IMPACT OF PIG KEEPING ON FARMERS' LIVELIHOODS OUTCOMES: A CASE OF MBEYA REGION, TANZANIA

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A DISSERTATION SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF ARTS IN RURAL DEVELOPMENT OF SOKOINE UNIVERSITY OF AGRICULTURE. MOROGORO, TANZANIA.

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ABSTRACT

In Tanzania, pig production for meat is becoming popular in many parts of the country and contributes significantly to the livelihood outcomes. The purpose of this study was to determine how pig keeping can contribute to smallholder farmers' livelihood outcomes. Specifically it focused on assessing the impact of pig husbandry introduced interventions on the livelihood outcomes of pig keepers, evaluating acceptability of the new model system, adopted technologies and products among smallholder pig farmers and at identifying factors affecting smallholder pig production. The study adopted a cross-sectional research survey and was conducted in Mbozi and Mbeya districts in Mbeya Region, Tanzania. Purposive sampling was used to select 160 smallholder pig farmers from intervention and control groups. Data were collected using a questionnaire, focus group discussion and key informant interviews. The study found out that pig keeping had contributed significantly to the livelihood outcomes of pig keepers in the intervention group as compared to the control group. Pig keepers in the former possessed more assets with high value following the intervention compared to the latter. In the intervention group four new management systems were introduced that included: knowledge/education, hygienic pig confinement, anthelmintic treatment and feed supplementation. Results from the study show that majority accepted and adopted the introduced interventions. Despite the contribution of pig keeping to the achievement of farmers' livelihood outcomes, households in both intervention and control groups face several constraints, however, the control group were severely affected by diseases while lack of capital was more serious to the intervention group. It is therefore recommended that; the Government and other stakeholders to invest in research and come up with better ways of dealing with the common pig diseases. It is further recommended that, education on pig production should be extended to all pig keepers in the study areas.

DECLARATION

I, **Edward Pius Mbwambo,** do hereby declare to the Senate of Sokoine University of Agriculture that this dissertation is my original work done within the period of registration and that it has neither been submitted nor being concurrently submitted for degree award in any other institution.

_____ _____

Edward Pius Mbwambo Date

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The above declaration is confirmed

_____ _____

Dr. Urassa, J. K. Date

(Supervisor)

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DEDICATION

I dedicate this valuable work to my wife Hilder Kitonga, and my beloved children Stephen and Ethan.

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LIST OF ABBREVIATIONS AND ACRONYMS

ANOVA	Analysis of Variance
ASF	African Swine Fever
DANIDA	Danish International Development Agency
DAS	District Administrative Secretary
DFID	Department for International Development
DNA	Deoxyribonucleic Acid
DSI	Development Studies Institute
FAO	Food and Agricultural Organization
FGD	Focus Group Discussion
Fig.	Figure
MDG	Millennium Development Goal
NSGRP	National Strategy for Growth and Reduction of Poverty
PC	Porcine Cysticercosis
RDS	Rural Development Strategy
SLIPP	Securing Rural Livelihood through Improved Pig Production
SPSS	Statistical Package for Social Sciences
SUA	Sokoine University of Agriculture
URT	United Republic of Tanzania
USA	United States of America
VEO	Village Executive Officer
WEO	Ward Executive Officer

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background Information

In recent decades there has been enormous growth in livestock production, driven by increasing demand for animal-source products among a large segment of the world's population. Globally, pig production is related highly with food security, people's livelihoods and economic development (FAO, 2009). According to FAO (2012), pork is the world's most widely eaten meat accounting for 40% of total meat eaten. Second to pork is chicken (29%), followed by beef (24%), turkey (2%) and others (5%). Literature (Penrith *et al.,* 2012), shows that pig population in Africa has increased by 284% during a 20 year period (i.e. between 1980 and 1999) far more than any other livestock species in the same period and the trend continues. Meseko (2013), points out that about 18 million pigs are ascribed to Africa and Nigeria with over 6 million swine accounting for over 30% of the continents' total pig production in Africa. In African rural communities, indigenous pigs have multiple functions; they provide disposable income during periods of food shortages, food, and manure for crops production and in some areas manure is a source of energy through biogas Chimanyo *et al.* (2005). Generally, an increase of up to 155% in annual pork consumption from 2000 to 2030 has been estimated in sub-Saharan Africa (FAO, 2011).

In Tanzania, pig production for meat is currently becoming popular in many parts of the country and contributes significantly to meat supplies. According to Kamaghe *et al.* (2014) the number of pigs in Tanzania is approaching 2 million and pig production is the fastest growing livestock sub-sector in the last two decades, this is primarily due to stimulated growth in pork consumption, especially in urban areas. About 54% of the pigs

in the country are found in the Southern Highlands of Tanzania, more specifically the regions of Mbeya, Iringa, Rukwa and Ruvuma (URT, 2012). Most pigs are kept in Mbeya, Iringa, Ruvuma, Kilimanjaro, Rukwa, Morogoro and Manyara regions. According to Ikegami (2011), Tanzania's pig population is concentrated in the southern regions with Mbeya Region consisting of 230 000 pigs, followed by Iringa and Ruvuma regions with a population of 180 000 and 130 000 pigs, respectively. Moreover, pigs are produced in a traditional smallholder farming system involving over 500 000 rural smallholder households (URT, 2012). Pig production in these households is primarily a market-oriented activity. Thus, pigs are sold to secure finances for the family. As pointed above, the majority of pigs are traditionally raised under the free-range system, only a few are kept under semi or intensive management.

1.2 Problem Statement

Local/indigenous pig breeds raised by the rural poor have received little attention; this could partly be attributed to the failure of agriculture development policies to accord importance to this genetic resource. In Tanzania, past researches (i.e. FAO, 2009; FAO, 2011; Irekhore, 2012; Njombe and Msanga, 2007) have concentrated on exotic pig breeds, and mainly on the use of locally available agro-industrial by-products for inclusion in rations. Documented information has often disregarded the existence of indigenous pigs in Tanzania. More than 90% of these pigs are found under traditional systems and are an integral part of smallholder farming systems. However, no concerted efforts have been made to study and describe these pigs despite their important roles in rural household's livelihoods outcomes. Also the performance of the local and crossbred pigs under the intensive system of production (after intervention) in study areas had not been significantly reported. Small-scale subsistence farmers keep the majority of pigs as a backyard activity in a mixed farming system, mainly depending on forages and

supplements. The performance of pigs in this system is generally low, as exemplified by the average slaughter weight of 50 – 70 kg at the age of one year. Under proper intensive pig management system, estimated live pig weight at slaughter age ranges between 90 – 150 kg (Koscinski *et al.,* 2007). Commercial pig production is limited to a few farmers with a regular income, mainly to meet the high cost of concentrate feeds among other requirements (Njombe and Msanga, 2007). Mbeya Region which is located in the Southern Highlands of Tanzania has 87% of local/indigenous pigs in the region which accounts for 33.8% of the total indigenous pig population in Tanzania (Lekule *et al*., 2005).

1.3 Justification for the Study

According to FAO (2011), smallholder livestock production is believed to comprise as much as 90% of the livestock sector in developing countries but the sector is characterised by extreme low productivity. As pointed out earlier most of the pig keepers in Tanzania are subsistence producers and their productivity is generally low: the major factors contributing to this low productivity include, poor nutrition, health care, poor husbandry and diseases, all these lead to low birth and growth rates, high mortality, and no or low market prices. Therefore, addressing these problems can make a major contribution to agricultural development.

Productivity of Tanzania's pig sector can be improved through more investment by both the public and private sectors. However, public investment in pig market development as well as the promotion of private investments of small-scale farmers must be based on sound knowledge (i.e. evidence based) of the actual and potential contribution of this sector to rural livelihoods. Hence, research and development needs to fill the region-specific knowledge gaps that can help to make this enterprise beneficial for rural

communities (FAO, 2011). Therefore, this study aimed to bridge the knowledge gap on indigenous pig husbandry in Mbeya Region with a poor improved keeping system, diseases control, and marketing to include agro-processing industry. Further to the above, the study could help pig farmers know about their situation on the ground, resources available and the constraints hindering pig production so that they can attempt changing their existing system hence improving pig productivity. Furthermore, results from the study do provide valuable information for the sector which could guide in designing strategies for improved productivity.

The study is in line with Tanzania's different development strategies for example: the National Strategy for Growth and Reduction of Poverty II (NSGRP II) which among other issues focuses on improved quality of life and social well-being, particularly of the poorest and most vulnerable groups in the population (URT, 2010). The study is also in line with Tanzania's' Development Vision 2025, Rural development strategy 2001 (RDS), and the Millennium development goal number one (MDG), the three strategies focus on reducing rural poverty and improving farm households' livelihoods outcomes in particular reduction of income poverty and hunger.

1.4 Objectives of the Study

1.4.1 General objective

To determine the contribution of pig farming to the livelihood outcomes of pig keepers in Mbeya and Mbozi districts.

1.4.2 Specific Objectives

i. To assess the impact of pig husbandry introduced interventions on the livelihood outcomes of pig keepers in the study areas.

ii. To evaluate acceptability of the new model system, adopted technologies and products among smallholder pig farmers.

iii. To identify factors affecting smallholder pig production in Mbeya and Mbozi districts.

1.5 Research Questions

i. How important is pig farming as a household livelihood strategy in Mbeya and Mbozi districts?

ii. Can pig farming enable households in Mbeya and Mbozi districts improve their livelihoods outcomes?

iii. What socio-economic constraints do pig farmers face in Mbeya and Mbozi districts?

iv. What support do pig farmers in Mbeya and Mbozi district receive from the government and other stakeholders to improve pig keeping?

v. How acceptable are the new model systems introduced by SLIPP project?

1.6 Research Hypotheses

i. Ho: Number of pigs kept does not differ between male headed households and female headed households.

   H_1: Number of pigs kept differs between male headed households and female headed households

ii. Ho: Achievement of livelihood outcomes does not differ between households involved in SLIPP project and those not.

   H_1: Achievement of livelihood outcomes differs between households involved in SLIPP project and those not

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Conceptualization of Key Terms

2.1.1 Livelihoods

Different authors have tried to define the term livelihood. According to Ellis (2000), livelihood is defined as assets, activities and access that determine living gained by an individual or household. Chambers and Conway (1992) cited by Ahmed and Lipton (1997) define livelihood as the ways in which people satisfy their needs or gain a living. According to Ahmed and Lipton, livelihood should be seen as a set of flows of income, from hired employment, self employment, remittances (usually in developing rural areas) or from a seasonally and annually variable combination of all these. Generally, a livelihood should be able to assist those involved to avoid poverty, and preferably, increase well-being of the concerned person and his/her dependents.

2.1.2 Livelihood strategies

Ellis (2000) defines a livelihood strategy as composition of activities that generate the means of a household‘s survival. According to Ellis a household’s choice of a particular livelihood strategy depends on many factors, which may include social influences, exogenous trends or shocks. Individuals in rural areas diversify by involving themselves in livestock keeping, crop production, and non-farm activities that may include trade. According to Morris *et al.* (2001), livelihood strategies refer to the combination of activities that people choose to undertake in order to achieve their livelihood goals. They include productive activities, investment strategies and reproductive choices. Livelihood approaches try to understand the strategies pursued and the factors behind people’s decisions and to reinforce the positive aspects of these strategies and militate against

constraints. The choice of strategies is a dynamic process in which people combine activities to meet their changing needs. For example, in farming households, activities are not necessarily confined to agriculture but often include non-farm activities in order to diversify income and meet household needs.

2.1.3 Livelihood outcomes

Livelihood outcomes are the results or outcomes of livelihood strategies. According to Eija (2005), livelihood outcomes include: increased household food security through improved and productive livestock and crop production, increased household income, increased local employment opportunities, enhanced social and human capital, reduced livelihoods vulnerability, ensured social inclusion (mainstreaming), ensured good governance, increased equal access to information, communication, education and empowerment in general. DFID (2008) defines livelihood outcomes as the achievements or outputs of livelihood strategies, such as more income, increased well-being, reduced vulnerability, improved food security and a more sustainable use of natural resources. When thinking about livelihood outcomes, the aims of a particular group as well as the extent to which these are already being achieved has to be understood. Therefore, the study's operational definition of livelihood outcomes focuses on farm household's accessibility and affordability of health services, education, assets acquisition, food security, and construction/ownership of good quality houses.

2.1.2 The livelihoods framework

According to Raphael *et al.* (2012) the livelihoods framework is a way of looking at the complexity of people's livelihoods, especially the livelihoods of the poor, whether in rural or urban areas. It seeks to understand the various dimensions of a person's livelihood; the strategies and objectives pursued and associated opportunities and constraints.

Furthermore, Raphael *et al.* (2012) stressed that livelihood strategies depend upon access to assets of one kind or another, whether such access involves private ownership or other forms of access. In the livelihoods framework, assets are conventionally divided into: natural capital, physical capital, human capital, financial capital, and social capital.

2.1.2.1 Human capital

Human capital denotes skills, knowledge (labour capacity), good health and ability to work, and pursue their livelihood strategies and achieve their livelihood objectives (DFID, 1999). Pig farming practices have developed as an indigenous technology and farmers have built up skills through their own knowledge in income generating activities such as pig farming, pig marketing, and agriculture at large, All these aspects of human capital contribute to failure or success in achievement of livelihood outcome.

2.1.2.2 Financial capital

Financial capital represents the financial resources available to individuals and households (e.g. savings, supplies of credit, regular remittances or pensions) that provide opportunity for the pursuit of different livelihood options. The main sources of financial capital include: available stocks comprising of cash, bank deposits, and or liquid assets such as livestock. Others are regular inflows of money comprising of labour income, pensions, or other transfers from the state and remittances, which are mostly dependent on others and need to be reliable (Raphael *et al.,* 2012).

2.1.2.3 Physical capital

Physical capital represents the basic infrastructure (transport, shelter, water, energy, and communications) and the production equipment and means enabling the pursuit of various livelihood strategies. These basic infrastructures are needed to support livelihoods such as

affordable transport, secure shelter and buildings, adequate water supply and sanitation, affordable energy and access to information (Raphael *et al.,* 2012).

2.1.2.4 Social capital

Social capital encompasses the social resources which people utilize in seeking livelihood outcomes. The social resources, upon which people draw in pursuit of livelihoods outcomes, include formal and informal social relationships, help in exchanging experience, sharing of knowledge and cooperation among rural household (Fine, 1999; Stirrat, 2004). Examples: networks, membership of groups, relationships of trust, access to wider institutions of society. Lack of social capital can affect the livelihood of farmers,

2.1.2.5 Natural capital

Natural capital means the natural resource stocks such as land, water, forest, air quality, erosion protection, biodiversity degree and rates of change which are all useful for livelihood outcomes achievement. Natural capital includes access to land, water, and wildlife from which households engage in agricultural pursuits and/or resource collection for both sustenance and income generation (Raphael *et al.,* 2012).

2.2 Pig Farming

Pig farming refers to the branch of agriculture concerned with the care and breeding of pigs. Pig farming is the practice of raising pigs for food and other products, such as leather, bacon, ham and sausages. Pig farming comes in a range of styles. Some pig farms are huge and factory-like, others are small and intimate. Each type of pig farming has different impacts on the pigs, the environment, pig farm workers, pork consumers and the public at large (Irekhore, 2012).

2.3 Pig Productivity

According to Okello *et al.* (2015) pig productivity is measured by reproduction and growth performance and these are influenced by genetic factors, feeding, environmental conditions and management practices such as lactation length, weaning age and parasites control. In addition, Okello *et al.* (2015) productivity in breeding herds is measured by piglets weaned per female per year (PWFY), and is determined by indices such as litters per female per year (LFY), farrowing rate (FRATE), culling rate (CULLR), Inter-farrowing interval (IFI), weaning-to-service interval (WTSI), number of piglets born alive (PBA) and pre-weaning piglet's mortality (PWM). In finishing herds, productivity is measured in average daily weight gain (DWG), and weight: age ratio (WT/AGE).

2.4 Pig Keeping Systems

2.4.1 Free-range (scavenging) system

This is a more or less extensive system whose main purpose is to guarantee the household emergency fall-back funds, supplying the pig (s) with very little feed from time to time, without any major investment of time or money (Muys and Westenbrink, 2004). The importance of the scavenging pig is rather as a 'saving account' or 'insurance policy', that is, they are sold when extra cash is needed (e.g. for buying seeds or fertilizers, at times of illness or festivals, in paying for school fees, to make up for a lost harvest etc) (Owen *et al.,* 2005; Ajali, 2007). The above is typical of small farmer mixed holdings. Free-range herds generally have lower set-up costs, but are slightly less productive in terms of weight gain per unit of food consumed, that is, sows eat more to compensate for the uncontrolled temperatures and there is greater potential for feed wastage (Owen *et al.,* 2005; Ajali 2007).

