HEALTH RISKS AND BIOSECURITY MEASURES IN PIG PRODUCTION IN URBAN AND PERI-URBAN AREAS OF MOROGORO MUNICIPALITY, TANZANIA

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ABSTRACT

Pig production is among other animal keeping activities that have been practised in Morogoro region for food as well as generating income. The increase in urban population in the region has resulted into the increase in urban and peri-urban farming as a response to the increament in food demand from plants as well as animals; thus created a need to understand the health risks that could be brought about, and the biosecurity measures that can cancel those risks. This crosssectional study was conducted in 13 wards of Morogoro municipality,Tanzania, to assess possible health risks in urban and peri-urban pig production and identify available biosecurity measures. A total of 282 pig farmers were randomly chosen from purposively selected streets answered a structured questionnaire to measure respondents' knowledge on the diseases that have affected his/her pigs, husbandry systems and practises, animal waste management as well as biosecurity practices and their feasibility. Twelve (12) key informants were interviewed on the subject: Qualitative data were subjected to content analysis and association between variables were assessed for statistical significance at a critical probability of $P < 0.05$. Data from questionnaire were analysed using the Statistical Package for Social Sciences (SPSS). The study revealed that, 48.2% of respondents were not aware of health risks associated with pig production. About 9.2% wore local protective gears (wrapping plastic bags on hands, and normal shoes-*yeboyebo*) while 19.1% did not have any protective measure. Only 0.4% generated biogas out of the manure. Animal quarantining was practiced by 68.4%, presence of screening was 20.6%, while veterinary service was accessible to 66.3%. Poor knowledge on animal wastes handling is becoming a major challenge to public health. Therefore the municipal authorities should ensure that farmers are advised and trained to generate biogas out of the animal wastes, its officials dealing with livestock development are well equipped to ensure accessible veterinary services to all the livestock keepers especially those who reside at the peripheral areas. By so doing; more knowledge will be disseminated on good farming practices.

DECLARATION

I, Christina John Henjewele, do hereby declare to the Senate of Sokoine University of Agriculture that this dissertation is my own original work done within the period of registration and that it has neither been submitted nor being concurrently submitted in any other institution.

_____ _____

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The declaration is hereby confirmed;

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DEDICATION

This work is dedicated to the almighty God; to my beloved parents Mr. John B. Henjewele and Mrs Anna J. Mpangala, my sisters Jiefrice and Angel, my brothers John and James, your moral support is always appreciated.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF PLATES

LIST OF APPENDICES

LIST OF ABBREVIATIONS

ASF	African swine fever
ASFV	African swine fever Virus
CSF	Classical Swine fever
DANIDA	Danish International Development Agency
EPA	Environmental Protection Agency
EPI-INFO	Epidemiological Information
FAO	Food and Agriculture Organization of the United Nations
Fig.	Figure
FMD	Foot and Mouth Disease
H1N1	Haemagglutinin-Neuraminidase
HEV	Hepatitis E Virus
IFAH	International Federation for Animal Health
LFO	Livestock Field Officer
NoV	Norovirus
OIE	Office International des Epizooties/World Organization for Animal Health
OTC	Oxytetracycline
PCR	Polymerase Chain Reaction
PPE	Personal Protective Equipment
PRCP	Pilot Research Cooperation Programme
RV	Rotaviruses
SaV	Sapovirus
SPSS	Statistical Package for Social Sciences
URT	United Republic of Tanzania

USA	United States of America
WB	World Bank
WEO's	Ward Executive Officers

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background

Workers on pig farms are more at risk from disease causing microorganisms that can be transmitted from animals to humans (zoonoses). Pig diseases transmissible to humans are caused by pathogens that include bacteria, viruses, parasites, and fungi. However most infections are mild and easily prevented with simple procedures such as wearing personal protective equipment (PPE) and hand washing (Morrow and Langley, 2000).

Emerging and re-emerging animal diseases have in recent years been associated with outbreaks that have serious consequences for animal and human health (IFAH, 2013). Approximately 75% of recently emerging animal diseases are zoonotic, meaning that they can be naturally transmitted between animals and humans. Approximately 60% of all human pathogens are of animal origin (IFAH, 2013) and the animal reservoirs include wild and domestic species.

The routes of transmission to humans vary from indirect means through food, or via an insect vector, to direct contact with farm or pet animals or through exposure to contaminated environments.

The 2009 influenza pandemic, caused by a new strain of swine-origin H1N1(Haemagglutinin-Neuraminidase), was a timely reminder of the risks for human health related to livestock production – the same livestock, including pigs, that supports the livelihoods and food security of almost a billion people, most of whom are poor (FAO/OIE/World Bank, 2010). In order to mitigate the risks associated with emerging

animal diseases, more robust surveillance and control measures need to be put in place, particularly in parts of the developing world where veterinary services and infrastructure remain limited. Among the solutions required to minimize the risk of disease spread, strengthening of biosecurity is a priority.

Biosecurity is the term used to describe the measures and procedures needed to protect a population against the introduction and spread of pathogens (FAO/WB/OIE, 2009). It requires adoption of attitudes and behaviours by people to reduce risk in all activities involving domestic, captive and wild animals and their products to prevent introduction and/or spread of disease causing agents. Each animal production system requires specific biosecurity measures. Although decision-makers should not compromise on public health, the measures to strengthen biosecurity in pig production must take into consideration the technical and financial capacity of stakeholders to implement them (FAO/OIE/World Bank, 2010).

Biosecurity measures are not focused only on zoonotic diseases. Other important diseases that can be transmitted within and between animal farms or through animal products and by-products need to be prevented from spread to avoid economic losses. Some diseases may be transmitted only between animal species, African swine fever (ASF) providing a good example.

1.2 Problem Statement and Justification of the Study

1.2.1 Problem Statement

Humans are affected by the H1N1 virus as well as other zoonotic pathogens originating from pigs. Some disease agents (including H1N1 virus) from pigs can also be transmitted to other animal species, which may result into deaths or reduced productivity. The

introduction of ASF to the Caucasus, porcine high fever disease in Asia, and earlier outbreaks of classical swine fever (CSF) and foot-and-mouth disease (FMD) in Europe and Taiwan Province of China have all had devastating effects on agricultural economies (FAO/OIE/World Bank,2010). African swine fever outbreaks were common in Tanzania; "the cases of ASF are still existing in our country, in February 2014 we observed some few cases in Mbeya Region" (Dr. Kabululu pers.comm). Once the outbreak occurs, almost all infected pigs die, resulting into considerable economic losses. In addition, the quarantine imposed by the government leads to additional economic losses as pig farmers and traders are unable to trade their pigs.

Some pig diseases are zoonotic, posing public health problems. A study conducted on pigs in south-eastern and western districts of Uganda, estimated prevalence of 2.3% to 32.4% trypanosomosis (Ocaido, 2013). Prevalence of *Trichuris suis* was 17% while that of *Ascaris suum* was 40%. Outdoor production system of pig management was the key risk factor for parasite infection.

Prevalence of porcine cysticercosis ranged from 0.12 to 45% in northern, Lake Kyoga basin, south western Uganda and along trans-border areas (Ocaido, 2013). In Tanzania, porcine cysticercosis prevalence of >30% have been reported in Mbeya region and is associated with free-range pig farming among other factors (Dr Kabululu's pers.comm). More studies on pigs contributed to an increased awareness of this zoonotic infection in many developing countries, including eastern and southern Africa (Phiri *et al*., 2003) and Mbulu District of Tanzania (Ngowi *et al*., 2004).

1.2.2 Study Justification

Assessment of health risks and biosecurity was purposely conducted in pig farming due to increased pig farming caused by rapid economic turnover compared to other animals hence increased contact and competition for resources between pigs and humans.

Furthermore, the current effects of emerging zoonotic diseases on human health and community stability are most serious and long-lasting in developing countries, where poorer living conditions are associated with higher infection rates and unavailability of proper treatment. The closer interactions between people, livestock and wildlife in these regions and the increasing movements of humans into previously unsettled areas can facilitate the jumping of pathogens between species and make them hotspots for the emergence of novel zoonotic infections (IFAH, 2013).

