nowadays supporting viable farmers' groups as members of a group act as guarantors to each other. Members use livestock and household items as security or collateral for acquiring credit. It is a simple process and does not involve a long process like posting of collaterals like land title deeds by banks and other financial institutions such as the Agricultural Finance Corporation (AFC). The microfinance institutions are particularly helpful to the women and the youth who mostly do not possess land title deeds.

Worm infestation was reported as the major disease/pest problem (80.8%), Table 4.7 in the study area. This was also observed in other studies by Lekule and Kyvsagaard, 2003; Ajala *et al.*, 2007; Kamuribo *et al.*, 2011).

Majority of the famers regularly dewormed their pigs, controlled fleas, mange, and sought the services of Para veterinary professionals for treatment. This is in contrast with pig farmers in many parts of South East and South Asian countries who tend to care for diseased pigs by themselves at initial stage and only ask for veterinary assistance in severe cases. In North East India about 64% of the households treat sick pigs, but 67% of these households treat pigs by themselves using pharmaceutical products or traditional medicine (Bernard *et al.*, 2012).

In Kenya, extension services have not been successful in the past as extension was used to achieve government goals which may or may not have coincided with farmers' objectives. Over three quarters of pig farmers (76.9%) in the study area learned pig farming from fellow farmers who might not have had adequate knowledge on pig farming. Trained extension staff contributed only 23.1% on extension consultations. Kenya's experience of using unsuccessful approaches to deliver services to farmers has taught policymakers that to be effective; extension agents should avoid a top-down planning and implementation of intervention to farmers' problems in favour of demand driven and farmer led approaches. These include; Farming Systems Approach, Rapid Rural Appraisal (PRA), Focal Area Development Approach (FADA) and Farmer Field Schools (Carey and Ething, 1997). In Kenya, the National Agriculture and Livestock Extension Programme (NALEP), a joint government and donor Programme (2001-2011) tried to address these concerns.

CHAPTER SIX

CONCLUSION AND RECOMMENDATIONS

This study **concludes** that;

- The most preferred pig production system in Embu-West Sub County is the intensive pig production system.
- The main challenges affecting pig production in Embu-West Sub County are:
 - Lack of good quality breeding stock,
 - High cost of commercial feeds
 - Lack of suitable pig housing
 - Diseases and pests
- The opportunities suggested for an enhanced pig industry in the sub-county include:
 - Pig farmers planting feedstuffs for direct feeding to pigs.
 - Establishment of animal feed manufacturing facilities.
 - Subsidizing cost of commercial feeds by the government.

RECOMMENDATIONS

1. Pig farmers should be trained on the basic aspects of pig farming. Good management of pigs is the main catalyst of good production. Farmers should be trained on how to keep financial and production records and to view pig farming as a business which needs better management to realize higher economic gains and food security.
2. Pig farmers should also be encouraged to form groups to enable them access credit from financial and micro financial institutions to acquire inputs. This will also make it easier to disseminate information to the farmers to improve pig farming.
3. Future research should be undertaken to establish the extent of pig production and consumption by Kenyans with comparative data from other African Countries.

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APPENDIX I

Plate 1- 7 are photographs taken by the writer (Kithinji) in some households in the study areas showing pig housing and various stages of production.



Plate 4. 1: Large White sow in an intensive system Source: Kithinji (2016)



**Plate 4. 2: Large White pigs (fatteners) feeding on sweet potato vines and garden weeds
An old vehicle tyre is has been cut and is used as a water trough. Source: Kithinji (2016)**

Most of the small-scale pig farmers use the locally available materials to build houses for their pigs. They also improvise the feeding and watering equipment. These are done as cost reducing measures.



Plate 4. 3: A gilt feeding in a wooden feed trough, beside is a recycled plastic water trough

The pig is housed in a platform type of floor made of poles and wood off cuts. The roofing is done with iron sheets. Source: Kithinji (2016)



Plate 4. 4: A lactating sow with piglets which are about two months old, housed in a platform-like pen. Source: Kithinji (2016)



**Plate 4. 5 : Large White sows in a intensive system housed in raised wooden pens
The roof is made of corrugated iron sheets. Two of the sows are sleeping. Source: Kithinji (2016)**



**Plate 4. 6 Large White and Landrace fatteners reared in an intensive system.
The floor is made of concrete, the walls made of poles and off cuts and the roofing of black plastic sheets. Source: Kithinji (2016)**



Plate 4.7: Large White gilts in an intensive system: Napier grass can be seen growing in the background.