Ikwap *et al.* (2014) reported that indigenous pigs under the free range system easily adapt and cope mainly to the local environment and condition due to their relatively small body size that leads to high mobility. The pigs scavenging behaviour has a nutritional benefit. For confined pigs a diet compounded from for example maize or sorghum which are readily available to smallholder farmers will only provide about 30% of the pig's requirement of lysine and methionine which are the most limiting amino acids in pig feeds. Generally, 20% supplement of green feeds and material of animal origin increases the amino acid provision to approximately 80% of the optimum. If pigs are kept enclosed this supplement has to be administered, which involves extra cost and labour (Lekule and Niels, 2003). But since scavenging pigs have better access to soil and a wider variety of grasses the cost of supplementing these lacking nutrients is avoided.

Productivity of scavenging pigs is generally low with litter size of 3 – 5 piglets. The sow breeds irregularly (due to poor control of weaning and boars choice), rates of piglet's mortality are high and growth rates are low often less than 120g per day instead of 142.0±7.2 g (Owen *et al.,* 2005; Ajali, 2007). Pigs kept in free range system will not grow quickly because they spend a lot of energy in their scavenging activities. Apart from the poor growth rate, scavenging pigs are also subjected to diseases/parasites. They are very much affected by different types of external parasites such as fleas, lice, soft ticks, and mites which can cause serious anaemia. In addition, the pigs become affected with cysticercosis and or African swine fever. Also the scavenging behaviour exposes pigs to different types of internal parasites (worms and protozoa) which affect pig's growth performance. In most cases, scavenging pigs are not kept to provide meat for the household, nor as a regular source of cash income (Owen *et al.,* 2005).

2.4.2 Semi-intensive system

A system differing from the above in that the animals are left to scavenge during the day and housed during the night and more attention is paid to their health and feeding. Its aims remain those of free-range pig keeping, but given a modest amount of inputs, its production is higher (Owen *et al.,* 2005; Ajali, 2007). This means that during confinement periods pigs cannot gather their own food and are completely dependent on their keepers. Most farmers using the semi-confinement system have semi permanent pig shelters in which once or twice a day fresh water and fodders usually kitchen refuse or agricultural waste have to be provided to the pigs (Ikwapi *et al.,* 2014). This system demands low financial input compared to intensive system, but more time, effort and technical knowledge need to be spent to optimize productivity of the semi-intensive systems. Generally, the system may need shelter made of simple local materials like bamboo, timber off cuts and logs plastered with mud or timber off cuts with an elevated floor. Management is normally minimal, and as a consequence, productivity tends to be relatively low and mortality can be high but not as in the free range system. This system of pig keeping opens up possibilities for improved feed and diseases control, which can result in faster growing and healthier pigs and/or larger litters. Pigs are also enclosed to prevent crops from being damaged by the animals and reduce the risk of pigs being stolen (Owen *et al.,* 2005; Ajali, 2007).

2.4.3 Intensive system

The intensive system aims at producing meat for the market efficiently and profitably, usually with larger numbers of pigs. This type of system requires significant inputs of time and money, with careful calculation of the costs and the resulting benefits. The system needs permanent pig shelters where pigs are stall-fed in the pens and all required nutrients have to be provided by the farmers (Muys and Westenbrink, 2004). This is difficult for

most of the pig farmers in rural areas as they cannot purchase feeds with the required nutrients for all pig types in terms of their ages, and feed requirements as it needs much capital, the reason being lack of money to buy feeds at all times.

According to Phengsavanh *et al.* (2011) the aim of putting pigs in an enclosure is not to intensify the system, but rather to keep pigs away from crops, improve village sanitation and reduce the risk of pig diseases. Despite the benefits of the intensive system, the system faces several problems such as insufficient funds to expand pig production, lack of labour to properly manage pigs and the high cost of commercial feeds. Nevertheless, FAO (2010) has reported a number of advantages: the housing design makes it easier to manage the animals; vaccinations and treatments are easy to administer; the environment can be kept clean and manure can easily be collected to use in crop production. In addition, farrowing can be carried out more successfully within a protected environment for sows and piglets, ensuring a higher survival rate of the new born. However, in comparison with the semi-intensive backyard system a relatively high level of inputs is required, for housing material, feeds, veterinary products and labour. Pig production is often the sole or a major source of income, and farmers require management skills and financial capacities to adequately benefit from the same (FAO, 2010).

2.5 Pig Farming and Rural Household's Livelihood Outcomes

2.5.1 Source of employment

Family members participate in the enterprise and this provides more employment opportunities for the farm family. On-farm processing also enables new skills and knowledge to be learnt and provides for more varied products to be sold and further employment opportunities for the farm family in both developed and developing countries (FAO, 2011). According to Novak (2012), pig farming has been among the sources of

employment in the United State of America. Employment, wages and establishments have increased steadily in the United States particularly in North Carolina at the aggregate level of the hog farming value chain over the last two decades. In 1992, the U.S.A pig farming industry employed 281 231 people in 7 838 establishments. By 2012 this number increased to 327 350 workers in 8 031 establishments, an increase of 14.1% and 2.5% respectively over the last two decades (1992-2012).

2.5.2 Source of income

According to FAO (2010), pigs provide income for farmers, strengthening their role in families as well as in local communities. Income is earned from the sale of animals and importantly from their products. Income from pig farming can be used to invest in farm assets, pay for school fees and health services. Furthermore, FAO (2010), reports that in poor rural areas and peri-urban areas, pig production often functions as a banking system where the animal is a source of wealth that can be accessed when additional income is needed. This might be the case when school fees need to be paid, household members seek medical assistance or cash is needed for further investments. Pigs provide income for women, strengthening their role in families as well as in local communities. Pigs can additionally be considered as a store of wealth and a safety net in times of crisis.

Green (2012), reported that small-scale pig keeping has become increasingly attractive to small-scale farmers in the highland areas in Tanzania because of contextual changes in the wider economy changes that have restructured the demand for pork. According to Green (2012), most farmers in Ulanga Morogoro have shifted from keeping cattle to pig keeping as a source of income. These factors do not apply to the economics of dairy farming. Green further stresses that dairy cattle have much greater costs than pigs in terms of the provision of fodder and preventive treatments against tick-borne diseases, but also the

opportunities to generate income from dairying are limited. The low demand for milk is not merely a matter of price. Milk is not a routine part of the households' local diets compared to pork. Pig keeping is popular partly because once a pig has reached a certain size it can be liquidated at any time.

2.5.3 Source of food

FAO (2011) reported that pig products range from primary commodities such as pork, to processed food products such as sausages and smoked hams to cooked salted ears, eaten as snacks. The main commodity in pig production is pork. Pork represents high value animal protein and is the most consumed meat in the world. At household level pig production provides access to animal protein for farm families, contributing to an improved diet for family members. FAO (2011), also emphases that Pork has beneficial components like essential amino acids, vitamins and iron, therefore contributes significantly to a more balanced diet. In food insecure areas this can be of high importance especially for children and pregnant or breast-feeding women. On-farm processing of pork can produce products with improved storage characteristics, enabling meat consumption throughout the year regardless of when slaughter occurs.

2.6 Desire fulfilment Theory of Well-Being

The study is in line with the desire satisfaction theory of well-being which states that; what is ultimately in a person's interest is getting what he wants, whatever it is. Whenever a person desires something other than his own pleasure, he desires it as a means to his own pleasure. Well-being is connected not to our actual desires but to our idealized desires. That view of well-being claims that, what is good for one, what makes one's life go well, is the satisfaction of one's desires. Most or all desire theorists would agree that the stronger the desire, the more beneficial is its satisfaction and the worse its frustration.

Furthermore the desire-fulfilment theory is guided with the assumptions that, getting a good life have to do with one's attitudes towards what one gets in life rather than the nature of those things themselves. If, however, fulfilling merely past desires is never a benefit at any time, this suggests the view that the desire theory count only desires for what goes on at the time of the desire. When someone can't get what he really wants, he may adapt his preferences to his predicament. If he succeeds in doing this, he is now getting everything he wants (Heathwood, 2014).

2.7 Pig Farming in the World

Compassion in World Farming (2013), reported that, more than a billion pigs are slaughtered in the world each year for meat, making them the most common mammal farmed for meat. Throughout the world, over half of commercial pig farming is highly intensive. This takes place indoors and is also known as industrial pig production or 'factory' farming. Adult female pigs are kept in close confinement systems throughout their lives. Their offspring are kept in barren pens at high stocking densities, until they are ready to go for slaughter. In addition, Compassion in World Farming (2013), claimed that several alternatives to intensive farming systems have been developed to overcome welfare concerns associated with intensive farming. Most are based on traditional farming systems that were commonly in use before industrialisation took place in the 1950s. Some use modern technology to achieve better welfare.

Compassion in World Farming (2013), have further reported that on average, modern sows have 10 piglets per litter and have 2.4 litters per year but some have 13 or 14 piglets per litter. At the end of the production period - after they have had an average of 3-5 litters - sows are culled (brought to slaughter), aged about 1½ to 2 years. Modern pigs can reach a slaughter weight of 100 kg in 24 weeks. Once mated, both gilts and dry sows are kept in

either ‘sow stalls’ or ‘tether stalls’ (see below) during their pregnancy which lasts for about 114 days (3 months, 3 weeks and 3 days). After giving birth, the sow remains with her piglets in the farrowing crates until they are weaned (removed), at 2-4 weeks. After weaning, sows are returned for mating or AI to repeat the reproduction cycle or they are sent away for slaughter (‘culled’). Boars are generally kept singly in pens. This is partly to prevent aggression and partly to ensure paternity of offspring (so that the farmer knows who has fathered a litter). The majority of pigs are slaughtered for bacon at a live-weight of 90-110 kg, when the pigs are 20 to 24 weeks of age (Compassion in World Farming, 2013).

2.8 Pig Farming in Sub Saharan Africa (SSA)

Pigs are among the main livestock species kept in Sub-Saharan Africa countries, followed by poultry and cattle. The last livestock census reported by UBOS (2009) ranked Uganda as the third highest pig producer with 3.2 millions pigs after South Africa and Nigeria. Uganda produces 115 000 tones of pork annually, and the country is among the largest consumers of pig meat in SSA with an estimated per capita consumption of 3.4 kg/person/year. In SSA countries the level of management on different farms in different countries classified into 3 categories (above average, average, and below average) based on the feeding systems, housing types and healthy practices (Okello *et al.,* 2015).

According to Okello *et al.* (2015) the above average system, pigs are fed commercial feeds, farm by-products and crop residues, and pigs are de-wormed routinely every 3 months. In this system pigs are housed in leak proof, highly cleaned daily, well ventilated with concrete or wooden floor above ground level. In average management, pigs are housed in leak proof, well ventilated, concrete or raised wooden floor, and cleaned occasionally. Pigs are fed with maize bran, rice bran, brewers’ waste and crop residues. In

addition, pigs are exposed to de-worming routine of 6 months interval and ectoparasites are occasionally controlled. Below average system pigs are housed in poor hygienic shed with leaking roofs, poor ventilation and seldomly cleaned. Feeds are provided erratically and comprise of locally available feed stuffs such as rice bran, and crop market wastes comprises majorly of banana peelings, cabbage leaves and sweet potatoes vines. Ectoparasites and endoparasites controls are seldomly practised (Okello *et al.,* 2015).

2.9 Pig Farming in Tanzania

According to Kamaghe *et al.* (2014), Tanzania is an agrarian country with 45million people (URT, 2012), of which about 80% of its labour force is engaged in agricultural production. Out of the 5.8 million agricultural households in the country, about 40% keep livestock, which include cattle, goats, poultry and pigs. Currently, it is estimated that Tanzania has 2 million pigs and pig production is the fastest growing livestock sub-sector in the last two decades primarily due to stimulated growth in pork consumption, especially in urban areas. In Tanzania, most pigs are kept in high human population areas in which land is of high agricultural potential. About 54% of the pigs in the country are thus found in the Southern Highlands of Tanzania, more specifically the regions of Mbeya, Iringa, Rukwa and Ruvuma. Moreover, pigs are produced in a traditional smallholder farming system involving over 500 000 rural smallholder households. Pig production in these households is primarily a market-oriented activity, and the pigs are sold to secure finances for the family (Kamaghe *et al.,* 2014).

2.10 Challenges Facing Pig Farming in Tanzania

In rural Tanzania pig farming households face many challenges. Among these are porcine diseases, poor feeding (nutrition requirement and balancing), lack of market, inbreeding, inadequate extension services and lack of capital. The above have prevented the

development of pig farming and production at large. Details to the above are presented below.

2.10.1 Pig diseases

2.10.1.1 Porcine *cysticercosis* (PC)

Komba *et al.* (2013) point out that the most common disease affecting pigs in Tanzania particularly in Mbozi and Mbeya districts is porcine cysticercosis. Porcine cysticercosis (PC) is caused by the larval stage of a zoonotic tapeworm (*Taeniasolium*); generally, this poses serious economic losses and public health risk among smallholder pig production communities. It is an important parasitic zoonosis with humans harbouring the adult stage of the parasite (taeniosis). Komba *et al.* (2013), argue that human infection results from ingestion of infected pork, whereas pigs get infected by consuming human faeces or feed/water contaminated with taeniid eggs from humans. Occasionally, humans ingest *T.solium* eggs, which develop into cysts in different body tissues with serious consequences resulting from cysts in the central nervous system, a condition termed as neurocys-ticercosis. PC is most prevalent in rural pig keeping communities of developing countries, Tanzania inclusive. According to Komba, PC implies a great public health risk not only to these rural areas where pigs are produced, but also to urban centres where pigs from rural areas are eventually transported. These urban centres are featured by large populations with high demand for pork. The need for controlling PC is fundamental for improving smallholder pig production, safe pork consumption and improvements in public health both in Tanzania.

2.10.1.2 African Swine Fever (ASF)

In Africa the most important pig diseases are the viral diseases, especially African swine fever (ASF), and particularly in the smallholder mixed intensive and extensive

management systems (Swai and Lymo, 2014). ASF is a deadly and devastating disease that can disrupt the pig industry and the entire local economy. African swine fever (ASF) is a highly contagious and deadly hemorrhagic disease of domestic pigs (of all breeds and ages) caused by African swine fever virus (ASFv), a double-stranded DNA virus of the family *Asfarviridae* and genus *Asfivirus*. According to Swai and Lyimo (2014) in eastern and southern African countries, the disease occurs through complex transmission cycles involving domestic pigs, soft ticks and wild African pigs, and warthogs (*Phaecochoerus africanus*), which do not develop signs of the disease. In spite of more than 50 years of research, there is no vaccine available against ASF. The losses are incurred in the form of productivity losses, morbidity and mortality.

2.10.2 Poor Nutrition's and balancing of pig feeds

Martens *et al.* (2012), points out that pig's diet is usually a mixture of several ingredients, which when combined should complement each other to meet the nutritional requirements. Thus, to formulate optimal diets for monogastric farm animals, it is important to identify the optimum inclusion level for the available forage species as well as the best administration form in mixed rations. Smallholders often lack access to good quality feed with sufficient energy content and the balanced amino acid profile that is needed to ensure satisfactory animal performance. Martens *et al*. (2012), argues that in smallholder systems of monogastric production, lack of essential amino acids is common as diets often consist of cereal grains or part of them (rice, rice bran, maize, or sorghum) or cassava. These only provide 30% or less of the pigs' requirements of lysine and methionine, which are the most limiting amino acids in pig feeds. Although many smallholders include other feed sources such as local roots or leaves, fruit (papaya) or agricultural by-products such as banana stems, these do little to improve the nutritional status of their pigs which results into poor growth and affect quick fattening of pigs (Martens *et al.,* 2012).

2.10.3 Lack of market

URT (2010) argues that lack of marketing facilities imposes a serious constraint on the marketing of pigs. Marketing consists of the commercial functions involved in transferring of goods and services from producers/sellers to consumers/buyers. Essentially, it is the process of creating or directing an organization to be successful in selling a product or service that people not only desire, but are willing to buy. Marketing is not just the final transactions of receiving a cheque. Furthermore, URT (2010) points out that the acts of buying supplies, renting equipment, paying labour, advertising, processing, distribution and selling are all part of marketing. It is also concerned with anticipating the customers' future needs and wants, which are often discovered through market research. Currently, the component of marketing is lacking in Tanzania particularly in the rural areas where the majority of smallholder pig producers are found. An improvement in pig productivity and marketing especially in the local sector could improve the livelihoods of the resource poor farmers.