A recent study by Lupindu *et al.,* 2012 conducted in peri-urban areas of Morogoro revealed that a large proportion of respondents were not aware that manure may contain a variety of pathogens hazardous to human and animal health thus it is clear that the current manure management practices of cattle keepers in Morogoro Region did not aim at preventing any transmission of pathogens between human, cattle and environment or other ways to protect human and animal health.

As some pig diseases have the potential to infect humans, there is a need to sensitize the implementation of the developed biosecurity measures to limit transmission of diseases between and among pigs and ensure good health of people. This study investigated potential health risks associated with pig production and their biosecurity measures as well as pig manure handling.

However, most of the major infectious diseases of swine are severe viral diseases affecting animals only. These viruses show a clear ability to spread and have severe impact with high mortality rates in susceptible pigs. Many countries have undertaken successful eradication programmes, but the viruses are still present in many parts of the world

(FAO/OIE/World Bank, 2010). Examples are foot-and-mouth disease (FMD), African swine fever (ASF), classical swine fever (CSF) and pseudo rabies (Aujeszky's disease).

ASF is one of the most serious trans boundary animal diseases owing to its high lethality in pigs, potentially devastating socio-economic consequences, propensity for rapid and unanticipated international spread through contaminated meat, and the lack of available vaccines (FAO/OIE/World Bank, 2010).These diseases represent a major threat to production and trade and should be regarded as a priority when considering biosecurity in relation to pig health.

1.3 Objectives

1.3.1 Overall objective

To determine health risks to both; animals and humans and biosecurity measures in place in pig production in urban and peri-urban areas of Morogoro municipality, Tanzania.

1.3.2 Specific objectives

i. To assess pig-farmers' perception on health problems affecting pig production in urban and peri-urban areas in Morogoro municipality;
ii. To identify biosecurity measures being practiced for controlling disease transmission and describe pig waste handling at farm level in Morogoro municipality.

1.4 Research Questions

i. What are the perceived health problems affecting pig production in urban and/or peri urban areas of Morogoro Municipality Tanzania?

ii. Which biosecurity measures are in place to reduce the transmission of diseases at farm level in urban and/or peri urban areas of Morogoro municipality Tanzania?

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Overview

Workers on pig farms are more at risk from disease causing microorganisms that can be transmitted from animals to humans (zoonoses). Pig diseases transmissible to humans are caused by pathogens that include bacteria, viruses, parasites, and fungi. However most infections are mild and easily prevented with simple procedures such as wearing PPE and hand washing (Morrow and Langley, 2000).

2.2 Health Risks Associated With Pig Production

In Medical/Veterinary Epidemiology, risk is the likelihood of occurrence of a disease/event in a population.

2.2.1 Pig manure disposal and management

Worldwide, manure disposal is a major environmental issue. In the United States, over 500 million tons of manure are produced annually whereas Denmark and China produce over 50 and 3,190 million tons, respectively (EPA, 2007; Copeland, 2010). In those countries however, mechanisms for recycling and safe disposal of animal wastes are in place. This is not the case for the developing countries, including Tanzania. The knowledge on the estimated quantities of animal wastes produced annually in the major cities is important in estimating the environmental and public health burdens associated with animal wastes and hence proper planning on management.

Animal manure management systems in the United States are designed to store, treat, and apply to land solid, semisolid, slurry, or liquid manure (that is, urine and fecal material) on agricultural fields after removal from the animal environment. Manure processed in swine management systems is usually in liquid (1 to 4% solids), slurry (5 to 15% solids), or semisolid form, and land application most often involves spreading on fields as fertilizer (Dickey *et al.,* 1981; Copeland and Zinn, 1998; Hill, 2003; Ziemer *et al.*, 2010).

If not properly treated, manure can be a source of animal and human infections with disease pathogens. Although the majority of microbes in swine manure are not zoonotic; several bacterial, viral, and parasitic pathogens have been detected (Ziemer *et al.*, 2010).

2.2.2 Important bacteria in swine manure

Bacterial pathogens that have been associated with swine manure include *Bacillus anthracis*, *Brucella* spp., *Campylobacter* spp., *Chlamydia* spp., *Escherichia coli*, *Leptospira* spp., *Listeria monocytogenes*, *Mycobacterium* spp., *Salmonella* spp. and *Yersinia* spp. These pathogens are zoonotic and may be transmitted either through direct contact with manure or indirectly through the environment (Strauch and Ballarini, 1994; Pell, 1997; Ziemer *et al.*, 2010). Other bacteria found in swine manure are *Clostridium spp*., *Lactobacillus spp*., *Enterococci* and *Staphylococcus spp.*

2.2.3 Important viruses in swine manure

Zoonotic viral pathogens that have been associated with swine manure include *Influenza* virus, an agent that can be transmitted easily between animals and humans .Swine hepatitis E virus (**HEV**), a novel virus closely related genetically and antigenically to human HEV, was discovered and characterized by Meng et al. (1997). Rotaviruses (**RV**) are the leading cause of acute viral gastroenteritis in the young of both avian and mammalian species,

including pigs and humans (Saif *et al*.,1994; Yuan et al., 2006).Caliciviruses include *Norovirus* (**NoV**), *Sapovirus* (**SaV**), *Vesivirus*, and *Lagovirus*. Viruses in the NoV and SaV genera cause diarrhea in humans and animals and are referred to as human or animal enteric caliciviruses (Green *et al*., 2001).

2.2.4 Important helminths in swine manure

In the study to detect intestinal parasites in pig slurries by Bornay-Llinares *et al.*, (2006), conducted in Spain, *Strongylida* eggs were detected in slurries from gestating or farrowing sows. Joachim *et al.* (2001) reported similar results: *Ascaris suum* eggs in 10.5% of the studied samples from piggeries of North-Western Germany. *Fasciola hepatica* eggs were observed only in the gestating and farrowing sows' production stages.

A study on *Helminthosis* in local and cross-bred pigs in the Morogoro Region of Tanzania conducted by Esrony*et al.,* 1997 showed that 53%of the pigs sampled were excreting *helminth* eggs in their faeces; the prevalence of *Oesophagostomum* spp in the 424 samples examined was 39.9%, whereas that of *Ascaris suum* was 11.6% and other helminths were *Strongyloide*s *ransomi* (9.0%) and *Trichuris suis* (4.9%) based on coprological results.

2.2.5 Important protozoa in swine manure

Cryptosporidium describes a genus of protozoan parasites that infect a wide range of vertebrates. *Giardia* describes a genus of flagellate protozoan parasites of the small intestine that infect a wide range of vertebrates. In the study conducted in Spain to detect intestinal parasites in pig slurries by Bornay-Llinares *et al.* (2006) three main protozoa species were detected in the pig slurries: *Ballantidium coli, Entamoeba coli* and *Cryptosporidium spp*. Cryptosporidiosis has been found to be of great public health

importance during this HIV/AIDS era as the parasite seems to commonly cause opportunistic infections.

2.3 Biosecurity Measures

Biosecurity is the term used to describe the measures and procedures needed to protect a population against the introduction and spread of pathogens. Biosecurity of pigs at the farm level is the set of practical measures taken to prevent entrance or export of infection into a pig farm and control the spread of infection within the farm hence, biosecurity is presented under two components – bio-exclusion and bio-containment. Bio-exclusion (or external biosecurity) combines all activities to preclude the introduction of disease to the farm while bio-containment (or internal biosecurity) refers to efforts to prevent the spread of a disease within the farm herd and to other farms (FAO/OIE/World Bank, 2010).

2.3.1 Main elements of biosecurity

The three main elements of biosecurity are; *Segregation,* meaning the creation and maintenance of barriers to limit the potential opportunities for infected animals and contaminated materials to enter an uninfected site. When properly applied, this step will prevent most contamination and infection. *Cleaning* makes sure that materials (e.g., vehicles, equipment) that have to enter (or leave) a site are thoroughly cleaned to remove visible dirt. This will also remove most of the pathogens that contaminate the materials. On the other hand, *Disinfection* aims at inactivating any pathogen that is present on materials that have already been thoroughly cleaned (FAO/OIE/World Bank, 2010).