There are clear distinctions between the feeding area, the sleeping area, the drinking trough and dunging area. The gilts are standing on the raised sleeping area which is covered with sawdust for pig comfort. They are facing the drinking and dunging area. .

Source: Kithinji (2016)

Appendix II Letter of Transmittal of data collection

Robert Kirima Kithinji

P.O. Box 1897– 60200

Meru

Cell phone 0723344600

Date.....

TO WHOM IT MAY CONCERN

RE: DATA COLLECTION REQUEST

I am a post graduate student of South Eastern Kenya University (SEKU) pursuing a Master of Science Degree in Livestock Production Systems. My Research proposal is on Challenges Affecting Smallholder Pig Production in Embu West Sub County, Embu County, Kenya.

I am requesting to undertake the study in your locality and in collaboration with your institution. The information and data gathered will be for my M.Sc. project, it will also help me and your institution to understand more about the various challenges affecting smallholder pig production. The respondents of this study will be the pig farmers, livestock service providers, pig traders and butchers in Embu West Sub County. The data will be collected using questionnaire, interviews, visual observation and photography to obtain information in relation to pig farming. All responses will be treated confidentially.

Thank you.

APPENDIX III
QUESTIONNAIRE FOR THE STUDY

Questionnaire

Code No.....

Division _____ **Location** _____
Sub-Location _____ **Village** _____
Name of Respondent _____ **Sex** _____ **Phone** _____
Name of the interviewee _____ **Sex** _____

All the responses will be confidential and are meant for the purpose of the study only.

The questionnaire comprises of four parts.

Put a tick next to your choice or list where required.

Part I

A: Household characteristics

1 Sex: (a) Male () (b) Female ()

2 Age: years

3 Family size members

4 Family head: (a) Male headed (), (b) Female headed (), (b) Youth Headed (), (c) Child headed- headed than 18 years ()

5 Education level of family head: Primary level (), (b) Secondary level (),
(c) Tertiary level (), (d) Informal ()

6 Religion/sect: Catholic (), (b) Protestant (), (c) Islam (), (d) Others (specify) -----

B: Social economics

7. Farm size: ----- acres

8. Farm enterprises: Cash crops; _____, _____, _____

(b) Food crops; _____, _____, _____

(c) Traditional foods; _____, _____, _____,

(d) Livestock; Cattle (), Shoats (), Poultry (), Pigs (), Others (specify) _____

9. Those involved in farming activities

(a) Parents only (), (b) both parents and children (), (c) Children (), (d) Hired workers ()

Part II: Pig Productivity: Respondent Interviews, Observation And Physical Inspection Of Households

10. What breeds of pigs do you keep?

a) Breed Total _____ Male _____ Female _____

(b) Breed Total _____ Male _____ Female _____

(c). Breed Total _____ Male _____ Female _____

11. Where do you get your breeding stock?

12. Which breeds do you value most?

S/No.	Breed	Rank
1		
2		
3		
4		
5		

13. What are the reasons for the valuing top ranked breed?

S/No.	Reasons	Rank
1		
2		
3		
4		

14. What is the average litter size at farrowing?

Breed 1 ----- Piglets

Breed 2 ----- Piglets

Breed 3 ----- Piglets

15. What is the average number weaned? -----

Breed 1 -----

Breed 2 -----

Breed 3 -----

16. Which rearing system (s) do you use?

(a) Intensive () (b) Semi intensive ()