According to URT (2010) in most cases pigs are not purchased in a central market; instead, buyers purchase pigs directly from smallholder farmers at the farm gate, sometimes using middlemen in finding and purchasing pigs. Buyers are the ones who dictate the selling price and farmers have no option than accepting, generally this favours the buyers over farmers, as a result the situation contributes to farmers' low income. The pig weight is the most important criteria for buyers in evaluating pig prices. Without weigh scales neither tape measure, buyers and farmers have to estimate the weight of the pig to negotiate the price. In addition, URT (2010) points out that, most farmers are unable to estimate pigs' weight thus, resulting in inequality in estimation of a pig weights during price negotiations. Farmers in most cases under estimate their pigs' weight, hence under value the pigs and consequently receive a poor price. On overall pig marketing systems in

rural Tanzania are found to be generally exploitative, collusive and economically inefficient and this contributes to poor achievement of farmers' livelihood outcomes. To create a fair ground between pig buyers and farmers on pig weights, use of tape measures should be encouraged, and farmers should be trained on their use. Tape measures can be used as alternative in the absence of weighing scales to get a pigs' weight estimate (URT, 2010).

2.10.4 Poor knowledge

Lack of knowledge of farmers to manage pigs is likely to produce poor meat products, which will face the challenge of competition in the market. Projects like piggery production need a lot of skills and knowledge to effectively manage these projects, since proper nutrition intake, good hygiene; proper housing and routine vaccination will be required. With regard to the above, most projects implemented in rural communities are thus vulnerable to failure because the rural people seem to be less skilled and lack knowledge. There is a great need for government and other stakeholders to invest more on knowledge provision through training particularly on health care, management system, and feeds and feeding (Ngowi *et al.,* 2011).

2.10.5 In-breeding

URT (2010) points out that replacement stock in most areas has no proper breeding records, which makes it difficult for farmers to trace parent stocks and hence inbreeding. Additionally, lack of breeding companies in the country is a limitation to improving pig herds. Pigs in Tanzania (particularly in rural areas) originate from one source and as such inbreeding is common; hence poor quality of stock. Inbreeding causes a loss in heterozygocity and increases homozygocity which results in increased lethal genes that increase embryonic death, mummified foetuses and stillbirths. Furthermore, URT (2010)

argues that inbreeding causes a decrease in production/reproductive performance and fitness (inbreeding depression), low birth weights, increased mortality and poor fertility. Experience shows that no provision of improved breeds from government farms due to unavailability of such, this results into increased use of own stock and that of neighbours, which give rise to inbreeding and consequently low productivity. Most pig keepers however do not keep breeding boars for breeding. Cash payments are often made for this service or a promise of one piglet after farrowing (URT, 2010).

2.10.6 Inadequate extension services

Agricultural extension includes the provision of farmers with knowledge, information, experiences, and technologies needed to increase and sustain productivity and for improved well-being and livelihoods (Elifadhi, 2013). Delivery of quality agricultural extension services in Tanzania has been a centre of attention for a long time. Extension areas in Tanzania are vast resulting in extension coverage being minimal due to inadequacy of personnel and hence service delivery is insufficient. Further, Elifadhi (2013) argues that in most cases, extension personnel are not adequately equipped to provide quality service and common challenges they normally face including lack of reliable means of transport to reach the farmers, limited financial support to carrying out demonstrations and field experiments on new technologies, sub-optimal housing, lack of working facilities and low salaries. As a result, extension officers are not motivated to perform their duties well, and consequently manifest in poor performance of farmers in production **(**Elifadhili, 2013).

2.10.7 Lack of capital

Beker *et al.* (2015) point out that smallholder pig producers are forced to practice free range (extensive system) due to lack of capital due to poverty. The prevailing production

system using free-range is common although economic studies have shown that this traditional system is wasteful and unprofitable due to poor feed conversion, high mortality rates, low reproductive rates and poor final products. Under this system pigs are adversely affected by climatic factors such as low environmental temperature (Hypothermia), high environmental temperature (hyperthermia), high wind speed, wet floor, diseases and energy intake. Furthermore, Beker *et al.* (2015) argue that the traditional system is somehow unavoidable due to the fact that farmers in Tanzania lack capital to shift into the intensive system which is more expensive in terms of housing and feeds. When pigs are kept enclosed, all nutrients have to be provided by the farmer, this is one of the major challenges of intensive pig production in Tanzania and other developing countries. Generally, intensive system if properly adopted results in high production in terms of large litter size (8 – 14 piglets), high pig weight at sale (90kgs – 150kgs), good quality pork meat and quick fattening (6 – 8 months) (Beker *et al.,* 2015).

2.11 Conceptual Framework

The study's conceptual framework (Fig. 1) is a modification of the DFID sustainable livelihood framework (SLF) (DFID, 1999), which assumes that, livelihood of any community comprises capabilities, assets, and activities required for a means of living (Chambers & Conway, 1992).

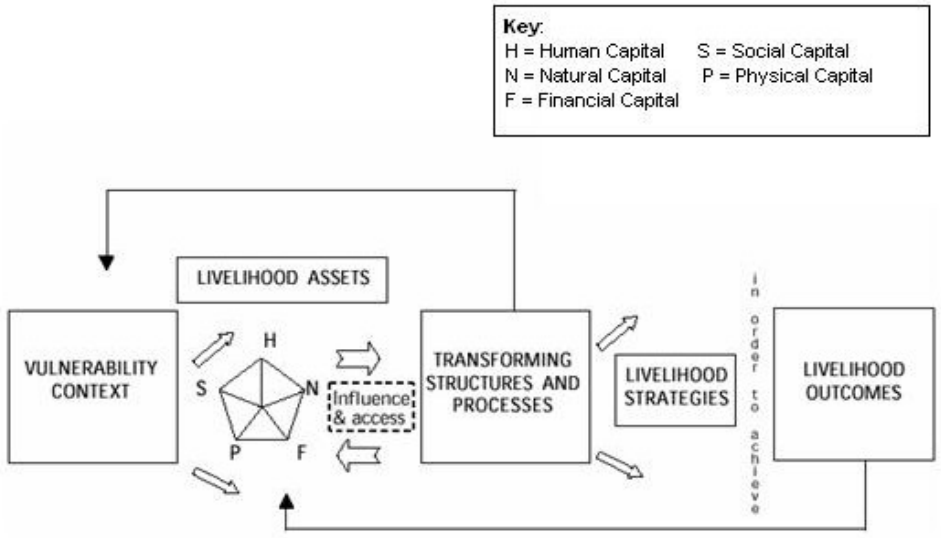


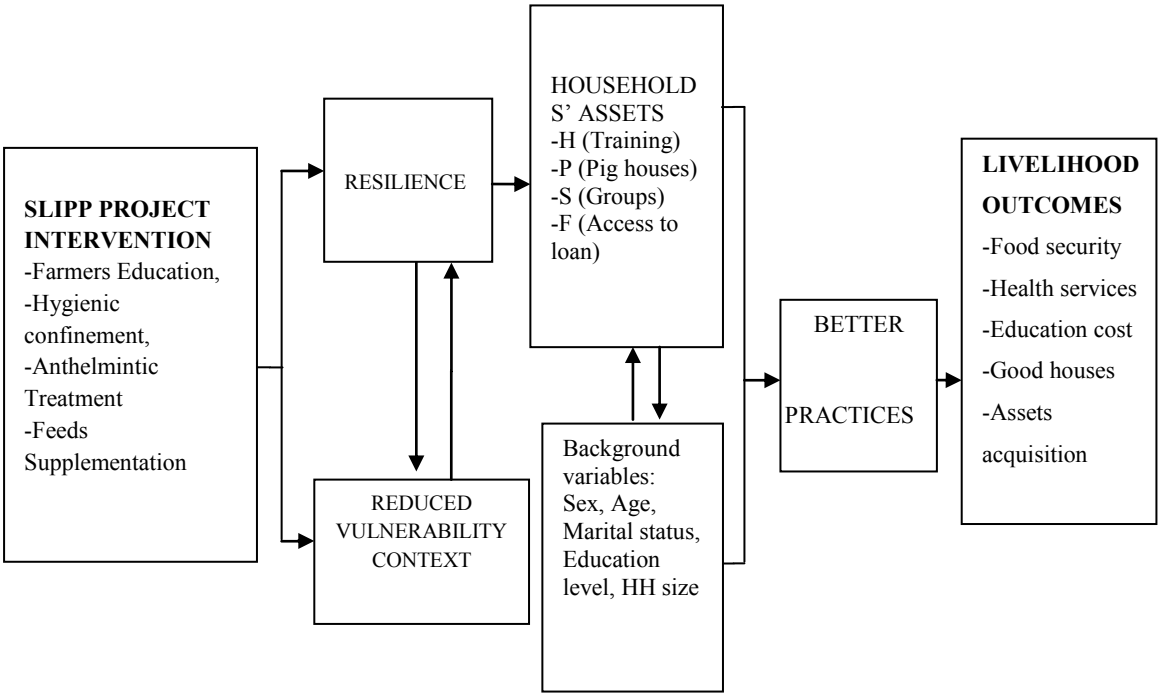
Figure 1: Sustainable livelihoods framework

(Source: DFID, 1999)

This study has borrowed some ideas from the sustainable livelihoods framework by DFID (1999) as a manifestation of project intervention. In order to adopt elements in Fig. 1, the following assumptions are made:

1. Individual households under the SLIPP projects' intervention are less vulnerable than households outside the project. This is because such households are likely to have better livelihood outcomes reflected from their income compared to non-project beneficiaries (Control group). Households in the intervention groups practises improved pig keeping based on their adoption of the intensive keeping system whereby pigs are housed throughout and provided with supplementation feeds, hence avoid diseases, and achieve quick growth.
2. Project beneficiaries/intervention group have more assets (i.e. have received training hence high human asset, are organized in groups hence more social capital, have improved pig housing hence more physical capital, are more likely to have access to microfinance's institutions (Financial capital) compared to the control group.

The role of the SLIPP project is assumed to be the equivalent of transforming structure and processes because the project objective in general terms is to securing rural livelihoods through improved smallholder pig production. Moreover, the project focuses on transformation of livelihood practices and hence enhances better livelihood outcomes. The project introduced to the intervention groups four model systems that included: knowledge/education, hygienic pig confinement, anthelmintic treatment and feed supplementation. Therefore, if all these four model systems adopted, the intervention households are expected to employ better livelihood strategies and achieve better livelihood outcomes, compared to control households. Thus, the project is guided by elements in Fig. 2 below.



H = Human Capital S = Social Capital

P = Physical Capital F = Financial Capital

Figure 2: **Conceptual framework for assessment of impact of pig keeping on farmers' livelihoods outcomes in Mbeya and Mbozi Districts, Mbeya Region, Tanzania. Adapted from DFID (1999)**

Based on the assumptions and what is presented in Fig. 2, it is important to note that the SLIPP project is assumed to be responsible for enhancing resilience of households against livelihood outcomes as explained in the vulnerability context specified by DFID (1999). By offering training on improved practices, support household in constructing pig houses, and encouraging communities to organize themselves into groups, the project is directly responsible for building social capital, physical capital, financial capital, and human capital. Furthermore, by providing anthelmintic treatment and feed supplementation, will reduce vulnerability context through diseases control and achieve quick growth. As a result, households use better strategies for better livelihood outcomes.

CHAPTER THREE

3.0 MATERIALS AND METHODS

3.1 Description of the Study Areas

The study was conducted in Mbozi and Mbeya districts, Mbeya Region. The region shares its borders with the countries of Zambia and Malawi to the South, Rukwa Region to the West; Tabora and Singida regions to the North; while Njombe Region lies to the East (URT, 1997). According to Ikegami (2011), the highest population of pigs in Tanzania is found in Mbeya Region. Therefore, the region served as the best area for the study on the contribution of pig farming to household's livelihoods outcomes. In addition, a DANIDA sponsored project (SLIPP) has been carried out in Mbeya and Mbozi districts, the project generally aimed at securing rural livelihoods through improved smallholder pig production. The projects' intervention started in June 2011 to December 2014. The study was carried out in 13 villages identified by SLIPP project, 7 villages in Mbozi District (4 intervention and 3 control villages), and 6 villages in Mbeya District (4 intervention and 2 control villages). The project introduced 4 model systems in intervention villages that include; farmers' education, hygienic pig confinement, anthelmintic treatment and feed supplementation. In the control villages the project introduced farmers education only with no follow up compared to intervention groups. Therefore, it was a good opportunity to determine the project's impact on the livelihood outcomes of rural households engaged in pig farming.

3.1.1 Mbeya District

Mbeya District is bordered to the north by Mbarali District and Chunya District, to the south by Mbeya City and Rungwe District, to the east by Njombe Region and to the west by Mbozi District. Administratively, the District has four divisions namely: Usongwe,

Isangati, Mbalizi and Tembela in which there are 25 wards and 143 villages. The district covers an area of 2 432 km^2 of which 1 898 km^2 is arable land which means that 78% of the total district land that is suitable for agriculture and animal husbandry (URT, 2010). Based on the population census report of 2012, the District's population was 305 319 (Males 143 779 and Females 161 540) (URT, 2012). The main ethnic groups found in Mbeya District are the Safwa, Malila and Nyakyusa who reside in Tembela, Isangati, Mbalizi and Usongwe Divisions respectively. Others included the Wanji, Ndali, Nyika and Kinga. Crop production is the main economic activity of the residents of the District followed by animal keeping. The crops grown include maize (*Zea mays*), bananas (*Musa paradisiacal*), paddy/rice (*Oryza sativa*), sorghum (*Sorghum bicolor*), pyrethrum (*Chrysanthemum cineranaefolium*), Irish potatoes (*Solanum tuberosum*), coffee (*Coffea spp*), sweet potatoes (*Ipomoea batatas*), sunflower (*Helianthus annuus*), sesame (*Sesamum indicum*) and groundnuts (*Arachis hypogaea*). Animals kept include sheep, goats, cattle, pigs, chicken, fish, and donkeys. The current study was conducted in six villages, that included 4 intervention villages (Iyawaya, Mshewe, Idimi, Jojo) and 2 control villages (Horongo and Santilya) (for more details see Fig. 3 and Table 1).

3.1.2 Mbozi District

Mbozi is situated to the South west of Mbeya Region; the District is bordered to the north by Chunya District, to the East by Mbeya Rural, to the South by Ileje District and to the West by Rukwa Region. The District has seven divisions namely; Igamba, Iyula, Itaka, Kamsamba, Msangano, Ndalambo and Vwawa. Based on the population census reports of 2012, the District had a population of 446 339 (Males 213 217 and Females 233 122) (URT, 2012). The main ethnic groups in Mbozi District are Nyiha, Nyamwanga, Wanda, Nyakyusa, Ndali, Lambya, Malila, and Safwa. In additional, there are a few nomadic and agro-pastoralists tribes such as the Maasai and Sukuma. The crop and livestock sectors

constitute the mainstay of the economy of the District and its population, in providing income, employment and ensuring adequate food supplies. In crop production, the main food crops grown are beans (*Phaseolus vulgaris*), maize (*Zea mays*), sorghum (*Sorghum bicolor*), sweet potatoes (*Ipomoea batatas*), Irish potatoes (*Solanum tuberosum*), paddy/rice (*Oryza sativa*), groundnuts (*Arachis hypogaea*), fruits and vegetable while cash crops grown are coffee (*Coffea spp*) and sunflower (*Helianthus annuus*). Mbozi District has six divisions, 26 wards, and 152 villages. The current study was conducted in seven villages, which included 4 intervention villages (Mbozi mission, Igale, Isansa and Itaka) and 3 control villages (Ipyana, Sambewe and Namlonga) (for more details see Fig. 3 and Table 1).