Biosecurity measures may vary from one farming system to another (that is small-scale scavenging, large-scale scavenging, small-scale confinement and large-scale confinement).

2.4 Urban and Peri-urban Livestock Farming

Literally, an urban area is characterized by higher population density and vast human features in comparison to the areas surrounding it. Urban areas may be cities, towns or conurbations, but the term is not commonly extended to rural settlements such as villages and hamlets while peri-urban area refers to a transition or interaction zone, where urban and rural activities are juxtaposed, and landscape features are subject to rapid modifications, induced by human activities (Douglas, 2006).

Urban and peri-urban livestock farming serves not only to provide food for the increasing urban population (thus increase in food demand) but also provide income for the livestock keepers. The practice also has a negative impact to the environment due to poor management of the animals as well as the animal wastes. The national livestock policy of 2006 (and still in use) states that;(i) The Government will strengthen technical support services and promote peri-urban livestock farming.(ii) The Government will encourage and support peri-urban livestock farming that is environmentally friendly.

2.5 Tanzania Perspectives

2.5.1 Pig population and distribution

Currently, Tanzania has approximately two million pigs. Some 99.5 per cent of pigs are kept by small producers in units averaging 3.04 animals (ranging from 2-48). About 18 per cent of households with livestock own pigs, 93.7 per cent of these having a herd of less than 19 and 69.2 per cent own 9 or fewer herd (Wilson and Swai, 2014).

More than 60 per cent of national pigs are reared in the Southern Highland regions of Iringa, Mbeya and Ruvuma. Morogoro, Dodoma and Kilimanjaro regions also have

considerable numbers of pigs. These are followed by Manyara, Rukwa and Kagera Regions. There are relatively few pigs in other mainland regions and very few pigs in the strongly Muslim offshore region of Zanzibar (Wilson and Swai, 2014).

In Morogoro town in 1999 there were more than 5,300 improved dairy cattle, approximately 2,000 goats, 260 sheep and 1,000 pigs. At this time in Morogoro 4.7 per cent of all households and 12.3 per cent of households keeping livestock, herded pigs either totally confined (as required by a municipal by-law) or stalled at night and free roaming during the day; the average number of pigs kept per km^2 was 10.5 (Wilson and Swai, 2014). Overall pig densities are low. They are highest in the largely urban region of Dar es Salaam ($27/km^2$) followed by Kilimanjaro ($9/km^2$), Mbeya ($6/km^2$), Iringa ($5/km^2$), Ruvuma and Dodoma ($3/km^2$). Other regions have densities of $2/km^2$ or less (URT, 2012).

2.5.2 Pig husbandry systems and manure handling

Many pigs in urban areas are totally confined in rudimentary houses made of local materials and with little consideration for hygiene or welfare whereas in rural areas most pigs roam freely or are tethered during the day and housed at night. Urban and peri-urban areas are important areas for keeping livestock including pigs and numbers are increasing rapidly in these systems (Wilson and Swai, 2014). The rapid increase of urban and peri-urban livestock keeping is the function of the elevating urban population hence the increase in demand for food including animal food products.

Lupindu *et al.,* 2012 reported that in Morogoro urban and peri-urban farming, the cattle manure was poorly managed that is; 90.8% of the respondents were disposing manure on land and 69.7% disposed manure within 10m from the household, 4.2% were collecting manure by hand picking, 60.5% collected manure only once a day, 41.2% were not using

rubber boots in the process. Currently there is no information about manure management for pigs in Morogoro Municipality.

2.5.3 Economic aspects of pigs

Pigs are a minor meat-producing species in Tanzania's array of domestic livestock as they account for about 3.7 per cent of meat-producing animals (Mkupasi *et al.,* 2011). The species is kept for income generation; provide food for the household, cooking fat, produce manure, and as a capital. Nevertheless, some people prefer keeping pigs over other livestock because it is relatively economical as the pigs may be fed with kitchen leftovers, and the production of multiple piglets at once leads to a fast increase of the herd size which translates into better income.

2.5.4 Pig diseases

Pigs in Tanzania do suffer a whole range of trade and production diseases and are a reservoir of several major zoonoses as well as notifiable diseases including African swine fever that are of international importance (Wilson and Swai, 2013). In 2011 African swine fever virus (ASFV) genome was detected in asymptomatic pigs in field samples in Mbeya, Tanzania. ASF outbreaks are frequent, the recent one occurred in 2014 in Mbeya Region (Dr. Kabululu's pers.comm).

Several helminths parasites of swine are infectious to humans, but human infection usually results from ingestion of raw or under cooked meat rather than from exposure to infected faeces (Ziemer *et al.,* 2010). Taeniosis and cysticercosis caused by *Taenia solium*, a parasitic infection from raw/inadequately cooked pork providing a good example.

CHAPTER THREE

3.0 MATERIALS AND METHODS

3.1 Description of the Study Area

This study was conducted in Morogoro municipality and the areas around the municipality (peri urban areas) in Morogoro region, Tanzania between October 2014 and January 2015. Morogoro region lies between latitude 5^{o} 58" and 10^{o} 0" to the South of the equator and between longitude 35^{o} 25" and 35^{o} 30" to the East of Greenwich Meridian. The area was selected purposely as the tremendous growth in urban and peri urban livestock production may influence the increase in the transmission of infectious diseases among animals and between animals and humans.

3.2 Study Design

This was a cross-sectional study focusing on the assessment of possible health risks in urban and peri-urban pig production and identifying the available biosecurity measures. The study units were pig farmers and key informats (ward livestock officers).

3.3 Study Population

The study population were farmers within and around the municipality who were keeping pigs in any rearing system where key informants included wards' livestock officers.

3.4 Sample size determination (pig farmers)

The sample size was calculated using the following formula:-

$$n = \frac{z^2 * P * (1 - P)}{E^2}$$

Where: n = required sample size, Z = z score (which for 95% confidence level is 1.96), P = known or estimated prevalence of a factor (prevalence of pig production health risks). Proportion not known, hence P=0.5 was used to obtain the maximum sample size. E = allowable error of estimation (in this study 5% was used). Therefore, the calculated sample size was:

$$n = \frac{1.96^2 x 0.5\ (1 - 0.5)}{(0.05)^2} = 384.14$$

Based on Morogoro Municipal livestock statistics it was estimated that Morogoro urban and peri-urban areas would have about 500 pig farmers. Being a finite population, the sample size was adjusted to take this into account. The sample size obtained above was adjusted for the finite population (N) using the formula $n_2 = nN/(n + (N-1))$ (Martin et al., 1987), where N = 500 pig farmers. Thus at least 217 pig farmers were required for this study. A total of 282 farmers were interviewed to take into account the multistage sampling design used.

However, 282 farms were enrolled in this study after they met all the inclusion criteria of being part of this study.

Inclusion criteria were:

- Farm located within the study area (Morogoro urban or peri-urban)
- The farmer gave an oral consent for being interviewed and for his/her farm being visited
- The farmer or any responsible delegate respondent was found at the household (farm) during the study period.

- Interview was conducted only when all the aforementioned conditions were gathered with no exception.

For the key informants, the sample size was 12 meaning that all of the livestock officers from the studied wards were included except for Bigwa which was having no livestock officer at the moment the study was carried out.

3.5 Sampling procedure

At the municipal level; purposive sampling technique was used to identify wards with pig production. Within wards; representative streets with the highest pig production were identified purposively based on the information provided by the ward livestock officers. Then, in the selected streets, households keeping pigs were chosen to participate in the study using snowball method of sampling that is, asking the current respondent to locate the next (Salganik and Hectathorn, 2004). In a household selected, the respondent was the one taking care of the pigs. A street in the context of this study means households that are located on the same road.