(c) Others (). Give description

17. List and rank the feed resources that you use for feeding your pigs

S/No.	Feed resource	Rank
1		
2		
3		
4		

18. Do you have problems feeding your pigs? Yes/No

19. If yes, what are the problems?

S/No.	Problem	Rank
1		
2		
3		
4		

20. How have you been solving these problems?

S/No.	Solutions	Rank
1		
2		
3		
4		

21. Do you have problems housing you pigs? Yes/ No

22. If yes, what are the problems?

S/No.	Problems	Rank
1		
2		
3		
4		

23. How have you been solving the top ranked housing problem?

S/No.	Solutions	Rank
1		
2		
3		
4		

24. What are the type of building materials used/ type of house?

- (a) Mud and grass thatch () (b) Corrugated iron sheets, brick and concrete ()
 (c) Not housed at all () (d) other (specify) -----

25. Do you carry out these routine husbandry practices on baby piglets?

- (a) Iron injection/paste, Yes/No (b) Clipping of needle teeth, Yes/No
 (c) Castration, Yes/No (d) tail docking, Yes/No

26. What other husbandry practices do you practice on your piglets?

27. Do you have disease/pest problems? Yes/No

28. If yes, List the problems and rank

S/No.	Problem (disease/pest)	Rank
1		
2		
3		
4		

29. How have you been solving the top ranked problem?

S/No.	Solutions	Rank
1		
2		
3		
4		

30. What health service providers are available to you?

31. What rearing system (enterprise) do you practice? Why do you prefer the system you are currently practicing?

S/No.	Production system	Reasons preferred
1	Farrow - Weaner (breeding)	
2	Farrow – Weaner (Slaughter)	
3	Weaner – finish	
4	Breeder	
5	All the above	

32. How do you market your pigs?

- (a) Contracted () (b) Traders come looking for pigs to buy () (c) Slaughter locally ()
 (d) Middlemen ()

33. Where are the pig markets? How far?

S/No.	Market	Distance (Km)
1		
2		
3		
4		

34. Have you been having marketing problems? Yes/No?

35. If yes, List the problems and rank

S/No.	Problem	Rank
1		
2		
3		
4		

36. How have you been solving the top ranked problem?

S/No.	Solutions	Rank
1		
2		
3		
4		

37. How do you benefit from pig farming?

- (a) White meat – food () (b) Income (), Value _____ Kshs/year
(c) Manure () (d) Any other (), Specify _____

38. Are you a member of a group/ society/ cooperative/Sacco? Yes/No

39. If yes, specify the type of group/ society/ cooperative / Sacco

40. What services do you get from the 39 above?

- (a) Inputs () (b) Health services for pigs () (c) Breeding services ()
(d) Marketing services () (e) Others, Specify _____

41. Are these services satisfactory to you? Yes/ No

42. If no, what do you suggest should be improved on?

43. Do you keep records of your pig enterprise? Yes/ No

44. If yes, List the types of records you keep?

45. How do you use the information from the records you keep?

46. Which extension services do you receive? Who gives these services?

S/No.	Extension service	Service provider
1		
2		
3		

APPENDIX I V. Random Integer Generated numbers

21	59	105	129	69	51	128	101	45	73
79	75	78	108	97	41	43	53	84	102
64	119	66	96	82	93	50	38	63	81
23	120	118	87	100	65	139	116	90	122
10	112	88	115	83	26	56	47	126	89
113	48	103	138	136	29	133	124	74	125
111	57	121	67	24	27	130	127	135	137
33	46	131	134	123	60	68	28	32	110
12	72	91	25	58	70	30	13	141	77
52	55	114	16	35	132	107	61	71	117
49	85	42	22						

Timestamp: 2015-03-30 03:49:45 UTC

***RANDOM INTEGERS SORTED OUT IN ASCENDING ORDER**

10, 12, 13, 16,21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 32, 33, 35, 38, 41, 42, 43,45, 46, 47,48, 49, 50, 51, 52, 53, 55, 56, 57, 58,59, 60, 61, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 74, 75, 77, 78, 79, 81, 82, 83, 84, 85, 87, 88, 89, 90, 91, 93, 96, 97,100, 101, 102, 103,105, 107,108, 110, 111, 112, 113, 114, 115, 116, 117,118,119, 120, 121, 122, 123, 124, 125, 126, 127, 128, 129, 130, 131, 132, 133, 134, 135, 136, 137 138, 139, 141.

*These are the numbers assigned to respondents in the sampled households.

Out of a targeted population of 142 households that keep pigs 104 households were sampled