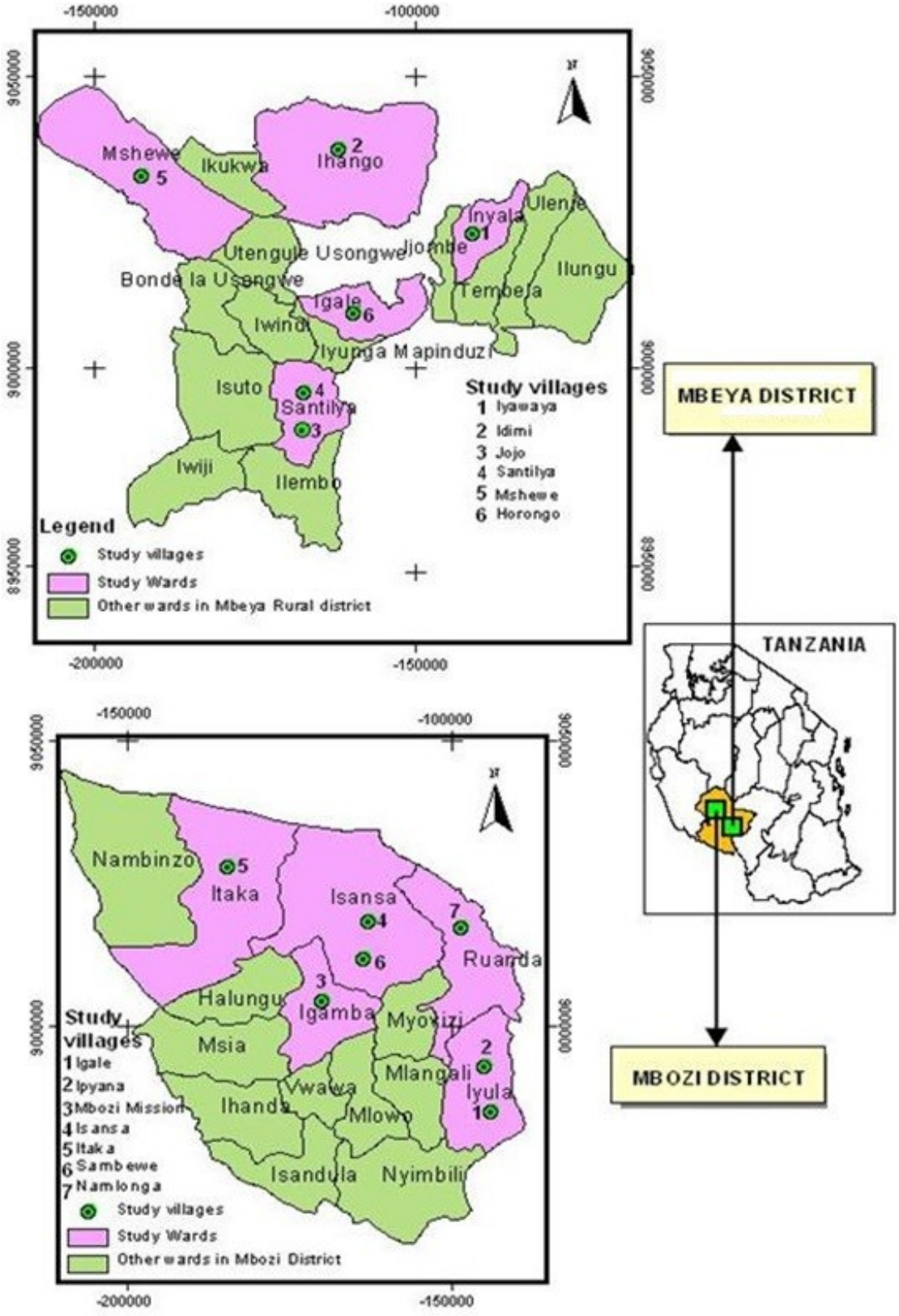


Figure 3: Map of Mbeya and Mbozi Districts showing the study villages

Source: Ministry of Land and Natural Resources (2012)

3.2 Research Design

The study's research design was a cross-sectional. According to Creswell (2003), the design allows collection of data, at one point in time. The choice of this method was based on its ability to allow data collection that meets the objectives and duration of the study. Data were collected during November 2014. According to Creswell, a cross sectional research design is cost effective and allows inclusion of participants or groups of people from whom a comparison can be made. Generally, data collected were used for simple descriptive purposes as well as determining relationships between variables.

3.3 Study Population

The study population was all households keeping pigs identified and participating in SLIPP project in Mbeya and Mbozi Districts. All smallholder farming households keeping pigs in both districts, constituted the study population. In addition, four extension officers (2 in Mbozi Districtand 2 in Mbeya District) were also involved during the in-depth interviews to supplement on the information collected. The unit of analysis was the household.

3.4 Sample Size and Sampling Techniques

The study involved 160 purposively selected (i.e. those participating in the SLIPP project) smallholder pig farmers from both districts who are actively involved in pig keeping. Purposive sampling were employed due to the fact that the SLIPP project had already identified smallholder pig keepers in both intervention and control villages in Mbozi and Mbeya districts. The purposive sampling technique is a type of non-probability sampling that is most effective when one needs to study a certain phenomenon with knowledgeable experts within. Purposive sampling may also be used with both qualitative and quantitative research techniques. The choice of the purposive sampling is fundamental to

the quality of data gathered to ensure reliability and competence of the informant (Tongco, 2007). On the other hand, a sample determination formula by Kothari (2004) was used to arrive to the sample size for this study.

$$n = \frac{z^2 pq}{d^2} \quad \text{.....} \quad (1)$$

Where:

n =sample size in the study area when population > 10 000.

z = Standard normal deviation, set at 1.96 (2.0 approximate) corresponding to the 95% confidence interval level.

p = Proportion of the target population (50% if population is not known).

q = 1.0 – p (1-50) (1-0.5) = 0.5

d = degree of accuracy desired, (set at the 95% equivalent to 0.05).

Therefore:

$$n = \frac{(2)^2(0.5)(0.5)}{(0.05)^2} = 4\ (0.25)/0.0025 = 400$$

Based on the above calculation, the sample size for this study supposed to be 400 respondents, but due to resource limitation in terms of time only 160 respondents were involved. According to Adler and Adler (1987), it is suggested that sample size should range between 30 and 60, with 30 being the minimum total respondents, but more respondents may be involved in the study when sub-populations are discernable within the setting and it is likely that members of these groups have varied perceptions, roles, statuses, problems with, or decisions about the scene.

Table 1: Study villages with their corresponding number of respondents

	Mbeya (n = 55)		Mbozi (n = 105)	
Village	**Intervention (n = 40)**	**Control (n = 15)**	**Intervention (n = 40)**	**Control (n = 65)**
Iyawaya	11	-	-	-
Idimi	15	-	-	-
Jojo	9	-	-	-
Santilya	-	7	-	-
Igale	-	-	10	-
Mbozi mission	-	-	12	-
Isansa	-	-	10	-
Itaka	-	-	8	-
Mshewe	5	-	-	-
Horongo	-	8	-	-
Ipyana	-	-	-	20
Sambewe	-	-	-	24
Namlonga	-	-	-	21

In this study purposive sampling technique and simple random sampling were used. Purposive sampling of both intervention and control groups was used to select wards, villages and key informants in both Mbozi and Mbeya districts. The random sampling was based on the project register made available to the researcher by the project officers of the villages involved. For the Focus Group Discussions (FGDs) extension officers and groups leaders were requested to organise individuals in groups of between six to twelve participants, however, these respondents were not involved in the individual interviews.

3.5 Data Type, Collection Method and Tools

Both qualitative and quantitative data were collected for this study. Primary data was collected using a pre-structured questionnaire (Appendix I) with open and close-ended questions. The primary data focused on pig keeping and farmer's livelihoods outcomes (food security, employment, income). In addition to the above, FGDs, and in-depth

interviews were used to compliment information about pig keeping and livelihoods outcomes of farmers in terms of constraints facing pig farmers, and overall productivity of the pigs kept by households. FGDs and in-depth interviews were guided by FGD/ interview guides (Appendix II and III respectively) with open-ended questions to provide more details on the subject matter. Six FGDs was conducted (i.e. 4 in intervention and 2 in control group) and three in-depth interviews were conducted (i.e. 2 for the intervention group and 1 for the control group). During the FGDs and in-depth interviews the researcher led the interview by asking questions and researcher assistants were recording the responses.

3.6 Ethical Considerations

Each individual was entitled to privacy and confidentiality both on ethical grounds and in terms of the protection of their personal data. Farmers' participation in the study was voluntary, and no farmer was coerced to participate in the study. The details of the research were explained to the farmers before the interviews. Participants were informed of their rights; assured of confidentiality and participants were informed that their identity would be kept anonymous. Animals were not used in this study and therefore the study posed no risks to animals as only human participants provided information in this study. Entrance into the different areas was pre-arranged in conjunction with the Regional Administrative Secretary in collaboration with the respective Districts' Administrative Secretary (DAS), Ward executive officer (WEO), Village executive office (VEO) and village chairperson working in the respective areas. Therefore, risks towards researchers were also minimal. Data collected, analysed and report prepared will be shared with those involved in the study (i.e. pig keepers, livestock officers, village/District and regional administration). Sharing of the report prepared will be shared with the concerned through

the Regional Administrative Secretary in order to improve pig productivity in the study areas.

3.7 Data Analysis

Quantitative data collected was analysed using the Statistical Package for Social Sciences (SPSS). SPSS was used to determine the correlation among independent and dependent variables and impacts of independent variables on the dependent variable. For objective one a binary logistic regression was used to assess the impact of interventions of pig husbandry on the livelihoods outcomes (food security, ability to pay for health services, ability to meet education cost and ability to construct a good quality house) by pig keepers in both the intervention and control villages.

The model to assess the impact of intervention was:

Logit (p_i) = log (p_i/1-p_i) = $b_0 + b_1x_1 + b_2x_2 + \ldots + b_kx_k$ (Agresti, 2002; Xie, 2000) ……. (2)

Where:

Logit (pi)= ln (odds(event), that is the natural log of the odds of an event occurring

p_i= prob (event), that is the probability that the event will occur, in this research people being food secure, ability to pay for health services, ability to pay education costs, and ability to construct quality houses

1-p_i = prob (non event), that is the probability that the event will not occur

b_0 = constant of the equation

b_1 to b_i = coefficients of the independent (predictor, response) variables

k = number of independent variables

x_1 to x_i = independent variables entered in the model, which were:

x_1= Intervention and control groups (Intervention = 1, control = 0)

x_2= Education of household head (Primary and above = 1, No formal education = 0)

x_3= Sex of household head (Male = 1, Female = 0)

x_4= Marital status (Married = 1, Not married = 0)

x_5= Age of household head (20 – 60 = 1, 61 – 80 = 0)

x_6= Household size (1 – 10 = 1, 11 – 15 = 0)

x_7= Number of pigs kept (1 – 5 = 1, 6 and above = 0)

x_8= Household farm size (1 – 5 = 1, 6 and above = 0)

x_9= Average annual income (500 000 – 5 000 000 = 0, 50 100 000 and above = 1)

x_{10}= Years/experience of keeping pigs (11 and above = 1, 1 – 10 = 0)

x_{11}= Occupation of household head (Agriculture = 1, non-farm activities = 0)

x_{12}= Location (Mbeya = 1, Mbozi = 0) [1].

In addition, paired-sample t-test was used to compare means of estimated value of assets owned within the groups (intervention and control) before and after the intervention. Also, independent – samples t-test was used to compare estimated value of assets between the groups before and after intervention independently. For objective two and three data were analysed using descriptive statistics whereby frequencies and percentages were computed. Further to the above, relationships between variables were examined using Chi-square tests. Coefficient interval (CI) is 95% with significant level (α) of 5%, therefore when p-value $p \leq 0.05$ there was enough statistical evidence to reject null hypothesis and accept the alternative hypothesis, while when $p > 0.05$, it means lack of statistically significant evidence to reject the null hypothesis or accept the alternative hypothesis

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Note: The dependent variables were four, and the model was run four times, using similar independent variables

3.8 Limitations of the Study

During Data collection it was a big challenge to get equal number of respondents in both districts (i.e. 80 respondents in Mbozi and 80 respondents in Mbeya) so as to create a fair ground on comparison purposes, therefore to address this the study obtained equal number of respondents in intervention and control groups (i.e. 80 respondents in intervention and 80 respondents in control groups). Also it was difficult to get respondents during interview as most were busy on farm activities; therefore the researcher had to wait for the farmers at their convenient time. Further, the study had aimed to determine the profit margin of pig keeping per household but, there was lack of updated information to allow calculation of profit margins (i.e. records were not kept to the desired standards).

CHAPTER FOUR

4.0 RESULTS AND DISCUSSION

4.1 Socio-demographic Characteristics of Respondents and Pig Ownership

4.1.1 Household head's age and pig ownership

Study findings as presented in Table 2 show that age of respondents in the study area ranged from 23 to 79 years. The majority of respondents, (90% and 85%) in the intervention and control group, respectively, belonged to the age group 23 to 60 years and a few, (10% and 15%) in the intervention and control group, respectively, were above 60 years. The results imply that, the majority of the household heads were in the active and productive age group range of 60 and below. It is the author's belief that in the active age, individuals are expected to be very active on the farm activities and can easily adopt agricultural innovations.

Active participation in economic activities depends on the age, therefore, performance can be influenced by age of a person. The implication of this is that the working age group (20 – 60) engages more in the business of pig farming than older people and hence represent high percentage of pig farmers in the area. The observation of this study is similar to a study reported in Angonia District, Mozambique (Pondja, 2010) on prevalence of porcine cysticercosis in developing countries, which reported that 80% of respondents ranged between 18 to 55 years old and only 20% were 56 and above years old. Also the current study is in line with the study in Bawku West District in Ghana (Akudugu *et al.,* 2012) on factors to consider on modernising agriculture, which reported that the majority (93%) of farm household heads and their partners were between 18 and 60 years of age.

Cross tabulation of respondent's age groups with numbers of pigs kept shows that age group of 20 – 60 in the intervention group had an average of 8.4 pigs per household, while

the control group had an average of 5.3 pigs per household. This observation seems to suggest that under the intensive pig keeping system adopted by intervention groups it is possible to keep more pigs compared to the free range adopted by control groups. The free range system is more vulnerable to diseases that results into high mortality rates, predators, low growth rates, lack of breeding control as mating is out of farmers control, all these contributes to poor production. However, confined pigs also need to be provided with more food and water, which is a major drawback. Generally, this observation conforms to what has been reported in literature (FAO, 2012), on pig production and health in Kenya, that 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.

Table 2: Respondent's social-demographic characteristics and average number of pigs kept per household (n = 160)

		Intervention (n = 80)			Control (n = 80)		
Characteristic		**Frequency**	**Total pigs**	**Average No of Pigs**	**Frequency**	**Total Pigs**	**Average No of Pigs**
Households' age group (years)	20 – 35	12 (15)	94	7.8	26 (32.5)	127	4.9
	36 – 60	60 (75)	509	8.5	42 (52.5)	229	5.5
	61 – 80	8 (10)	55	6.9	12 (15)	99	8.3
Household heads' sex	Male	73 (91.3)	610	8.4	67 (83.8)	374	5.6
	Female	7 (8.7)	48	6.9	13 (16.2)	81	6.2
Household heads' marital status	Married	71 (88.8)	605	8.5	63 (78.8)	359	5.7
	Not married	9 (11.2)	53	5.9	17 (21.2)	96	5.7
Household heads' education level	No education	3 (3.8)	24	8.0	8 (10)	77	9.6
	Primary educ	77 (96.2)	634	8.2	72 (90)	378	5.3
Household size	1 – 5	36 (27)	271	7.5	25 (26.3)	127	5.1
	6 – 10	29 (61.3)	264	9.1	37 (54.2)	218	6.1
	11 – 15	15 (11.7)	123	8.2	18 (19.5)	110	5.9

NB: Number in brackets indicate percent

4.1.2 Household head's sex and pig ownership

The distribution of household heads by sex in both the intervention and control villages is shown in Table 2 above. Generally, male headed households (MHHs) were the majority (91.3% and 83.7%) compared to female headed household (FHHs) (8.8% and 16.2%) in intervention and control groups respectively. The observation suggests pig keeping in the study area is mostly done by MHHs. These observations do not mean women were not involved in pig keeping in the study areas; but rather they were considered as helpers and men as the owners of the project. Women were mostly devoting much of their labour to pig production in terms of feeding, watering and cleaning the pens. The predominance of men in pig keeping as observed in this study is in agreement with the findings of Defang *et al.* (2014) who reported that pig production is dominated by men in the west region of Cameroon, but does not mean that females were not highly involved in pig production in the study area, females were usually involved as helpers or suppliers of labour in light farm operation such as feeding, watering and cleaning of the pig houses.

In addition to the above, a cross tabulation of the number of pigs kept per household, in terms of household head's sex shows that MHHs had an average of 8.4 and 5.6 pigs per household in the intervention and control groups respectively. For FHHs the average was 6.9 and 6.2 pigs per household in the intervention and control groups, respectively. Generally, observations revealed that MHHs in the intervention group had more pigs compared to their counterparts in the control group. Study results further show that there was a slight difference in number of pigs kept by FHHs in both the intervention and control groups.