3.6 Data Collection Method

A structured questionnaire of English language (Appendix 1) was translated to Swahili, pre-tested and then administered by the reseacher to each respondent (one per household) to collect information on possible health risk factors associated with urban and peri-urban pig production. This was combined with observations where possible. The information collected included repondent's perceived general health status of the pigs, routine screening, prevention and treatment of diseases, occurences of diseases (the respondent was asked to name the disease(s) she/he could remember to have affected her/his pigs), husbandry systems and practices, animal waste management as well as the practiced biosecurity measures.

3.6.1 Primary data collection techniques

(i) Key-informant interviews

The interview involved all the wards livestock officers as key informants who were potential for the required information on this study, whereby detailed information on health risks in urban and peri-urban pig production was obtained through answering of the semi structured questionnaires (Appendix 2). All key informants who were given the questionnaires responded to the questions accordingly.

Plate 1: Key informant interview during a study to assess health risks and biosecurity measures in urban and peri-urban pig farming in Morogoro municipality, Tanzania, October 2014- January 2015.

(ii) Farmer interviews

The semi-structured questionnaire was administered by the researcher to the pig farmers (Fig. 2) and it consisted of both closed and open-ended questions (Appendix 1). Close-ended questions were useful in testing the respondents' understanding on the topic while open ended questions gave respondents freedom to express their views about the topic in detail. The average time spent to complete one interview per respondent was 12 minutes.

Plate 2: Pig farmers interview during a study to assess health risks and biosecurity measures in urban and peri-urban pig farming in Morogoro municipality, Tanzania, October 2014- January 2015.

(iii) On-site observations

On-site observations (Plate 3) were carried out for the objective of assessing the on-site situations of interest as well as probing for issues that were initially unclear in order to generate further information and understanding on the topic. These were carried out concurrently with the interviews.

Plate 3: On-site observation during a study to assess health risks and biosecurity measures in urban and peri-urban pig farming in Morogoro municipality, Tanzania, October 2014- January 2015.

3.7 Data Analysis

Quantitative data from structured interviews were analysed using the Statistical Package for Social Sciences (SPSS) version 20 (2011). Descriptive statistics such as proportions and means were calculated depending on the type of the variable. Comparisons between proportions were performed using EPI-INFO 7 (2012). For quantitative data, association between variables were assessed for statistical significance at a critical probability of $P < 0.05$ using Chi square. Qualitative data from key informants were subjected to content analysis, that is; themes (the main ideas) in each of the response given in a research question were identified and analysed.

CHAPTER FOUR

4.0 RESULTS

1. Socio-demographic and general information of the pig farmers

The study a total of 13 wards of Morogoro Municipality, namely; Kihonda, Kihonda Maghorofani, Bigwa, Kilakala, Mazimbu, Mkundi, Kingolwira, Chamwino, Lukobe, Mafisa, Boma, Kichangani and Mindu. The population of pig farmers per ward was as indicated in Table 1 below: the highest population were those from Kilakala ward, the lowest being those from Boma.

Table 1: Distribution of pig farmers by ward as per study in urban and peri-urban pig farming in Morogoro municipality, Tanzania

Wards	Frequency	Percent
Kilakala	69	24.5
Bigwa	47	16.7
Mindu	20	7.1
Lukobe	18	6.4
Mazimbu	18	6.4
Kingolwira	22	7.8
Kihonda	16	5.7
Kihonda Maghorofani	15	5.3
Chamwino	17	6.0
Kichangani	8	2.8
Boma	5	1.8
Mafisa	9	3.2
Mkundi	18	6.4
Total	**282**	**100.0**

Table 2 below shows that most of the respondents had primary education only while a few had college education. The youngest respondent was 13 years old while the oldest was 80 years old, female respondents were fewer than males.

Most pig farmers in Morogoro Municipality did not merely depend on pig farming for their livelihoods, majority engaged themselves in agricultural activities (land cultivation), few were government employees, while others were engaging themselves in informal employment (referred to as *Day Workers*).

Most of the farmers confined their pigs while 5.4% practiced free-ranging or semi-intensive system, local breeds dominated other breeds (exotic and cross breeds) refer to Table 2.

Table 2: Respondents' socio-demographic characteristics and their husbandry systems in urban and peri-urban pig farming in Morogoro municipality, Tanzania (n=282)

Variable	Category	Frequency (%)
Sex	Male	150 (53.2)
	Female	132 (46.8)
Age	≤ 30 years	74 (26.2)
	>30 - 50 years	143 (50.7)
	>50 years	65 (23.1)
Education level	No formal education	58 (20.6)
	Primary education	156 (55.3)
	Secondary education	56 (19.8)
	College/university	12 (4.3)
Occupation	Farmers	162 (57.4)
	Government employee	12 (4.3)
	Self-employment/ business	36 (12.8)
	Day workers	72 (25.5)
Pig breeds	Local	149 (52.8)
	Exotic	31 (11)
	Crossbreed	102 (36.2)
Husbandry practices	Free ranging	12 (4.3)
	Confinement	267 (94.7)
	Semi-intensive	3 (1.0)

At the moment the study was undertaken majority of respondents perceived their pigs as apparently healthy (not sick) while few admitted that their pigs were sick. Moreover, 48.2% of the respondents were not aware of any health risk that could be associated with pig farming.

Table 3 shows the distribution of the health risks known by pig farmers. Some knew that there were pig diseases that could be brought about by dirty environment or lack of vaccination (without knowing specifically which diseases are those). Others (2.5%) were concerned with the risk of being injured when attending pigs. Some farmers (6.8%) specified that bacteria, amoeba and zoonosis attributed to pigs could be threats to pig keeper's health.

Table 3: Perception on health risks related to pig farming in urban and peri-urban areas of Morogoro municipality, Tanzania.

Health Risks	Frequency	Percent
Get injured	7	2.5
Disease	53	18.8
Zoonosis	15	5.3
Worms	49	17.4
Bacteria	3	1.1
Amoeba	1	.4
Couldn't specify	18	6.4
Not Aware	136	48.2
Total	**282**	**100.0**

The awareness of health risks was not correlated to the location of farmers (p= 0.173) whereas the awareness of health risks was significantly correlated to the sex of farmers (p=0.009) with men being more aware than women. More over, some of the farmers (31.2%) responded that cleanliness can help mitigate the risks, few said that vaccination helps a lot, while the majority (55%) knew nothing on how to over come those risks.

Pig farmers in Morogoro municipality were handling pig manure in various ways as displayed in Table 4. The majority (90.8%) of the farmers were using the manure as

fertiliser in their farms while only a negligible proportion (0.4%) was using it to make biogas.

As displayed in Table 4 below, the majority (84.8%) of pig farmers in Morogoro Municipality, whenever they suspected that their animals were sick, before doing anything they called livestock field officers to confirm the sickness. Others (7.4%) treated their animals themselves without consulting the experts. And in cases of medication failures, few farmers (9.9%) opted to slaughter the animal and consume the meat before it dies and become non-useful.

Table 4: Various handling practices in urban and peri-urban pig farming in Morogoro municipality, Tanzania (n=282)

Variable	Category	Frequency (%)
Handling of pig manure	Taken to farms	256 (90.8)
	Thrown away	25 (8.8)
	Make biogas	1 (0.4)
Handling of sick pigs	Call field officer	239 (84.8)
	Own treatment	21 (7.4)
	Never experienced	12 (4.3)
	Do nothing	10 (3.5)
Handling of dead pigs	Burying	217 (77)
	Selling the meat	37 (13.1)
	Calling the Vet	28 (9.9)
Action to prevent infection	Cleanliness	88 (31.2)
	Proper feeding	39 (13.8)
	No action taken	155 (55)
Adherence to withdraw period	Yes	204 (72.3)
	No	78 (27.7)
Action taken in case medication fails	Slaughtering	28 (9.9)
	Further medication	197 (69.9)

	Don't know	57 (20.2)

Handling of dead pigs (not slaughtered) is also differing from one another, Table 4 displays that 77% of the keepers disposed their dead pigs by burying them, others (13.1%) sold the meat from the dead pigs while few (9.9%) called the vet to conduct the inspection procedure before proceeding with other processes e.g. cooking the meat for dogs or burying it.