4.1.3 Household heads' marital status and pig ownership

Marital status has a strong implication on pig keeping involvement and agriculture activities in general. The significance of marital status on agricultural production can be

explained in terms of the family labour supply. The findings in Table 2 show that the majority (88.8% and 78.8%) of the households' head in the intervention and control groups, respectively, were married couples. Findings on the comparison of average number of pigs kept in the intervention group shows significant difference as the average was 8.5 and 5.9 pigs for married and unmarried households' heads respectively. In the control group there was no difference as the average was 5.7 and 5.7 pigs for married and unmarried household heads respectively.

Generally, the Findings show that married household heads in the intervention group had more pigs as compared to married households in the control groups. Findings also show that married households kept more pigs than unmarried households in both intervention and control groups. Households with married couples were much more successful in pig keeping based on the fact that in the village settings women are the ones who stay at home longer compared to men. Therefore, women are the ones who feed and water pigs on a daily basis. Similar findings are reported in a study carried out in Iringa and Kilolo Districts on constraints and opportunities of small-scale pig farming, where it was reported that the majority (82.9%) of pig farming households were headed by married individuals (Karimuribo *et al.,* 2011).

4.1.4 Household head's education level and pig ownership

Education is globally believed to be an important aspect in agricultural productivity and adoption of innovations. Knowledge associated with primary education has been known to significantly improve agricultural productivity (Padhy and Jena, 2015). The findings in Table 2 show that the majority (96.2% and 90%) of household heads in the intervention and control villages respectively, had attained different levels of primary education and above, while only 3.8% and 10% in the intervention and control villages, respectively, had

no formal education. Generally, there were no significant differences in education level between the intervention and control groups. Such findings have also been reported in Iringa (Karimuribo *et al.,* 2011) on characteristic and production constraints of rural based small scale pig farming, which reported that majority (70.7%) of small-scale pig farmers in the study area, had acquired at least primary school education. This could be used as an opportunity for improvement of pig production by the extension services through training of farmers and provision of extension materials such as leaflets and handouts, which can be used to transfer knowledge to the farmers.

Study findings further show that those with primary education and above in the intervention groups had a higher number of pigs with an average of 8.2 pigs per household compared to an average of 5.3 pigs owned per household in the control group. Furthermore, findings show that household heads without formal education in the control group had a high average (9.6) of pigs compared to those with primary and above education with an average of 5.3 pigs per household. This result implies that education level of household heads in control groups had no contribution to average number of pigs kept per household. It is the study's' assumption that pig keeping in control groups was not guided by improved pig keeping knowledge therefore both groups (with and without formal education) had an equal chance to have many pigs. Ng'ang'a *et al.* (2011) pointed out that education level of the household head is one of the important demographic variables which influence the choice and good performance of a livelihood activity. Literate household heads can easily access financial capital in the form of rural credit. Also literate heads are better equipped to learn new information as well as accessing different information thereby increasing probability of improving their productivity in pig keeping in terms big litter size (more piglets) and more pig weight at sale. According to

Ajali *et al.* (2011) on social-economic and technical characteristics of pig farming, which reported that lack of education can highly contribute to poor pig production at large.

4.1.5 Household size and pig ownership

Findings in Table 2 show that, the majority (61.3% and 54.3% in intervention and control group, respectively) of the households had 6 – 10 members, and a few 27% and 26.3% in the intervention and the control villages, respectively, had 1 – 5 members. In addition, households with the size of 6 – 10 members had a high average number of pigs of 9.1 and 6.1 in intervention and control groups, respectively, compared to households with the size of 1 – 5 members which had an average of 7.5 and 5.1 in the intervention and control group respectively. Generally, households with more members had more pigs in both the intervention and control group; however the intervention group had the highest average of 9.1 and 7.5 pigs in the 6 – 10 and 1 – 5 household size categories respectively. It is the study's assumption that larger household implies availability of sufficient labour and when this labour is fully utilized then high production/productivity could be achieved. This agrees with the findings of Kimbi *et al.* (2015) on smallholder pigs' production systems in Tanzania, reported that large household size with seven to nine individuals had a significantly larger mean herd size of pig than those households consisting of six or less individuals.

4.2 Household Economic and Farm Characteristics

4.2.1 Economic activities and herd size

In the study areas, 3 economic activities were identified as shown in Table 3. These were agriculture (crop production and livestock keeping), petty businesses, and formal employment. The majority, 80% and 85% in the intervention and control groups, respectively, identified agriculture as their main economic activity and source of

livelihood. Also, 16.3% and 9.5 in both the intervention and control groups, respectively, engaged in petty business as their main economic activity, and a few 3.7% and 5.5% in the intervention and control groups, respectively, had formal employment as their main economic activity. This shows that agriculture in its broad sense (pig keeping inclusive) is the main economic activity and major source of income. The results of the present study are in agreement with those reported in Iringa and Kilolo Districts (Karimuribo *et al.,* 2011) that pig farmers also had other sources of income apart from pig keeping including crop production, keeping other livestock (mainly dairy cattle, chicken, ducks, rabbits and goats), business and a few had salaried employment.

Further to the above, a cross tabulation between economic activities and average number of pigs kept, shows that households engaged in agriculture had an average of 7.9 and 5.4 in the intervention and control group respectively (Table 3). Households with petty trade as the main economic activity had an average of 9.9 and 5.8 pigs per household in the intervention and control group respectively. Findings further show that households in both intervention and control groups with formal employment as their main economic activity had an average of 8.7 pigs per household. Generally, households in the intervention group on average kept more pigs compared to those in the control group. However, those involved in petty trade and formal employment had the highest average number of pigs kept. The findings suggest that, involvement in petty trade and formal employment provide extra income which can be used as capital to invest in pig keeping in terms of feeds, housing and drugs resulting into high production in terms of high pig number.

Table 3: Farm and economic characteristics of respondents (n=160)

Characteristic		Intervention (n=80) Frequency	Total Pigs	Average Pig No	Control (n=80) Frequency	Total Pigs	Average Pigs No
Farm size (acres)	1 – 5	41 (51.3)	326	7.9	40 (50)	229	5.7
	6 – 10	26 (32.5)	221	8.5	24 (30)	133	5.5
	≥ 11	13 (16.2)	111	8.5	16 (20)	93	5.8
Years of keeping pigs	1 – 10	21 (26.3)	143	6.8	30 (37.5)	161	5.4
	11 – 20	49 (61.2)	398	8.1	31 (38.8)	171	5.5
	≥ 21	10 (12.5)	117	11.7	19 (23.7)	123	6.5
Household head's main economic activities							
Agriculture		64 (80)	503	7.9	68 (85)	368	5.4
Petty Trade		13 (16.3)	129	9.9	6 (9.5)	35	5.8
Formal Employment		3 (3.7)	26	8.7	6 (5.5)	52	8.7

NB: Number in brackets indicate percent

4.2.2 Households' farm size and pig herd size

Farm size is among the important production factors in rural areas. A household's land contributes significantly to crop and livestock production. Findings from the study (Table 3) show that about half (51.3% and 50%) of respondents in the intervention and the control groups, respectively, had 1 – 5 acres of farm land. In addition, 32.5% and 30% in the intervention and control group respectively had 6 – 10 acres, and 16.2% and 20% in the intervention and control groups, respectively, had 11 acres or more. These findings suggest that majority of the respondents own and practice agriculture in small pieces of land (1 – 5 acres) mostly at the subsistence level and not as a commercial enterprise. Subsistence agriculture is the most common practice in rural settings as production involves family labour, use of the hand hoe and poor inputs (Mnenwa and Maliti, 2010).

In the study areas the mean number of pigs owned per household was 7, while the minimum was 1 and maximum was 28 pigs. Generally, when the farm size of respondents was cross tabulated with the number of pigs kept, results revealed that respondents in the intervention groups, had high (8.2) average number of pigs per households compared to 5.7 pigs per household in the control group. Within groups (Intervention and control) there were no big differences, when different farm size categories were cross tabulated with number of pigs kept.

4.2.3 Experience in years of keeping pigs and number of pigs kept

Households in the intervention and control groups had different years of experience in keeping pigs. Majority (61.2%) of the respondents in the intervention group had an experience of 11 - 20 years, while only 38.8% of households in the control group had such experience. Findings in Table 3 also show that, more than a quarter and a third (26.3% and 37.5%) of respondents in the intervention and control groups, respectively, had 1 – 10 years of experience. According to Table 3, a few (12.5% and 23.7%) of the respondents in the intervention and control groups, respectively, had 21 years or more of pig keeping experience. This finding suggests that respondents in the intervention group had long experience in keeping pigs compared to those in the control group, and this could be the contributing factor of accepting and benefiting more from interventions by the SLIPP project.

Study findings (Table 3) further show that households in the intervention group with long experience had a higher average number of pigs compared to the control group. Within groups, findings show that households in the intervention group with 21 and above years of experience had an average of 11.7 pigs per household, followed by those with 11 – 20 years of experience with an average of 8.1 pigs. Within the control groups households

with 21 and above years of experience had an average of 6.5 pigs per household. Again, the result suggests that there is a relationship between ones experience of keeping pigs and average number of pigs kept per household; moreover it was the study's assumption that long experience together with intervention contributed to the high number of pigs kept per household.

The above findings are in line with those of a study conducted in South Africa by Sibongiseni (2013), whereby it was reported that half of the respondents (50%) had more than 6 years of experience in farming with higher number of pigs, while 35% had 2 to 5 years of experience and 14.8% were new farmers with less than one year of farming with a low number of pigs. One assumption that could be drawn from a relatively long-term involvement in pig farming would be that the experience gained could have had an impact on production. Generally, good management of production parameters together with long experience results in a good performance that includes: frequency of farrowing per sow per annum (at least twice a year), correct feeding and housing, timely breeding of gilts and sows, routinely de-worming and vaccination spotting animals on heat, and weaning of piglets.

4.3 Households Main Reasons for Keeping Pigs

Findings from the study areas are shown in Table 4, both the intervention and the control groups identified three major reasons for keeping pigs that included: a source of income, food and manure. As shown in Table 4, of all the respondents (100%) interviewed, income was mentioned as the main reason for keeping pigs, and that pig keeping was their main source of income particularly those in the intervention groups. Secondly, 40.6% of the respondents claimed that pig keeping provided manure for crop production and a few respondents (10%) claimed that they kept pigs as a source of food. When results were

cross tabulated between the intervention and control groups there was a significant difference (X^2- value: 11.427, and p = 0.001) as the majority (53.8%) of those in the intervention claimed to use pig manure in crop production and a few (27.5%) in the control group acknowledged the use of pig manure for crop production. It is the study assumption that, the intervention group mostly use pig manure as intensive keeping system contributed to easy manure collection compared to free range system practised by the control group. Generally, farmers in the study areas preferred using pig manure compared to cattle manure. The main reason for this preference was that majority of households keep pigs compared to cattle and hence increased availability of pig manure relative to cattle. Also farmers believed that nutrients from pig manure are utilized immediately by plants as it takes less time to decompose and thus make nutrients quickly available to the plants.

Pig keeping is simple in rural areas as it requires little initial capital to start the project. Furthermore, the project gives quick returns as pigs can be ready for slaughter or sale at the age of 6 months or more. Also, pigs utilize leftover food and can resist harsh conditions compared to other livestock spices such as cattle. The current study is thus in line with the study done in Mbozi and Mbeya districts (Kamaghe *et al.,* 2014) where it was reported that of the 98 respondents, 40 (81.6%) and 45 (93.6%) in Mbeya and Mbozi districts, respectively, claimed pig keeping as their main source of household income. Also, of the 98 respondents, 42 (87.5%) and 47 (95.9%) in Mbeya and Mbozi districts, respectively, reported that they used pig manure to improve soil fertility for crop production. Observations from the current study are also similar to Petrus *et al.* (2011) study where it was reported that farmers reared pigs for both income generation and home consumption.

Table 4: Households reasons for keeping pigs (n = 160)

Reason	Intervention (n=80)	Control (n=80)	X^2- value	p- value
Income	80 (100)	80 (100)	-	-
Food	4 (5)	12 (15)	4.444	0.062**
Manure	43 (53.8)	22 (27.5)	11.427	0.001**

NB: Number in brackets indicate percent

4.4 Contribution of Pig Keeping to the Farming Households' Livelihood Outcomes

4.4.1 Factors influencing the surveyed households' food security and their ability to meet costs for health, education and construction of a good house

This section examines in detail household livelihood outcomes using binary logistic regression models. The models are based on the hypothesis that some farm characteristics, household characteristics, average annual income and occupation may have influenced households' livelihood outcomes. A total of twelve independent/predictor variables were used against four dependent variables (livelihood outcomes). Independent variable used include; education of household head, sex of household head, being in intervention or control group, household head's marital status, household head's age, household size, years of keeping pigs (i.e. experience), total number of pig kept per household, household farm size, average annual income, household head's main occupation, and household's district of residence (location). All these independent/predictor variables were included in the four separate modets that were used to determine their contribution to the four livelihood outcomes (food security, ability to pay for health services, ability to meet households' education costs, and construction of a good house) considered by the study.

To address the above, binary logistic regression analysis was used. The models' R^2 has been presented showing Cox & Snell R^2 and Nagelkerke R^2, as an important output of the

binary logistic regression model. According to Garson (2008) The Cox-Snell R^2 and Nagelkerke R^2 are attempts to provide a logistic analogy to R^2 in Ordinary Least Square (OLS) regression; hence are called pseudo R^2. Nagelkerke R^2 is a modification of Cox-Snell R^2 to assure that Cox-Snell R^2 varies from zero to one, as does R^2 in OLS regression. That is, Nagelkerke's R^2 divides Cox and Snell's R^2 by its maximum in order to achieve a measure that ranges from 0 to 1. Therefore, Nagelkerke's R^2 will normally be higher than the Cox and Snell measure but will tend to run lower than the corresponding OLS R^2. If Cox-Snell R^2 is not modified, its maximum value is usually less than 1, making it difficult to interpret. Garson (2008) notes that Nagelkerke R^2 is normally higher than Cox-Snell R^2 and is the most-reported of the pseudo R^2 estimates.

4.4.1.1 Food security

Binary logistic regression results for the food security outcomes are shown in Table 5, the model's R^2 was 0.360 (Cox & Snell R^2), and 0.480 (Negelkerke R^2). Therefore, based on the Nagelkerke R^2 of 0.480, this means that the independent variables entered in the model explained 48% of the variance in the dependent variable. Among the twelve independent variables regressed against food security only two (intervention/control, and location) were positively and significantly ($p \leq 0.05$) associated with the surveyed household's food security. However, households with farm size of 1 – 5 acres was slightly significant at 10% ($p = 0.067$). This implies that households in the intervention group and those in Mbeya district were likely to be food secure.

Generally, the above observation seems to suggest that households in the intervention groups were presumably doing better in pig farming and were able to earn more income which then contributed to the achievement of food security. Farmers in the intervention group received training from the SLIPP project on how improved pig keeping can

contribute to a higher productivity (i.e. hire number of pigs). Farmers get income from the sale of pigs and use the same income to buy food and/or invest in crop production and achieve food security. This finding is similar to the finding by Sibongiseni (2013), in South Africa whereby it was reported that training provided to pig farmers focused on breeding management skills that allowed farmers to know when to breed gilts and sows for better productivity. That means that trained farmers increased production and made more profit from selling more piglets and pigs than untrained farmers. Training of pig farmers was therefore better at increasing farm productivity and households' food security.

Table 5: Binary logistic regression analysis results for households' food security

						95.0% C.I. for EXP(B)	
Variable	**B**	**S.E.**	**Wald**	**Sig.**	**Exp(B)**	**Lower**	**Upper**
Intervention & Control	**1.440**	**0.503**	**8.190**	**0.004****	**4.219**	**1.574**	**11.309**
Education of household head	0-.744	1.048	0.503	0.478	.475	0.061	3.710
Sex of household head	1.112	1.119	0.987	0.320	3.039	0.339	27.224
Marital status of household head	0-.518	1.013	0.262	0.609	.595	0.082	4.340
Age of household head	0.000	0.018	0.000	0.985	1.000	0.966	1.035
Household size	-0.052	0.096	0.290	0.590	.949	0.786	1.147
Years of keeping pigs	0.005	0.028	0.028	0.867	1.005	0.951	1.062
Pig number kept per household	-0.053	0.051	1.079	0.299	.948	0.858	1.048
Household farm size	-0.185	0.101	3.350	0.067*	.831	0.682	1.013
Households' average annual income	0.000	0.000	1.866	0.172	1.000	1.000	1.000
Household head Occupation	-0.512	0.597	0.737	0.391	.599	0.186	1.929
District	**2.331**	**0.531**	**19.270**	**0.000*****	**10.288**	**3.634**	**29.131**

NB: B: Coefficient, SE: Standard error, Wald: Wald test statistics, Sig: degree of significance (p-value), Exp (B): Odds ratio, *: sig at p = 0.1, **: sig at p = 0.05, *: sig at p = 0.001**

According to Table 5 households in Mbeya District performed better in pig farming than those in Mbozi District in terms of association between pig farming and household food security. One of the reasons could be the fact that the District is close to the Mbeya city which has a high population and a big number of bars, restaurants, and food vendors selling roasted pork, popularly known as *"kitimoto"* compared to Vwawa town in Mbozi District. In addition, Mbeya city has a good number of tourist hotels, motels, lodges and hostels which also contribute significantly to high pork demand compared to Mbozi District. Geographically, Mbeya District is close to Mbeya City and therefore it provides a better opportunity than Mbozi District for businessmen to reduce transaction costs when exporting live pigs to Morogoro and Dar es Salaam which are important markets.

The current study is similar to a previous study conducted in the Southern highlands by Wilson (2013) who reported that pork demand is increasing in urban and peri-urban areas due to the increasing customer's preference for its delicacy. Also the current research is similar to that by Green (2013) in Mahenge, Morogoro, where it was reported that the daily sale of pork meat and the evolution of a *"kitimoto"* meat sector is a very recent phenomenon, originating in the urban fashion for fried pork, but made possible by a combination of technology and changes in the disposable income of a proportion of consumers in what is less in rural setting than a new 'urban' periphery. It may also be because of the availability of electricity and refrigerators for pork storage in the District centre which makes innovations like the "*kitimoto"* trade viable. This combination of electricity and technology means that "*kitimoto*" sellers can sell daily and are more capable of dealing with unsold volumes of pork.

4.4.1.2 Ability to pay for health services

The binary logistic regression results for the ability to pay for health services outcomes are shown in Table 6, the model's R^2 was 0.509 (Cox & Snell R^2), and 0.682 (Negelkerke R^2),

therefore, by considering Negelkerke R^2, it means that the independent variables entered in the model explained 68.2% of variance in the dependent variable. Based on the analysis three variables had statistically significant effect on household's ability to pay for health services, these were significant at the 0.001 and 0.05 level. The significant Variables include; being in the intervention group (Wald of 25.199 and p = 0.000), household farm size (Wald of 5.663 and p = of 0.017) and being in Mbeya district (Wald: 16.114 and p = 0.000). Farmers in the intervention group received training from the SLIPP project on improved pig keeping that resulted to high production (i.e. high pig number), which then through the use of pig sales income, they were able to pay for health services. The current research is similar to a previous study by FAO (2011) whereby it was reported that training on improved pig husbandry enabled farmers to raise pigs successfully and improved production hence earned additional income, and the additional income was used to invest in farm assets, pay for school fees and medical treatment.

The binary logistic regression results also show that farm size (1 – 5 acres) was associated with ability to pay for health services. It also means that due to the small farm size farmers concentrate on pig farming as a way of ensuring they earn enough for a living. It is the study's assumption that small farm size (1 – 5 acres) provides farmers with enough time to work on their fields as well as on pig keeping, compared to big farm size (6 – 10 acres). Enough time for pig keeping resulted to high production that increases farmers' income which in turn contributed to the ability to pay for health services. Further, the results show that location of pig farmers (Mbeya District) associate with ability to pay for the health services, compared to farmers in Mbozi District. As explained earlier, one of the reasons could be the fact that the district is close to Mbeya City which has a high population (potential consumers) and a big number of bars, restaurants, and food vendors selling roast

pork, popularly known as *"kitimoto"* all these increased farmers income that contributed to their ability to pay for health services.

Table 6: Binary logistic regression analysis results for households' ability to pay for health services

						95.0% C.I. for EXP(B)	
Variable	**B**	**S.E.**	**Wald**	**Sig.**	**Exp(B)**	**Lower**	**Upper**
Intervention & Control	**3.124**	**0.622**	**25.199**	**0.000*** **	**22.746**	**6.716**	**77.035**
Education of household head	-1.973	1.412	1.951	0.162	0.139	0.009	2.215
Sex of household head	0.064	1.357	0.002	0.962	1.066	0.075	15.250
Marital status of household head	0.248	1.154	0.046	0.830	1.281	0.133	12.300
Age of household head	0.011	0.021	0.270	0.604	1.011	0.970	1.054
Household size	0.077	0.123	0.392	0.531	1.080	0.849	1.375
Years of keeping pigs	0.013	0.035	0.147	0.702	1.014	0.946	1.086
Pig number kept per household	-0.030	0.064	0.225	0.635	0.970	0.856	1.099
Household farm size	**0.259**	**0.109**	**5.663**	**0.017****	**1.295**	**1.047**	**1.602**
Household average annual income	0.000	0.000	0.398	0.528	1.000	1.000	1.000
Occupation of household head	0.095	0.690	0.019	0.890	1.100	0.284	4.253
District	**3.186**	**0.794**	**16.114**	**0.000*** **	**24.196**	**5.107**	**114.649**

NB: B: Coefficient, SE: Standard error, Wald: Wald test statistics, Sig: degree of significance (p-value), Exp (B): Odds ratio, *: sig at p = 0.1, **: sig at p = 0.05, *: sig at p = 0.001**

4.4.1.3 Ability to meet education cost

Results from the binary logistic regression (Table 7) show the households ability to meet education costs, the model's R^2 was 0.619 (Cox and Snell R^2), and 0.844 (Negelkerke R^2), therefore, by considering Negelkerke R^2, it means that the independent variables entered in the model explained 84.4% of variance in the dependent variable. Based on the analysis five independent variables were statistically significant and hence associated with the household's ability to meet education cost. Variables associated with household's ability

to meet education cost include: being in the intervention group (Wald of 15.491 and p = 0.000), household farm size (Wald of 4.233 and p = of 0.040), being in Mbeya District (Wald: 8.835 and p = 0.003), household size (Wald of 6.972 and p = 0.008) and household average annual income (Wald of 7.750 and p = 0.005). Household size (1 – 10 members) associated with the ability to meet education cost of the pig household members. This result suggests that a larger household implies availability of sufficient labour and when this labour is fully utilized, high production will be achieved. High production results in to raising/increasing the farmers' income thus contributing to the ability to pay for education cost of the household members. These results are in line with a study by Adikwu, (2013), who reported that larger household size (≥10) tends to work hard and produce more in agriculture so as to cope with the food and financial needs of the family members' education costs inclusive.

Further, the results show that a household average annual income (≥ 50 100 000) associated with the ability to pay for education cost. Households' average annual income is considered as a proxy indicator in achieving livelihood outcomes with ability to pay for education cost inclusive. These results imply that households with high average annual incomes were in a better position to afford education cost for their family members. Also a study in western Kenya by Dewey *et al.* (2011) reported that smallholder pig farming is an important livelihood source in many households in rural Western Kenya. The pigs are sold and contribute highly to the family average annual income which can in turn be used to buy food, pay for school fees and pay for medical bills.

Table 7: Binary logistic regression analysis results for households' ability to meet education cost

						95.0% C.I. for EXP(B)	
Variable	**B**	**S.E.**	**Wald**	**Sig.**	**Exp(B)**	**Lower**	**Upper**
Intervention & Control	**4.265**	**1.084**	**15.491**	**0.000*** **	**71.189**	**8.510**	**595.505**
Education of household head	-2.577	2.663	0.937	0.333	0.076	0.000	14.049
Sex of household head	0.492	1.766	0.078	0.780	1.636	0.051	52.145
Marital status of household head	-0.241	1.346	0.032	0.858	0.786	0.056	10.987
Age of household head	0.000	0.028	0.000	0.994	1.000	0.947	1.056
Household size	**0.748**	**0.283**	**6.972**	**0.008****	**2.113**	**1.213**	**3.681**
Years of keeping pigs	0.017	0.046	0.132	0.716	1.017	0.930	1.112
Pig number kept per household	0.015	0.111	0.019	0.890	1.015	0.817	1.262
Household farm size	**0.299**	**0.145**	**4.233**	**0.040****	**1.348**	**1.014**	**1.792**
Average annual income	**0.000**	**0.000**	**7.750**	**0.005****	**1.000**	**1.000**	**1.000**
Occupation of household head	-1.757	1.295	1.840	0.175	0.173	0.014	2.185
District	**3.829**	**1.288**	**8.835**	**0.003****	**45.999**	**3.684**	**574.297**

NB: B: Coefficient, SE: Standard error, Wald: Wald test statistics, Sig: degree of significance (p-value), Exp (B): Odds ratio, *: sig at p = 0.1, **: sig at p = 0.05, *: sig at p = 0.001**

4.4.1.4 Ability to construct good quality houses

Results from the binary logistic regression (Table 8) show households ability to construct/own a good quality houses. The model's R^2 was 0.496 (Cox & Snell R^2), and 0.665 (Negelkerke R^2), therefore, by considering Negelkerke R^2, it means that the independent variables entered in the model explained 66.5% of variance in the dependent variable. Based on the analysis six independent variables were statistically and significantly associated with the surveyed household's ability to construct/own a good quality house. Variables associated with household's ability to construct/own good quality house include; location (i.e. being in Mbeya) (Wald of 3.870, p = 0.049), (being in the intervention group) (Wald of 28.275, p = 0.000), (households' sex, male headed

households) (Wald of 8.083, p = 0.004), (Marital status of household heads/married) (Wald of 9.310, p = 0.002), years of keeping pigs (Wald of 5.009, p = 0.025), and household farm size (those with 1 – 5 acres) (Wald of 5.497, p = 0.019).

Based on the logistic regression results male headed households were more likely to construct good quality houses in the study areas. These results suggest that, men are stronger economically compared to women, in terms of resources ownership and decision making. Moreover, most African cultures favour men over women in resources ownership/inheritance such as land/farm, animals, house and any other asset in the family. These resources are the main factors of production that support men to perform better in production compared to women who are mostly considered as assistants in the family and do not posses any productive assets, and as a result male headed households afford constructing good quality houses compared to female headed households. The current study is in line with a study on women, marriage and assets inheritance in Uganda by Doss (2010) who reported that the African culture favours men over women in assets inheritance/ownership including land and this situation enables men's' better performance in terms of acquisition of assets and construction of good quality house among others.

The binary logistic regression results also show that households with married couples being better off in terms of ability to construct good quality house. This result suggests that married household heads perform better in pig keeping compared to the unmarried ones. In the study areas, while men engaged in other economic activities away from homes women are the ones available at home and devoting their time in pig keeping. It is the study's assumption that, other economic activities done by men normally provide capital to the pig project in terms of feeds, treatment and housing. Therefore, combining the efforts by men and women contributes to high production that enables producers to generate additional income which in turn helps in achieving construction of good quality house.

Long experience (≥ 11 years) of keeping pigs had a significant impact on ability to construct good quality houses. It is the study's assumption that, long experience in pig keeping contributes to better pig keeping practices that result in to high production, thus high income which enabled farmers in construction of good quality houses. These results are contrary to the findings of Antwi and Seahlodi (2011) who reported that more than half (51.5%) of the successful farmers in South Africa (Gauteng province) have been in the pig farming business for less than five years.

Table 8: Binary logistic regression analysis results for households' ability construct good quality houses

Variable						95.0% C.I. for EXP(B)	
	B	S.E.	Wald	Sig.	Exp(B)	Lower	Upper
Intervention & Control	**3.587**	**0.675**	**28.275**	**0.000*** **	**36.118**	**9.629**	**135.487**
Education of household head	-0.668	1.140	0.343	0.558	0.513	.055	4.793
Sex of household head	**3.836**	**1.349**	**8.083**	**0.004****	**46.354**	**3.292**	**652.596**
Marital status of household head	**-3.968**	**1.301**	**9.310**	**0.002****	**0.019**	**.001**	**.242**
Age of household head	-0.008	0.022	0.136	0.712	0.992	.950	1.035
Household size	0.004	0.127	0.001	0.973	1.004	.783	1.288
Years of keeping pigs/experience	**0.087**	**0.039**	**5.009**	**0.025****	**1.091**	**1.011**	**1.176**
Pig number kept per household	0.004	0.065	0.004	0.947	1.004	.884	1.141
Household farm size	**0.221**	**0.094**	**5.497**	**0.019****	**1.247**	**1.037**	**1.500**
Average annual income	0.000	0.000	0.306	0.580	1.000	1.000	1.000
Occupation of household head	0.337	0.710	0.225	0.635	1.400	.349	5.626
District	**1.245**	**0.633**	**3.870**	**0.049****	**3.472**	**1.005**	**11.997**

NB: B: Coefficient, SE: Standard error, Wald: Wald test statistics, Sig: degree of significance (p-value), Exp (B): Odds ratio, x: *: sig at p = 0.1, **: sig at p = 0.05, *: sig at p = 0.001**

4.4.2 The contribution of the SLIPP intervention to surveyed household livelihood outcomes

Generally, the binary logistic regression results have shown that, the intervention contributed significantly to household's ability to achieve the identified livelihood outcomes in both districts (Mbeya and Mbozi). Further to the above, farm households in Mbeya District were better off compared to those in Mbozi District in achieving livelihood outcomes. Farm size also contributed significantly to the most of livelihood outcomes (ability to pay health services, ability to pay education cost, and ownership of good houses). The important contribution of pig keeping in rural livelihood outcomes was echoed by FGD participants and the respondents alike as shown in the quotes below:

> We benefit from pig keeping as we can afford to pay for the school fees and other school contributions for our children. In addition, we have managed to build good houses from income earned from pig enterprise. (A male participant, Namlonga village Mbozi, 19/ 11/ 2014).

> Another respondent during the interview claimed to have constructed a modern toilet from the income earned from pig's sales. (A 42 years old male respondent, at Mshewe village Mbeya, 23/ 11/ 2014).

> From the pig project income after the intervention, I have managed to buy a generator (for power generation), television set, and Startimes and Azam decoder, the above are used to show movies and football matches. My hall can accommodate 50 people. I normally show several live local and international football matches and charge Tshs 500 per person per match. This has been a good source of income especially when live football matches are in progress such as the Tanzania Vodacom Premier League, the Africa Cup of Nations, and the English Premier

> League (EPL). In our village a good number of villagers are football fans and love watching live matches. Income from the pig project has also enabled me to purchase a pool table from which I also earn income, I normally charge Tshs 200 per game". Furthermore, with my regular income I can afford to actively participate in our rotating saving and credit association (ROSCA) (A 54 year's old male respondent, Iyawaya village Mbeya District, 01/ 11/ 2014).

The observations presented above conform to what was reported by Mutua *et al*. (2011) in a study covering Busia and Kakamega Districts, Western Kenya where it was found that, farmers sold pigs so as to purchase family food, pay school fees, and footing medical bills. Other reasons given included to get money to build houses, buy cattle, buy farm inputs, and cover pig feed costs. Again, a study by Green (2013) has also revealed that pig keeping is a source of capital income, which can be realized at times of the year when major expenses are expected. In addition, it can also be used as a way to put aside small amounts of money which alternatively might evaporate. Pig farming remains a viable sector and with proper management, presents an opportunity for farmers to boost their incomes through increased production. Due to the lack of capital among smallholder farmers pig keeping can be a remedy to the problem as the sector relies on little capital investment and family labour as key inputs.

4.4.3 Hypotheses testing

Based on the results from binary logistic regression, the first null hypothesis that pig production does not differ between male headed households and female headed households is rejected. Also, the second null hypothesis that achievement of livelihood outcomes does not differ between households involved in the project and those not involved is rejected. Generally, the results have

shown that male headed and the intervention households are better off in achievement of livelihood outcomes compared to female headed and the control households.

4.4.4 Estimated value of assets owned between and within the groups before and after the intervention

The study listed household's assets with their estimated value in both the intervention and control groups, for the periods before and after the intervention. In order to be able to make comparison for the two groups, SLIPP project time table (before and after) was used for both the intervention and control group. The comparison of estimated value of assets was done, between and within the two groups (intervention and control). Before the tests were done (Independent-samples t-test and Paired-samples t-test), data were first transformed by natural log to make them fairly normal, as they were not normally distributed. Generally, the study found out that pig keepers benefitted a lot from pig farming and especially those in the SLIPP project (Intervention group).

4.4.4.1 Assets value between the intervention and control groups before the SLIPP intervention

Estimated value of assets owned by the intervention and control groups, before intervention was compared. From the results of the levenes' test for equality of the variance displayed in the first two columns of Table 9, the second line was selected because the probability shown in levenes' test (first line) was 0.000 which was significant that violate/disobey the assumption of equal variance. Otherwise, if the value of probability was not significant, then the first line would have been selected. Results from the second line show a t-value = 1.78 with 94.72 degrees of freedom and a probability ($p = 0.079$) which was only slightly significant ($p = 0.1$). These results imply that there was only a slight significant difference between estimated value of assets owned by

intervention and control groups before interventions introduction in the study areas. These results suggest that before intervention the two groups (intervention and control) show some slight significant difference (p = 0.079) in terms of the value of assets owned.