For the strategies employed to prevent infections/diseases to the animals as indicated in Table 4 above, cleanliness of the environment surrounding their animals and proper feeding of the animals were the measures that were observed by 45% of the farmers. It was also found out that not all farmers adhered to withdrawal period.

Not all pig farmers were provided with veterinary services, as shown in Table 5, screening of animals to discover their health status and routine health check-ups for keepers (prior occurrence of a disease) were almost out of practice among pig farmers of Morogoro municipality as displayed in Table 5.

Table 5 below revealed that pig farmers of Morogoro Municipality had different protective measures in place, only 9.2% wore local protective gears (like wrapping plastic bags on hands, and normal shoes-*yeboyebo*), for the case of formal trainings to impart knowledge to the pig farmers on biosecurity measures in pig production; only 15.6% of the population had such kind of a skill.

Furthermore, 68.4% were quarantining their animals for preventing fights between the animals. Also there was a correlation between the presence of biosecurity training and the sanitary measures at p=0.015 (using the Pearson's correlation test of SPSS).

For the context of this study, "**veterinary services**" refers to technical advice on preventing animal diseases and/or treatment of sick animals. "**Presence of screening**" refers to a test or testing carried out routinely on supposedly healthy pigs in order to establish, as early as possible, whether or not they have an illness or disease. "**Routine check-up for keepers**" means the tendency of pig farmers to conduct regular medical examinations to find out their current health status regardless of the occurrence of the disease.

Table 5: Routine measures for preventing pig diseases in urban and peri-urban pig farming in Morogoro municipality, Tanzania (n=282).

Variable	Category	Frequency (%)
Veterinary service	Yes	187 (66.3)
	No	95 (33.7)
Presence of screening	Yes	58 (20.6)
	No	224 (79.4)
Routine check-up for keepers	Yes	54 (19.1)
	No	228 (80.9)
Protective measures	Nothing	54 (19.1)
	Gloves	55 (19.5)
	Gloves and gumboot	31 (11)
	Gumboots	116 (41.1)
	Local protective gears	26 (9.2)
Presence of biosecurity training	Yes	44 (15.6)
	No	238 (84.4)
Quarantining	Yes	193 (68.4)
	No	89 (31.6)

Knowledge and Practices of Livestock Officers on Health Status of Pigs, Treatment and Biosecurity Measures

1: Animal Health Status and Treatment

Common pig diseases in Morogoro municipality as reported by ward livestock officers were worm infestation, followed by mange, diarrhoea, pneumonia and diamond disease while fever was the least common. As explained by the ward livestock officers, those diseases were caused by poor management of animals (including poor feeding, poor handling of husbandry facilities, poor sanitation), microorganisms through inhalation/ingestion via food/water plus other factors like lack of education, poor economic status and traditional mind-set of the keepers.

The ward livestock officers got information about a sick animal through two ways; active visiting the household of their pig farmers to check the animals, and sometimes informed by the owners. They were also applying different disease control techniques as follows; treatment of the sick animals to prevent further infection, vaccination, education on good husbandry (proper feeding, sanitation) and quarantining, technical advice, while '*three months routine*' following deworming schedule and regular visits were useful to check the animal's health status.

Most of the experts (83.3%) claimed that they were doing routine screening for prevention of diseases in their areas, moreover it was discovered that the experts themselves confused vaccination, sanitation, quarantining, treatment and proper feeding with screening. At the same time, one of the experts complained that there was poor response from farmers whenever he was planning to conduct animal screening.

Occurrence of pig death due to diseases was also common, and whenever it occurred; among the immediate steps taken by the experts were; conducting post-mortem, supervising the immediate burial of the carcass after death, taking disease history and later advice on deworming was given in cases where worm infestation contributed to the occurrence of the event.

The most frequent drugs used in treatment of sick pigs were ox-tetracycline, penistrep, sulfadimidine, tylosin, limoxin-50 and ivermectin. Fifty percent (50%) of experts gave technical advice to the livestock keepers in their respective areas regarding drug withdrawal periods and side effects that could be encountered due to drug/antibiotic residue, sometimes they totally prohibited farmers from using un-prescribed drugs.

Few of them (8.4%) were not able to follow up on farmer's adherence as they claimed that the environment was not conducive for them to do so (without giving details). One of the livestock officers narrated, "Farmers are complaining that sometimes it is very difficult to observe withdrawal condition as the risk of the pig dying during medication is high, thus they are obliged to slaughter the animal before it dies in order to avoid the double loss".

In cases where a pig does not recover after treatment, most of ward livestock officers (83.3%) advised farmers to consult the veterinary officer for further medication, while 8.3% of them advised their farmers to quarantine while other livestock officers (8.4%) advised the farmers to slaughter the pigs.

2: Husbandry Practices and Biosecurity Measures

The practice of confinement was a dominant way of pig husbandry in the municipal, and the local breeds were the most common in the studied area. For the sanitary measures that

were observed by experts when attending pigs; it was found out that the use of gumboots was most commonly observed, followed by the use of gloves and overalls, other measures like washing hands, use of disposable syringe, and sterilization of equipment were not adequately observed, while disinfection was almost negligible.

There was no regular health check-up for people attending pigs (prior the occurrence of a disease), but pigs were regularly checked and the most common disease conditions reported were worm infestation, mange and diarrhoea, but the good thing was the assurance of treatment of sick pigs was high. Some livestock officers (67%) performed health check-ups for pigs on a monthly basis while others (25%) were conducting it quarterly according to the deworming schedule.

According to ward livestock officers; large quantities of pig wastes in the municipal were disposed in farms as manure, while other disposal mechanisms like throwing at the back of the pig pen were also practised. The fate of the thrown manure in the latter practice was not known by these livestock officers. Moreover, 67% of the livestock officers claimed that they conducted trainings to their farmers on biosecurity measures in farming.

CHAPTER FIVE

5.0 DISCUSSION

5.1 The Overview of Pig Production in Morogoro Urban and Peri-urban

Pig production especially in urban areas, is challenged by limited space for safekeeping animals as well as proper disposal of pig wastes that would be environmental friendly and bringing no harm to the health of animals and humans. Low education level among pig farmers can be one among the factors that aggravate the poor farming conditions, that is; poor feeds, handling practices, poor sanitation and hence low protection of both animals and keepers themselves from the associated health risks. Studies conducted on pigs have demonstrated to an increased awareness of zoonotic infections in many developing countries, including eastern and southern Africa (Phiri *et al*., 2003) and Mbulu district of Tanzania (Ngowi *et al*., 2004).

In this study, the highest population of pig farmers in urban and peri-urban areas of Morogoro municipality, Tanzania, comprised of those who attained primary education only while the lowest population were those with college education. The level of education was not found to influence the acquiring of formal trainings on biosecurity measures among the pig farmers.

5.2 Pig Production Constraints

Shortage of livestock field officers like in Bigwa; one of the wards with the highest pig production practices in the municipal, (at the period when the study was carried out there was no livestock officer to attend farmers), poor commitment of the experts as they were not paying regular visits to their farmers to check on the animals and give technical

advice, lack of funds to conduct the trainings regularly among other factors that may be known by the experts themselves.

The livestock experts were claiming that shortage of resources like funds to organize trainings, lack of transport to visit farmers' households (as the houses were scattered), and sometimes poor response from farmers were among the factors that contributed to the failure in the implementation.

In Morogoro municipality about one-third of pig farmers did not have access to veterinary services due to lack of funds to pay for the services, remoteness of the households or shortage of experts in some areas. Availability of experts helps to impart knowledge to the farmers on how to protect themselves as well as their animals from diseases. Also provision of veterinary services like vaccination and treatment prevent and cure diseases, thus prevent the introduction and spread of diseases in a population therefore adequate veterinary services available and accessible to all livestock keepers would ensure good livestock keeping practices in the population.

It has been found out in this study that most pig farmers in Morogoro municipality were not merely depending on pig farming for their livelihood. A large proportion engaged in other economic activities, notably crop farming followed by casual labour works. This makes them busy and with little time devoted for taking care of their pigs, posing a greater risk for the animals.