Table 9: Independent samples t-test of owned assets values between the intervention and control groups before the intervention (n = 160)

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	T	Df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Estimated total value of assets owned before intervention	Equal variances assumed	17.82	.000	-1.78	158	.078	-984375.00	553972.68	-2078522.05	109772.05
	Equal variances not assumed			-1.78	94.72	.079	-984375.00	553972.68	-2084192.24	115442.24

4.4.4.2 Assets value between the intervention and control groups after the intervention

Estimated value of assets owned by the intervention and control groups after the intervention was compared. From the results of the levenes' test for equality of the variance displayed in the first two columns of Table 10, the second line was selected because the probability shown in levenes' test (first line) was 0.016 which was significant that violate/disobey the assumption of equal variance. Otherwise, if the value of probability was not significant, then the first line would have been selected. Results from the second line show a t-value = 1.98 with 96.47 degrees of freedom and a probability (p = 0.050) which was statistically significant. These results imply that there was a

significant difference between the estimated value of assets owned between the intervention and the control groups after introduction of the interventions. These results suggest that, the intervention group had assets with a higher estimated value compared to the control group. It is the study's assumption that, the intervention group had assets of higher value as a result of the high income from better pig keeping practises after adoption of introduced intervention by SLIPP project.

Table 10: Independent samples t-test of assets value owned between the intervention and control groups after the intervention (n = 160)

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	T	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Estimated total value of assets owned after intervention	Equal variances assumed	5.93	.016	1.98	158	.049	5702325.00	2875367.30	23209.83	1.138E7
	Equal variances not assumed			1.98	96.47	.050	5702325.00	2875367.30	-4879.87	1.141E7

4.4.4.3 Value of Assets owned by the intervention group before and after the interventions

Comparing the estimated value of assets owned by the intervention groups independently, before and after the intervention, results (Table 11) show that the means was 1.13E7 and 2.03E6 (Appendix 4) before and after the intervention, respectively. The difference between the two means was statistically significant (p = 0.001 and t was 3.556). These results suggest that the intervention group in both districts had assets with a high estimated

value after the intervention compared to before the intervention. The present study is similar to a study conducted in Kamuli, Uganda by Ampaire (2011) where it was reported that adoption of improved pig keeping husbandry and other small livestock has been established purposely for acquisition of assets and as a promising pathway out of poverty for rural farmers in developing countries.

Table 11: Paired samples t-test of asserts value owned by the intervention group before and after the intervention (n = 80)

	Paired Differences							
				95% Confidence Interval of the Difference				Sig. (2-tailed)
	Mean	Std. Deviation	Std. Error Mean	Lower	Upper	t	df	
Estimated total value of assets owned before and after the intervention	9.300E6	2.339E7	2615395.32	4094510.84	1.451E7	3.556	79	.001

4.4.3.4 Value of assets owned by the control group before and after the intervention

Again, comparing the estimated value of assets owned within the control groups independently in both districts before and after the intervention, results (Table 12) show that the means were 3.02E6 and 5.63E6 (see Appendix 5) before and after the intervention, respectively. The difference between the two means was statistically significant ($p = 0.000$ and t was 3.84). These results suggest that the control groups had assets with a high estimated value after the period of the intervention compared to before the period of intervention. It is the study's' assumptions that, with time, pig keepers in control groups had changed positively from poor keeping management systems to somehow improved keeping system which could be partly contributed by education on improved pig keeping

husbandry provided by SLIPP project. Furthermore, observation from the study suggests that, the positive changes by control group could have been also contributed by spill-over effect from the intervention group by the control groups adopted some improved management systems skills (through coping) from their counterparts (the intervention groups), this has been witnessed by some of pig keepers in the control group by started confining their pigs and supplementing their feeds.

Table 12: Paired samples t-test of asserts value owned by the control group before and after the intervention (n = 80)

	Paired Differences							
				95% Confidence Interval of the Difference				
	Mean	Std. Deviation	Std. Error Mean	Lower	Upper	T	df	Sig. (2-tailed)
Estimated total value of assets owned before and after intervention	2.614E6	6088827.75	680751.64	1258622.76	3968627.24	3.84	79	.000

4.4.4 The list of assets owned before and after the intervention

When individual assets owned before intervention were cross tabulated between intervention and control villages, (Table 13) it was revealed that there were no significant differences between intervention and control group in all assets listed except for one. More than half (58.8%) of the respondents in intervention group had houses with a corrugated iron sheet roof, compared to 40% in the control group. Results were also supported by the level of significance with x^2 value of 5.626 and $p = 0.018$.

Table 13: Assets owned before the intervention (n = 160)

Asset	Intervention (n = 80)	Control (n = 80)	X^2 value	p- value
Farm/land	67 (83.8)	60 (75)	1.871	0.171
Bicycle	25 (31.3)	27 (33.8)	0.114	0.736
Motorcycle *(Bodaboda)*	2 (2.5)	4 (5)	0.693	0.405
Car	1 (1.3)	2 (2.5)	0.340	0.560
Television	4 (5)	3 (3.8)	0.149	0.699
Radio	44 (55)	38 (47.5)	0.901	0.343
Cattle/goat/poultry	33 (41.3)	32 (40)	0.026	0.872
Furniture	19 (23.8)	15 (18.8)	0.598	0.440
House with corrugated iron sheet roof	47 (58.8)	32 (40)	5.626	0.018**

NB: Number in brackets indicate percent, *: sig at p = 0.1, **: sig at p = 0.05, ***: sig at p = 0.001

Again, when assets owned after intervention were cross tabulated between intervention and control group as shown in Table 14 it was revealed that 77.5% and 25% of respondents in intervention and control group respectively own furniture, this shows that the majority of respondents in the intervention group owned furniture compared with those in the control group. Of the 80 respondents, 88.8% and 41.3% in the intervention and control group, respectively, reported that their houses were roofed with corrugated iron sheets. Further to this, 36.3 and 11.3 in intervention and control group, respectively, indicated that they owned a motorcycle, which is also an indicator, that pig keepers in intervention group own more motorcycles compared to the control group.

Further to the above, the study findings show that only a few, 21.3% and 7.5%, of the respondents in intervention and control group, respectively, indicated that they possessed a television set. Findings also show that having television sets in the homes was related to having electricity. Study results showed that, 65% and 26.3 of the respondents in intervention and control group, respectively, reported that they had modern toilets. These findings further show that, majority (65%) of the respondents with modern toilets is in the

intervention group, compared to a few (26.3%) of the respondents in the control group. findings from this study further show that most, (78.8%) and a few (11.3%) households in the intervention and control group, respectively, confined their pigs in improved pig houses, which is a good indicator of adoption of the among SLIPP project new model systems (hygienic pig confinement).

Study results (Table 14) also show that, majority (96.3% and 88.7%) of the households in the intervention and control group respectively own land; there was also a slight significant differences ($p = 0.072$) of land ownership whereby slightly more households in the intervention group own land compared to the control group. Again, ownership of bicycles was slightly significant ($p = 0.081$) different between the groups meaning that, slightly more households in the intervention group own bicycles compared to the control group. Further, to the above findings, the findings (Table 14) show that ownership of tricycle were slightly significant ($p = 0.080$) whereby the three tricycle identified in the study were owned by one pig keeper in the control group. The particular pig keeper used the three tricycles for income generation whereby other farmers/villagers hire the same to carry luggage including farm produce from one place to another.

Table 14: Assets ownership after the intervention (n = 160)

Asset	Intervention (n = 80)	Control (n = 80)	X^2 value	p- value
Farm/Land	77 (96.3)	71 (88.7)	3.243	0.072
Generator	1 (1.3)	-	1.006	0.316
Milling machine	2 (2.5)	1 (1.3)	0.340	0.560
Furniture	62 (77.5)	20 (25)	44.128	0.000***
House with corrugated iron sheet roof	71 (88.8)	33 (41.3)	39.670	0.000***
Car	4 (5)	3 (3.8)	0.149	0.699
Motorcycle (*Bodaboda*)	29 (36.3)	9 (11.3)	13.805	0.000***
Sewing machine	3 (3.8)	1 (1.3)	1.026	0.311
Television	17 (21.3)	6 (7.5)	6.144	0.031***
Radio	58 (72.5)	54 (67.5)	0.476	0.490
Bicycle	42 (52.5)	31 (38.7)	3.048	0.081
Bajaj/Tricycle	-	3 (3.8)	3.057	0.080
Modern toilet	52 (65)	21 (26.3)	24.210	0.000***
Pig house	63 (78.8)	9 (11.3)	73.636	0.000***
Cattle/goat/poultry	61 (76.3)	54 (67.5)	1.515	0.218

NB: Number in brackets indicate percent, *: sig at p = 0.1, **: sig at p = 0.05, *: sig at p = 0.001**

4.5 Factors Affecting Smallholder Pig Production

The respondents in the study areas (intervention and control groups) identified 9 factors affecting smallholder pig production as presented in Table 15. Factors identified included, disease outbreaks, lack of capital, lack of improved breeding boars, poor access to livestock extension services, seasonal availability of pig feeds (maize bran and cotton seedcake), poor market and low selling price, poor availability of pig drugs, minerals and vitamins, cancellation of SLIPP project support and poor knowledge on improved pig keeping. Majority (72.5%) and (82.5%) of the respondents in the intervention and control groups, respectively, claimed diseases as the main factor, although the control group seemed to be more affected. The control group may have been more affected by diseases, due to the fact that they mostly practised free range management system which may make pigs more vulnerable to diseases compared to the intensive management system adopted

by those in the intervention group. Study findings further show that the majority (60%) of the respondents in intervention groups claimed seasonal availability of pig feeds as their second major adverse factor, compared to a few (22.5%) of the respondents in control group. These findings imply that it was a challenge to find/buy feeds for pigs when they are confined rather than letting the pigs find their own food. The present study concurs with a study conducted in Namibia by Petrus *et al.* (2011) where it was reported that, smallholder pig production in developing countries is mostly affected by: lack of capital and no access to micro-finance or credit, lack of supporting services from extension officers, poor market and low selling prices and poor expertise resulting in poor management on improved pig keeping.

Table 15: Factors affecting smallholder pig production (n = 160)

Factor	Intervention (n=80)	Control (n=80)	X^2-value	p- value
Diseases outbreak	58 (72.5)	66 (82.5)	2.294	0.185
Lack of capital	41(51.3)	39 (48.8)	0.100	0.874
Lack of improved breeding boars	23 (28.7)	24 (30)	0.030	1.000
Poor access to livestock extension services	9 (11.3)	-	9.536	0.003**
Seasonal availability of pig feeds	48 (60)	18 (22.5)	23.211	0.000***
	22 (27.5)	20 (25)	0.129	0.858
Poor market & low selling price				
Poor availability of pig drugs, minerals and vitamins	8 (10)	3 (3.8)	2.441	0.210
Cancellation of SLIPP project support	4 (5)	9 (11.3)	2.093	0.247
Poor knowledge on improved pig keeping	8 (10)	7 (8.7)	0.074	1.000

NB: Number in brackets indicate percent, *: sig at p = 0.1, **: sig at p = 0.05, *: sig at p = 0.001**

Table 15 further shows that about half (51.3% and 48.8%) of the respondents in intervention and control groups, respectively, claimed that lack of capital as among the major factors affecting pig production. More than half of respondents in the intervention group identified lack of capital as their third factor affecting pig productivity, due to the fact that they adopted SLIPP project intervention (hygienic pig confinement and feed

supplementation) which requires capital for pig housing and feeds. The majority of households in the control group did not provide feeds nor housing for their pigs, hence, capital was not a major problem. Observations from the study are in line with what was reported in other studies which found similar production limitations, these include: parasites and diseases, high costs of inputs, such as feed, inadequate capital input, feed scarcity, inadequate advisory/extension services, lack of good quality breeding stock, poor and unorganized marketing, lack of adequate knowledge on improved pig management, and expensive veterinary drugs (Jacobson *et al.,* 2014; James *et al.,* 2014; Muhanguzi *et al.,* 2012; Dewey *et al.,* 2011). The observed challenges were also pointed out during the FGDs as shown in the quotes below.

> Demand for pigs is very high but low selling price offered by buyers from town leads to low income which results to poor achievement of livelihood outcomes. (A male participant, Mshewe village Mbeya District, 10/11/ 2015).

> Diseases outbreaks kill the pigs so often hence, affecting production and income at large'' (A female participant, Sambewe villages Mbozi District, 15/11/ 2015).

In addition, observations from the current study conform to those of a study conducted in Rombo District, Kilimanjaro region by Swai and Lyimo, (2014) where it was reported that among the important diseases of pigs, viral diseases were a major constraint, especially African swine fever (ASF), and particularly in the smallholder mixed intensive and extensive management systems. Furthermore, Swai and Lyimo, stress on average, the number of pigs lost per household was 4 with the overall mortality of 84 %. Generally, piglet mortality depletes the replacement stock hence reduced off-take. Pig diseases as the

main challenge was also pointed out during the FGDs in the current study as shown in the quotes below;

> People are very much interested and inspired to keep and rear pigs but majority are highly discouraged following last year's disease outbreak which killed almost all the pigs in the village (A 49 year's old male participant, Itaka village, Mbozi District, 13/11/ 2015).

> Though pig keeping is the simplest project with a high income compared to other livestock species but disease scare farmers. I had 16 pigs and all of them died during last year's disease outbreak (A 41 year's old female participant, at Mshewe village, Mbeya District, 10/11/ 2014).

4.6 Evaluation of Acceptability and Adoption of the new SLIPP Management system

In the intervention villages SLIPP project introduced four (4) model systems purposely to improve pig farming and eventually livelihood outcomes of smallholder farmers. The four model systems introduced include: knowledge/education on improved pig farming, hygienic pig confinement, deworming/anthelmintic treatment of pigs, and feeds supplementation.

4.6.1 Knowledge/education on improved pig farming

The SLIPP project focused on education of smallholder farmers regarding pig management, pig disease and pig welfare. Farmers were trained on different pig management practices and their importance such as; docking (removal of piglet's tail), teeth clipping (removal of piglets canines teeth), management of herd boar, management of sows before and after pregnancy, signs of heat, mating, signs of farrowing and other general and routine practices in pig keeping. Further, farmers were also trained on how to

control ectoparasites through spraying/dipping as a routine practice. Findings in Table 16 show that majority (98.8%) of the respondents in the intervention groups in both districts (Mbozi and Mbeya) claimed to accept and adopt knowledge on improved pig farming. The findings of the present study are in agreement with the previous work by Mutua *et al*. (2011) who reported that farmers in Kakamega District, Kenya were trained on different management practices including the routine practices. Routine practices included spraying/dipping to control ectoparasites, daily cleanliness of pig pens, feeding, and watering. Further, to the above findings, Mutua emphasis on the importance of teeth clipping, docking and management of sows and piglets.

4.6.2 Hygienic pig confinement

In hygienic pig confinement, in contrast to the free roaming pigs, confinement will require solid housing; stable feed and water supply, waste handling, and introduction of breeding stock by the farmer (see Plate 1 and 2). Findings in Table 16 show that the majority (95%) in intervention group accept and adopted hygienic pig confinement, which enabled them to highly reduce risk of their pigs being infected by diseases such as porcine cysticercosis which is commonly in free range system. Hygienic pig confinement is claimed to be a major part of a solution to avoid infectious diseases in pigs keeping. Similar findings have also been reported by Dewey *et al.* (2011) in a study carried out in Busia and Kakamega districts, western Kenya it was reported that the free range keeping of pigs has been associated with increased risks of contracting porcine cysticercosis.