Pig production was therefore taken as a complementary activity, unlike cattle keeping, much little attention paid, and therefore pigs, among other animals were more at risk of infections/diseases. According to Tomass *et al*. (2013) pigs are widely raised under

extensive management in developing countries of Africa because; there is availability of cost free feed (household or municipal garbage), and possibilities for the animals to get better nutrition through scavenging. Thus, infection of pigs with gastrointestinal (GIT) parasites is widely reported from all corners of the world and shown to be influenced by the type of pig management practiced. For those keepers who were also keeping other animals like cattle and goats admitted that they devoted much more time and attention in cattle than in other animals, including pigs.

5.3 Pig Husbandry Practises in the Municipality

On the type of pig husbandry practiced by pig farmers of Morogoro Municipality, confinement was the most dominant. Most farmers confined their pigs to avoid conflicts with their neighbours, precisely due to religious reasons and local government regulations. Similar mode of husbandry was reported by Lupindu *et al.* (2012) however, the reasons for such confinement were not in accordance with those recorded in the current study. According to Lupindu *et al*. (2012) cattle farmers kept their animals in confinement for security reasons. Whatever reason for confinement, farmers confining their pigs protect them from infections from other animals and external environment.

Though the tendency of confining pigs is highly practiced in the municipality, and of course it plays a big role in reducing the possibility of infections from other and among the animals, farmers themselves were not aware of the fact thus it is crucial to make them understand that confinement does not only help them to avoid conflicts with the neighbourhood but also prevents new infections hence safekeeping their animals. That understanding will create a need to confine animals even when they happen to live among the neighbourhood that has no problem with the free ranging.

Free range and semi-confinement management system is an important risk factor for porcine cysticercosis as verified by Makundi (2012) that low prevalence of porcine cysticercosis in Morogoro region was mainly due to intensive farming system mainstreamed by the local government by-laws regulating livestock farming in urban areas.

Free range system exposes the roaming pigs to *Taenia solium* eggs as they can easily access human faeces from *Taenia solium* carrier humans. Other studies elsewhere within Africa (Sikasunge *et al*., 2007; Krecek *et al*., 2008; Waiswa *et al*., 2009; Pondja *et al*., 2010; Komba *et al.,* 2013) and Latin America (Sarti *et al*., 1997; Sakai *et al.,* 2001; Komba *et al.,* 2013) also identified extensive pig management system as an important risk factor for transmission of *Taenia solium* eggs to pigs.

Taenia solium cysticercosis is an infection involving pig as intermediate host and human being as definitive and/or intermediate host. Ingestion of infective eggs passed by a person with an adult cestode of *Taenia solium* either by autoinfection, direct contact with another tapeworm carrier or indirectly via ingestion of contaminated food, water, or hands may lead to cysticercosis in humans whereby larval tapeworm cysts develop in the muscles, eye and central nervous system. Human cysticercosis causes a variety of neurological symptoms, most commonly seizures due to cysts in the brain, a condition known as neurocysticercosis (Makundi, 2012). Therefore, thorough meat inspection is needed to ensure food safety to the consumers.

5.4 Health Risks in Pig Production

This study revealed lack of awareness on possible health risks that could be associated with pig production either from the pigs themselves or their wastes. These findings are

similar to the findings by Lupindu *et al.* (2012). Lack of knowledge on health risks in pig production is another important risk for both, people and the animals to acquire diseases as there is a great possibility that they would have no or minimal biosecurity measures in place. Prior to biosecurity trainings farmers need to be aware of the health risks that could counteract their productivity as well as their wellbeing if their production practices did not conform to the guidelines. The acquired knowledge would drive the desire to have proper preventive and/or protective measures in place and to further ensure good quality of the produce.

Understanding the health risks associated with pig production on its own helps nothing, if there is lack of knowledge on how to mitigate the risks. In this study, about half of the respondents did not know any health risk mitigation measure though majority of the remaining proportion mentioned cleanliness could help to mitigate the risks.

In reality, cleaning without disinfection is not an effective way in preventing infections, and most farmers did not practice the combination of cleanliness and disinfection. Canadian Swine Health Board Technical Committee on Biosecurity, (2010) defined **cleaning** as the removal of any visible accumulation of organic matter and debris or other residues while **disinfection** is the application of a physical or chemical process to a surface for the purpose of destroying or inhibiting the activity of disease-causing microorganisms.

For effective control of diseases, a combination of measures is inevitable. Vaccination, good sanitary practices, and quarantine of new and sick animals, proper feeding, regular screening, and early treatment of the sick are important measures to be appreciated.

Findings of the present study revealed that most of pig keepers were not aware of some of the diseases prevailing in their areas. There was an indication that some farmers could not recognise their sick pigs as most of those who were saying that their pigs were normal were apparently not normal as most had mange. The finding agrees with Boa *et al* (2006) that intestines of all *Ascaris*-infected pigs appeared normal, but pigs had multi focal parasitic interstitial hepatitis and multi focal parasitic granulomatous pneumonia composed of 1–2 mm large pale nodules, histopathologically consisting of eosinophilic granulomas.

This condition puts farmers into more danger of zoonosis as they frequently come into contact with their pigs without even knowing the actual health status of their animals, thus it is worth that knowledge on signs and symptoms of diseases be disseminated so that diseases could be treated earlier following early detection.

The awareness of health risks was not correlated with the location of farmers in the study area. This calls for awareness creation in all areas where pig production is practiced in the municipality. On the other hand awareness of health risks was significantly correlated with the sex of farmers, with men being more aware than women. This might be due to the fact that African tradition does not allow women to mingle too much or bring their household issues outside or discuss it with others. They therefore stay silent on a number of issues even with the Veterinary personnel, while men have the possibility to discuss with their fellow farmers or veterinarians to get more knowledge.

According to Kolawole (1997) on Womanism and African consciousness, Women's voicelessness is a paradox that is imposed by socialization. The quest for a re-

conceptualization of gender theory has embraced the rejection of the culture of silence and the unfolding of the areas of women's audibility in both traditional and modern societies.

5.5 Management of Wastes/Manure

For the disposal of a dead pig, it was found out that most of pig keepers disposed their dead pigs by burying them, while a few called the veterinary personnel to conduct an inspection before proceeding with other processes, such as cooking the meat for dogs or burying it. Livestock field officers should advice farmers to consult veterinary officers for inspection and advice before burying a dead pig to prevent transmission of diseases.

Lupindu *et al* (2012) on cattle manure management found out that some cattle keepers used manure as fertilizer, especially those owning large pieces of land while others did not use manure as fertilizer at all. However, in both cases, most respondents spread manure direct on land as the preferred way of disposal, those who did not spread manure on land opted for burning or giving it away to friends in plastic bags. In the present study, pig manure was handled through various ways by pig farmers of Morogoro municipality, with most farmers disposing it directly to farms.

Improper handling of animal wastes, such as throwing it into open environments as reported by some pig farmers is a public health risk, especially in urban areas as the population is growing very fast and the land is continuing being scarce. The thrown away animal wastes if infected with disease causing microorganisms are more likely to infect large populations of people due to increased interaction of people and animals, worsened by poor veterinary services provided and unfavourable infrastructures as there are no official reservations for animal waste disposal located by the municipality.

These detrimental effects of manure handling practices in urban and peri-urban areas come as a result of land scarcity and poor manure handling infrastructures because urban and

peri-urban livestock farming was not integrated in planning process of towns like Morogoro, Dar es salaam, Dodoma and Mbeya (Mvena, 1999).

Further findings indicated that more efforts need to be directed to the meat inspection procedure, and making sure that they are effective and efficiently conducted as it has been discovered that some pig farmers sold meat from dead pigs and therefore the risks associated with the production can be passed to the customers through consumption of meat from infected dead pigs. A great public health risk not only to these rural areas where pigs are produced, but also to urban centers where pigs from rural areas are eventually trans-ported (Sikasunge *et al.,* 2007; Mkupasi *et al.,* 2011).