Plate 1: Pig house in confinement system

Plate 2: Pig house with thatched grass roof in confinement system

Table 16: Items of the new management system introduced by the SLIPP project, accepted and adopted by pig keepers in the intervention group (n = 80)

Management Model/system	Frequency	Percentage
Knowledge/Education	79	98.8
Hygienic pig confinement	76	95.0
Deworming/Anthelmintic treatment of pigs	78	97.5
Feeds supplementation	79	98.8

4.6.3 Anthelmintic treatment of pigs

Generally, anthelmintic treatment of pigs focuses on control of ectoparasites and endoparasites, through spraying/dipping, deworming and vaccination. Further, anthelmintic treatment also aims at controlling of porcine cysticercosis which is the most common and dangerous zoonosis diseases. Pigs de-worming is carried out either orally by *Flubenol* or through injection by *Ivermectin*. Infection by parasites negatively affects productivity of pigs and leads to poor growth rates, decreased litter size, reduced weight gain, poor feed utilisation and conversion, reduced fertility, condemnation of affected organs, high treatment costs and mortality. Therefore, anthelmintic treatment, and proper pig pen hygiene have been a controlling factor of endoparasites and hectoparasites. Findings in Table 16 show that 97.5% of the respondents in the intervention groups accepted and adopted anthelmintic treatment of pigs. This is similar to the findings by Obonyo *et al.* (2013) in Homabay District, Kenya where it was reported that poor hygienic and nutritional conditions favour a higher prevalence, burden and rate of helminth transmission, similar to the situation in extensive outdoor management systems without anthelmintic interventions. The use of ivermectin for the treatment of ectoparasites might have reduced the prevalence of helminths in pigs in the study area.

4.6.4 Feed supplementation

In feed supplementation farmers were emphasized to include important nutrients in feeds ration including; carbohydrates, protein, fat, vitamins and minerals. The SLIPP project emphasised on the use of commercial feeds (e.g. vitamins, maize bran, cotton seedcake and minerals) but in case of poor availability or lack of finances farmers were advised to opt for the locally available feed items such as tree leaves, waste/by-products, potatoes or potato vines and cassava. Findings in Table 17 show that majority (98.8%) of the respondents in the intervention group accepted and adopted feed supplementation by providing their pigs with feeds ration inclusive of carbohydrates, proteins, vitamins, and minerals. This agrees with the report of Okoli *et al.* (2009) that feed intake is one of the most important factors determining both productivity and growth performance of livestock. For a feed to be regarded as being of good quality, it must contain appropriate levels of carbohydrates, proteins, fats, vitamins and minerals among others. By ingesting sufficient quality feed, the animals will be able to deposit sufficient nutrients in their body to support vital body maintenance processes, growth, milk production and reproduction.

Evaluation of the new management system introduced focused only on intervention villages and farmers. Findings in Table 17 show that majority (95%) of the respondents in the intervention villages claimed to accept and adopt the new management system introduced by the SLIPP project. Hygienic pig confinement is claimed to be a major part of a solution to avoid infectious diseases such as porcine cysticercosis. Such findings have also been reported (Dewey *et al.,* 2011) in a study carried out in Busia and Kakamega districts, western Kenya whereby it is reported that the free range behaviour of pigs has been associated with increased risks of contracting porcine cysticercosis.

This observation suggests that the introduced management systems were appropriate and farmers were able to adopt. The above is supported by what was reported during the in-depth interviews with livestock officers who said:

> The new management model introduced by the SLIPP project has been so helpful to smallholder pig keepers in terms of quick fattening and growth and hence increased production. In addition, pig confinement has highly reduced conflict among farmers. Before the project's introduction, majority of the pigs were scavenging randomly and fed on neighbour's crops as a consequence there were lot of conflicts (Key informant, Idimi village in Mbeya district, 7/ 11/ 2014).

The appropriateness of the new management model introduced was also supported by pig keepers during the FGDs as shown in the quote below:

> Before the introduction of the new management system, we used not to routinely de-worm our pigs, no supplementation was done, and neither did we confine our pigs. As a result, pig mortality was high due to diseases and growth was slow due to poor feeds. However, currently we are enjoying pig keeping as we are more knowledgeable on the best management system. Furthermore, those who were not keeping pigs before have now been inspired into pig keeping. The project has generally improved our livelihood outcomes" (FGD participants, Itaka village, Mbozi District, 13/ 11/ 2014).

The findings of this study also concur with the findings of a study carried out in Homobay District in Kenya by Obonyo *et al.* (2013) which reported that, poor husbandry and feeding practices, low level of education and lack of access to quality extension services were identified as possible constraints in pig production. Therefore, the need for farmers to be educated and encouraged to improve on husbandry practices for increased pig

productivity. There is need for control of helminthes and control measures should integrate better nutrition with anthelmintic treatment. Pigs which are not housed are in constant contact with soil because of their feeding behaviour which increases the uptake of parasite eggs and larvae as well as intermediate hosts hence increased worm burdens. Moreover, pig housing increases productivity and safeguards the pigs from theft and diseases of public health importance such as cysticercosis. Poor nutrition also lowers the resistance of the animals to infections thus, enhancing the establishment of worm burdens and increasing their pathogenicity. Consequently, worm burdens tend to be higher in poorly fed than in well fed animals (Obonyo *et al.,* 2013).

4.7 Keeping Systems Practiced by Control Groups

Furthermore, the current study identified pig keeping systems practised by the control groups. Findings in Table 17 show that more than half (58.8%) of the respondents in the control group practiced free range system in keeping their pigs (Plate 3), while (17.5%) adopted total confinement, 16.2% practised tethering system, and a few (7.5%) practised semi confinement system of pig keeping. Tethering as opposed to free range system involves pigs being tied up by a rope mostly to a tree (see Plate 4). Sometimes when a weak rope is used, pigs may break the rope and end up roaming around which may also result into conflict and being infected with diseases same as in free range system.

Plate 3: Scavenging pig in free range system

Plate 4: Tethered pig

In most cases tethering causes wounds or fracture to those using pig legs in tethering, and wounds mostly end up with bacterial infections. These findings are in agreement with the study carried out in Busia and Kakamega districts, western Kenya by Dewey *et al.* (2011) on indigenous pig management practices in rural villages, which reported that the purchase of strong ropes to tether pigs was a problem in many households resulting in the use of weak tethers which were easily broken by the pigs setting them free to roam leading to conflicts with neighbours. Tether wounds observed on the neck and leg of the pigs is a welfare concern such wounds can lead to secondary bacterial infections.

The above is supported by the opinion and results from the in-depth interviews with one of the livestock officers who said:

> I have been educating pig farmers to practice intensive pig keeping in my village, but it has been very difficult for them to adopt as they strongly claim to lack capital in pig housing and feeds. Apart from improving production, intensive pig keeping will minimise conflicts resulting from scavenging pigs which feed on neighbours' crops, and people will live in peace and harmony. Also, the ropes used for tethering sometime cause wounds or lameness. Moreover the wound may eventually results into a serious bacterial infection. (Key informant, Namlonga village, Mbozi District, 16/11/2014).

Table 17: Keeping system in Control groups (n=80

Keeping System	Frequency	Percent
Total confinement	14	17.5
Semi confinement	6	7.5
Free range	47	58.8
Tethering	13	16.2

CHAPTER FIVE

5.0 CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

The general objective of the study was to determine the contribution of pig farming to the livelihood outcomes of pig keepers in Mbeya and Mbozi districts. Specifically, it focused on assessing the impact of pig husbandry introduced interventions on the livelihood outcomes of pig keepers, evaluating acceptability of the new model system, adopted technologies and products among smallholder pig farmers and at identifying factors affecting smallholder pig production.

Based on the findings of the study it is concluded that, pig keeping has been proved to partly contribute to the achievement of the surveyed households livelihood outcomes in terms of; food security, ability to pay for health services, ability to meet education cost, ability to construct/own good quality houses and acquisition of assets. It is also concluded that after the intervention pig keepers in the intervention group own more assets with a high value compared to the control group. The reasons for this was the adoption of better and improved pig keeping practices that contributed to high production thus high income.

It is further concluded that, male headed households perform better in pig keeping compared to female headed households. Good performance observed in the male headed households was in terms of a high average number of pigs kept per households, and adoption of hygienic pig confinement and feed supplementation. The study also concludes that, achievement of livelihood outcomes is high for the pig keepers in the intervention group compared to the control group.

The study further concludes that, there were high (≥ 95%) adoption of the newly introduced (four) management systems that included; knowledge/education, hygienic pig confinement, anthelmintic treatment, and feeds supplementation. The introduced management systems highly resulted into high pig production thus, contributing to achievement of the adopters' livelihood outcomes.

It is also concluded that, despite the achievement of livelihood outcomes pig keepers in both the intervention and control group face a number of constraints these include: disease outbreaks, lack of capital and seasonal availability of pig feeds as the main factors. However, the control group was severely affected by diseases while lack of capital and seasonal availability of feeds was more serious in the intervention group.

Lastly, it is concluded that, although pig keeping in the study areas faces a lot of challenges, disease outbreaks and lack of capital to be among the prominent constraints; the intervention program by SLIPP project has proven to be effective in contributing to reduction of risks against disease outbreaks through hygienic pig confinement and feeds supplementation. This is supported by the high pig production by the intervention group compared to control group and through achievement of livelihood outcomes.

5.2 Recommendations

From the findings of the study, to improve pig production in Mbeya Region the following are recommended.

i. As reported by the study, diseases outbreak was identified as the most serious constraint to pig keepers in achieving livelihood outcomes. Therefore, the SLIPP project in collaboration with the Government (Uyole Research Institute) need to conduct intensive research and come up with vaccination and curative drugs of

most deadly pig diseases including African Swine fever (ASF) and porcine cysticercosis (PC)

ii. The study results revealed that pig farmers in the intervention groups perform better compared to control group in terms of livelihood outcomes achievement. Therefore, it is recommended that education on pig production should be extended to all pig keepers in the country so as to improve pig keeping husbandry and pig keepers livelihood outcomes in general.

iii. Lack of capital has been identified as among the major problems (second to the pig diseases) that hinders pig farmers in achieving livelihood outcomes. The local government authority (LGAs) of Mbeya and Mbozi districts should work to strengthen farmers groups by encouraging farmers to form/join saving and credit associations which will enable them to access and acquire loans with low interest rates.

iv. Seasonality in availability of pig feeds particularly maize bran is also a constraint to pig keeping, therefore it is recommended that, LGAs in collaboration with other stakeholders to train pig keepers on substitutes and locally available feed items (tree leaves, waste/by-products, potatoes or potato vines, cassava, brewery wastes etc) as alternative to maize bran.

5.3 Suggested Areas for Further Research

a) In the study areas women are the ones found at home most of the time providing much of the labour required in pig keeping. The women are also involved in daily cleaning of the pens, provision of feeds and water and any other chores related to

pig keeping. Since women are the major source of the labour used to take care of pigs though men are the ones involved in sales and dictate the use of income earned, there is a need for a gendered study to determine how the different household members benefit from pig farming in Mbeya and Mbozi districts.

b) Further, research is also suggested to focus on cost-benefit analysis of the pig project in the study areas.

c) Lastly, determination of pig project productivity (per unit of labour and input) has not been captured by the current study; therefore this could also be an important area for further research.

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APPENDICES

Appendix 1: Questionnaire on impact of Pig keeping on farmer's livelihoods outcomes in Mbozi and Mbeya Districts

Name of Interviewer..... Date.....Questionnaire No.....

1. Household Identification

Name of respondent.....

Name of Household head.....

Education level of respondent.....

District.....

Division.....

Ward.....

Village.....

Telephone No.....

2. Household Background Variables

i. Education level of Household head

a) No formal education b) Primary education c) Secondary education d) college

ii. Sex of respondents

a) Male b) Female

iii. Sex of Head of household

a) Male b) Female

iv. Household head's main occupation

Employed by government b) Self-employed c) Business d) Farming

v. Marital status

a) Married b) Single c) Divorced d)) Widow/widower

vi. Respondents' year of birth..... Household head year of birth.....

vii. Members of household

S/N	Name	Age	Sex	Education l.	Occupation
1.					
2.					
3.					
4.					
5.					
6.					
7.					
8.					
9.					
10.					
11.					
12.					

3. Information on pig farming

i) When did your household start to keep pigs? (Indicate year).....

ii) Why do you keep pigs?

a) For income b) For food c) Manure production d) Others (Specify)....

iii) What pig breeds do you keep?

a) Indigenous b) Exotic c) Crossbreed d) Others (Specify).....

iv) Details of pigs kept by household?

S/N	Description	Actual number
1.	Sows	
2.	Boars	
3.	Gilts	
4.	Growers	
5.	Piglets	

v) How do you raise your pigs

a) Free range/scavenging b) Small scale confined c) Large scale confined d) Large scale out door

If household practices free range why?

.....

What are the levels of the following production parameters in your herd

a) Age at first service.....b) Piglets farrowed per litter.....c) Average pigs weaned per litter.....d) Piglets weaning age..... e) Litter per sow per year.....

vi) Are the livestock extension and veterinary services available and accessible in your area? Yes / No

If yes what services?.....

If no what are the reasons?

.....

.....

a) Do you keep records in your pig keeping? Yes/ No

If yes what are those records?.....

If No give reasons.....

vii) What is your household total farm size?.....(Acres)

viii) How much of your farm land is dedicated to pig farming?.....(Acres)

4. Information on pigs production costs

What is estimated cost of production per week?

S/N	Description	Cost
1.	Feeds	
2.	Drugs	
3.	Veterinary services	
4.	Labour	
5.	Others (specify).....	

5. Information on the Pigs Marketing

a) To whom do you sell your pigs/pig products?.....

b) Price of pigs at sale (Live and slaughter animal)

S/N	Description	Live animal	Slaughtered	
			Weight (Kgs)	Price
1.	Gilt			
2.	Sow			
3.	Boars			
4.	Others (Specify).....			
	Total			

6. Information on Pig farming and Livelihoods outcomes

i) What are the factors affecting smallholder pig farmers?

.....

.....

Is pig keeping project improving your living standard? Yes/ No

If yes give reasons.

.....

If No why?.....

7. Household Income

i) What is your household average annual income?

.....(Tsh)

ii) What is the average annual contribution of the following to your household's income

S/N	Source of Income	Amount in Tshs
1.	Pig farming	
2.	Other livestock (Cattle, goats, sheep, poultry etc)	
3.	Crop farming	
4.	Other income generating activities (petty trade, casual labour, formal employment, etc)	

iii) Before your household's involvement in pig farming what was your household's average income .....(Tsh)

iv) Has your household income increased after your involvement in pig keeping? Yes/No

If yes by what percentage?

a) Up to 25% b) 26 – 50% c) 51 – 75% d) more than 75%

If no give reasons.....

Contribution of pig keeping to households' livelihoods outcomes

S/N	Livelihoods Outcome	Before Household's Involvement in pig farming		After Household's Involvement in pig farming	
		Yes	No	Yes	No
1	Household's food security for all year				
2	Household's ability to pay for health services				

3	Household's ability to meet children's education costs (where applicable)				
4	Household's ownership of a good quality house				

8. Household's Asset Ownership

i) What are the assets owned before and after pig keeping farming

S/N	Assets owned Before	Estimated value	Assets owned After	Estimated Value
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				

ii) Information on the model system adopted in improving pig keeping

i) Are you aware of the new pig keeping model system introduced in your area?

a) Yes b) No

ii) If Yes explain how have you adopted and practice

a) Knowledge/education provided.....

b) Hygienic pig confinement.....

c) De-worming/Anthelmintic treatment of pigs.....

d) Feed supplementation.....

If household has not adopted the new pig keeping model system give reasons.....

7 What are your general comments on pig keeping in your area.....

Thank you very much for your cooperation in this research

Appendix 2: Check List to be Used in the Focus Group Discussions

1. What are the major pig breeds kept in your area?

2. Which of the above mentioned pig breeds are the most important and why?

3. What is the status of pig keeping in your area?

4. What are the requirements for keeping pigs in your area?

5. Does pig keeping in your area have the potential of reducing one‘s poverty?

6. Among men and women what is the level of participation in pig keeping and why?

7. How would you describe pig and pork marketing in your area?

8. Where do pig keepers sell their pigs/pigs in your area?

9. Is it easier to raise pig or other type of livestock in this area?

10. What challenges do pig farmers face in your area?

11. What can be done to improve/raise pig productivity in the study area?

Appendix 3: In-Depth Interview Guide/Checklist

1. How actively do pig keepers seek agricultural extension services?

   On what matters do they seek extension services?

2. What is your general view of pig keeping in your area?

3. What is your general view of pig marketing in your area?

4. What problems do pig keepers encounter in pig production?

5. Are the farmers willing to adopt new pig keeping models introduced?

6. Can pig farming be a route out of poverty in your area?

7. Is there good relationship between pig keepers and traders?

Thank you very much for your cooperation in this research

Appendix 4: Value of Assets owned by the intervention group before and before the interventions

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Estimated total value of assets owned before intervention	1.13E7	80	2.439E7	2726784.902
	Estimated total value of assets owned after intervention	2.03E6	80	1497191.120	167391.056

Appendix 5: Value of assets owned by the control group before and after the interventions

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Estimated total value of assets owned before the intervention	3.02E6	80	4723269.759	528077.613
	Estimated total value of assets owned after intervention	5.63E6	80	8160300.161	912349.294