Boa *et al* (2006) on swine cysticercosis reported that the households where home slaughtering of pigs took place without pork inspection had a higher risk of porcine cysticercosis. Pigs slaughtered at home and not officially inspected pose a serious public health risk. Public education on the danger of consuming uninspected pork is a necessity in these areas.

The practice of treating the animals by farmers themselves exposes them to the dangers of zoonosis as most of them did not have both the appropriate skills for the animal treatment and biosecurity measures in place. Few farmers treated their animals without consulting the livestock officers.

5.6 Biosecurity Measures for Good Animal Production

For the strategies employed to prevent infections/diseases to the animals, more than half of the pig farmers were not taking any action to prevent infection because of lack of

knowledge. Lack of knowledge on biosecurity measures is a serious threat to the health of both, the animals and the animal keepers too.

Some pig farmers of Morogoro municipality did not have adequate protective measures in place, few wore local protective gears (like wrapping plastic bags on hands, and normal shoes-*yeboyebo*) while others did not have any protective measure, similarly to Lupindu *et al* (2012) who reported that the use of rubber boots was an observed practice by less than a half of respondents while the remaining fraction wore ordinary shoes e.g. sandals while handling manure.

Attending pigs/animals with bare hands and/or feet increases the chances of infections from human to the animals and vice versa. Lambert and D'Allaire (2009) on biosecurity in swine production reported that most producers were concerned by biosecurity but others, although well aware of the consequences of a lack of biosecurity, did not comply or applied the rules only partially. These non-compliant producers may increase the risk of contamination of farm's surroundings and may represent a real threat, especially in a high pig density area.

For the municipal to ensure good farming practices (that is environmental friendly) and improved productivity from the livestock sector, biosecurity training is inevitable. Results reveal that majority of farmers had never received a formal training on the subject and they were just applying their usual way of pig husbandry (the way their parents and others were doing). It will never be possible to fight/prevent zoonotic diseases without taking appropriate measures to equip the animal keepers with appropriate skills on biosecurity.

Adherence to antimicrobial withdrawal period is another issue of public health concern as it was also found out that many farmers were not adhering to withdrawal periods in case their pigs were treated. Adherence to medical withdrawal times may be burdensome, inconvenient and expensive. Also lack of treatment records or failure to adequately identify treated animals can also lead to insufficient withdrawal times (Blackwell 2013).

Residues of antimicrobial animal drug raise special concerns with regard to allergic reactions and carcinogenicity. Ordinary cooking procedures for meat, even to "well done," cannot be relied on to inactivate drug residues (Moats, 1999; Blackwell, 2013). Allergic reactions are manifested in many ways, from life-threatening anaphylactic reactions to lesser reactions such as rashes.

In addition, lack of knowledge on which steps to be taken in case medication fails, as observed in this study, verifies that some of the pig farmers of Morogoro municipality were bio-in secured from infections/diseases from their animals thus experts have to equip their livestock keepers on appropriate measures to be taken whenever medication fails.

The practice of screening animals helps to detect the possibility of future occurrence of a disease or presence of a hidden disease thus early control of disease spread. Screening of animals to discover their health status (prior occurrence of a disease) was almost out of practice among pig farmers of Morogoro municipality.

Routine health check-ups for pig keepers (focusing on those who attend the pigs) prior symptoms of a disease among pig farmers was conducted by only a few farmers (19.1%) and the rest were just treating the diseases after they were confirmed infected, a situation that could expose the animals to the danger of zoonotic diseases from humans. Health

check-ups help to detect and therefore treat the infection earlier, thus preventing the spread of the disease.

Quarantine of new animals is very crucial in protecting other pigs from new infections that can be brought about by incoming pigs. Quarantine measures were not effectively observed among pig farmers of Morogoro municipality, limited space being the major reason. For the majority who were quarantining their animals (68.4%) they were doing so for preventing fights between the animals (newly incoming versus the indigenous).

More knowledge dissemination is needed to make farmers aware of the importance of quarantining that it goes further than just preventing fights among animals, and may be through that even those who were not quarantining will find the means to ensure other pig houses are constructed and reserved for new incoming animals.

As verified by the study, animal keepers are more at risk of infections/diseases from their animals than other groups of the society. Since zoonotic microorganisms have the ability of jumping from one specie to another and cause infections, proper biosecurity measures in place are inevitable whenever we are thinking/planning of protecting the health of animals and their keepers.

CHAPTER SIX

6.0 CONCLUSIONS AND RECOMMENDATIONS

Pig production in Morogoro Municipality, is surrounded with lots of constraints socially, economically and health wise whereby pig farmers lack proper production inputs that is; poor housing for pigs, protective gears, for ensuring good farming practices, shortage of funds to cover the cost of veterinary services exacerbated by poor knowledge on biosecurity measures.

Other constraints like lack of reservations (due to shortage of land) for their temporary animal wastes disposal is becoming a major challenge and a source of conflicts with the society as well as the officials concerned with public health, thus farmers should be advised and trained on generation of biogas out of the manure. Furthermore, due to increased urban population and therefore increased interaction of people and animals, the chances that animal diseases can easily infect human beings and vice versa, have also been increased.

Strengthening of biosecurity is a priority among the solutions required to minimize the risk of disease spread. It does not reduce the necessity for appropriate preparedness plans and adequate resources to control disease outbreaks once they occur; but it is proactive, has a preventive impact and enables producers to protect their assets. The municipality should therefore ensure that its officials dealing with livestock development are motivated enough to enhance their commitment to work, and well equipped (provision of transport) to ensure accessible veterinary services to all the livestock keepers especially those who reside at the

peripheral areas. By so doing; more knowledge on good farming practices will be disseminated.

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APPENDICES

Appendix 1: A farmer's questionnaire during a study to assess health risks and biosecurity measures in urban and peri-urban pig farming in Morogoro municipality, Tanzania, October 2014- January 2015.

PART A: RESPONDENT PARTICULARS

1. Education level of respondent:……
2. Date of interview:……/……/20…..
3. Age of the respondent (years)….....
4. Sex of the respondent:

   ☐ Male ☐ Female
5. Ward……
6. Occupation of the respondent

   ☐ Small holder farmer ☐ Government employe ☐ Self employment ☐ others (specify).....
7. Position of the respondent in the house hold

   ☐ Father Mother ☐

   ☐ Child (Daughter or Son) ☐ Employee ☐ Others (Specify)……

PART B: HEALTH STATUS OF THE ANIMALS AND BIOSECURITY MEASURES

PART B – 1: ANIMAL HEALTH STATUS AND TREATMENT

1. Do you receive any veterinary service?

   Yes No

2. What is the general health status of the animals in your herd?

   Normal/ not sick ☐ Sick ☐

If sick, what is the problem, specify/mention……

……...

3. What do you do when you have a sick animal?

   ……

4. Are there any cases of occurrence of animal death due to diseases?

   Yes ☐ No ☐

If yes, specify the disease……...

5. What actions are you taking to prevent further infections?

   ……

6. How long do you stay after antibiotics administrations/treatment before consuming the animal products? .....

7. What do you do if the pig does not recover after medication?

   Slaughtering ☐ Further medication ☐ others (specify)☐……

PART B – 2: HUSBANDRY PRACTICES AND BIOSECURITY MEASURES

1. What type of pig husbandry are you practicing?

Free ranging ☐ Confinement ☐ others (specify)……..

2. Which kind (race) of pig are you breeding/keeping?

   Local ☐ Exotic ☐ crossbreed ☐

3. Is there any routine screening for prevention of diseases?

   Yes ☐ No ☐

If yes, mention the diseases and their screening/prevention procedure:

……

If no, give reasons……

4. Mention the sanitary measures that you take during attending pigs?

……

5. What is the source and status of water that you are using for animal drinking and cleaning of the herd and/or equipment?.....

6. What is the source of feeds used to nourish your pigs?

Mention:……

7. Are there any routine check-ups of health status of those people who are attending pigs?

Yes ☐ No ☐

If No skip to question 10

8. If yes, what are the common diseases found?

……

9. Are they treated if found sick?

……..……...

10. How frequently do you perform health check-ups to your animals?

☐ Monthly ☐ Quarterly ☐ Yearly ☐ other (specify)……

11. If yes, what are the common diseases found?

……

12. Are they treated if they found sick?

……..……..……

13. What kind of protective measures are you taking when attending sick pigs?

Mention:……

14. How do you handle pig wastes at the household level?

……

15. Do you have knowledge on biosecurity measures in farming?

Yes ☐ No ☐

If yes, how did you get the

knowledge……

16. How do you handle a dead animal (not slaughtered)?

……

17. What do you do with pork meat from a slaughtered sick animal?

☐ A-sell ☐ B-For household consumption ☐ both A and B

PART C: KNOWLEDGE ON HEALTH RISKS IN PIG PRODUCTION

1. Do you know the health risks associated with pig production?

Yes ☐ No ☐

2. If yes, what risks do you know?

……

3. What measures do you take to protect yourself and/or your animals from those risks?

……

4. Do you require that pigs entering your herd go through a period of isolation?

Yes ☐ No ☐

Give reason to your answer

……

5. Do you know any source(s) of diseases in pigs?

Yes ☐ No ☐

IfYes,mention:…….

6. What can be done to prevent pig diseases?

……

Thank you* very *much for your participation in this study

Appendix 2: A key informant's questionnaire during a study to assess health risks and biosecurity measures in urban and peri-urban pig farming in Morogoro municipality, Tanzania, October 2014- January 2015.

PART A: RESPONDENT PARTICULARS

1. Name of respondent:…….……

2. Date of interview:…..…/……/20……

3. Occupation:……..

PART B: HEALTH STATUS OF ANIMALS AND BIOSECURITY MEASURES

PART B – 1: ANIMAL HEALTH STATUS AND TREATMENT

4. What are the common pig diseases in your area?

   ……

5. What are the sources of these diseases?

   ……

6. How do you get the information about a sick animal?

   ……

7. How do you control diseases?

   ……

8. Is there any routine screening and prevention of diseases?

   Yes ☐ No ☐

If yes, mention screening and prevention procedures for the most common pig diseases in the area……

If no, give reasons why……..

9. Are there any cases of occurrence of pig death due to diseases?

   Yes ☐ No ☐

If answered Yes, what actions do you

take:……..…

10. Do you use antibiotics in treating sick pigs?

Yes ☐ No ☐

If answered Yes, mention the type of antibiotics that are commonly

used:……...……

……

11. How do you control farmers' adherence to withdrawal periods after antibiotics administration?.....

12. What do you advice farmers if a pig does not recover after treatment?

……

PART B – 2: HUSBANDRY PRACTICES AND BIOSECURITY MEASURES

18. What type of animal husbandry do people practise in your area?

Free ranging ☐ Confinement ☐ others (specify)……..

19. Which breed (race) of pig do people keep in your area?

Local ☐ Exotic ☐ crossbreed ☐

20. Mention the sanitary measures that you take during attending pigs?

……

21. In your area, are there any check-ups of health status of people attending pigs?

Yes ☐ No ☐

22. If yes, what are the common diseases found?

……

23. Are there any routine check-ups of health status of pigs in this area?

Yes ☐ No ☐

If No skip to question 10

24. If yes, what are the common pig diseases found in this area?

……

25. Are they treated if they are found sick?

……..……...

26. How frequently do you perform health check-ups of your pigs?

☐ Monthly ☐ Quarterly ☐ Yearly ☐ other (specify)……

27. How do you handle pig wastes in your area?

……

28. Do you conduct some training to your farmers on biosecurity measures (good hygienic practices in farming)?

…….....

29. How do you handle a dead animal (not slaughtered)?

……

30. Do you use antibiotics in treatment of sick animals specifically pigs?

Yes ☐ No ☐

If Yes, mention type of antibiotics that you are commonly using:……...…

….....

31. Do you ensure that farmers adhere to the withdraw periods after antibiotics administrations/treatment?

Yes ☐ No ☐

Ifyes,how……..

Ifno,why……

32. What do you advice farmers if the pig does not recover after medication?

Slaughtering ☐ l☐er medication others (specify)…….....

Appendix 3: Education level of the respondents, breeds of pigs kept and pig manure handling in the municipality

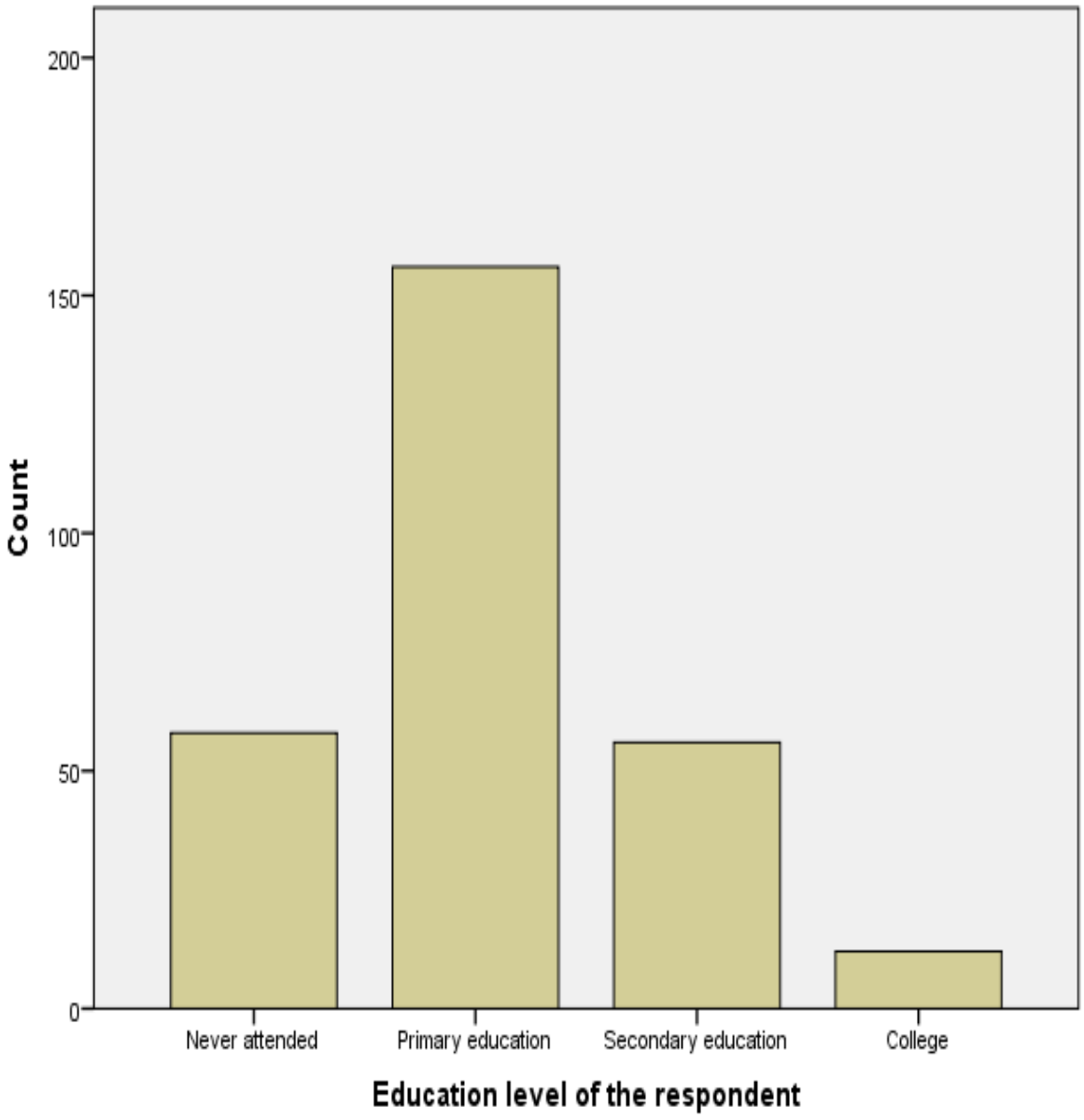

Figure 1: Education level of respondents

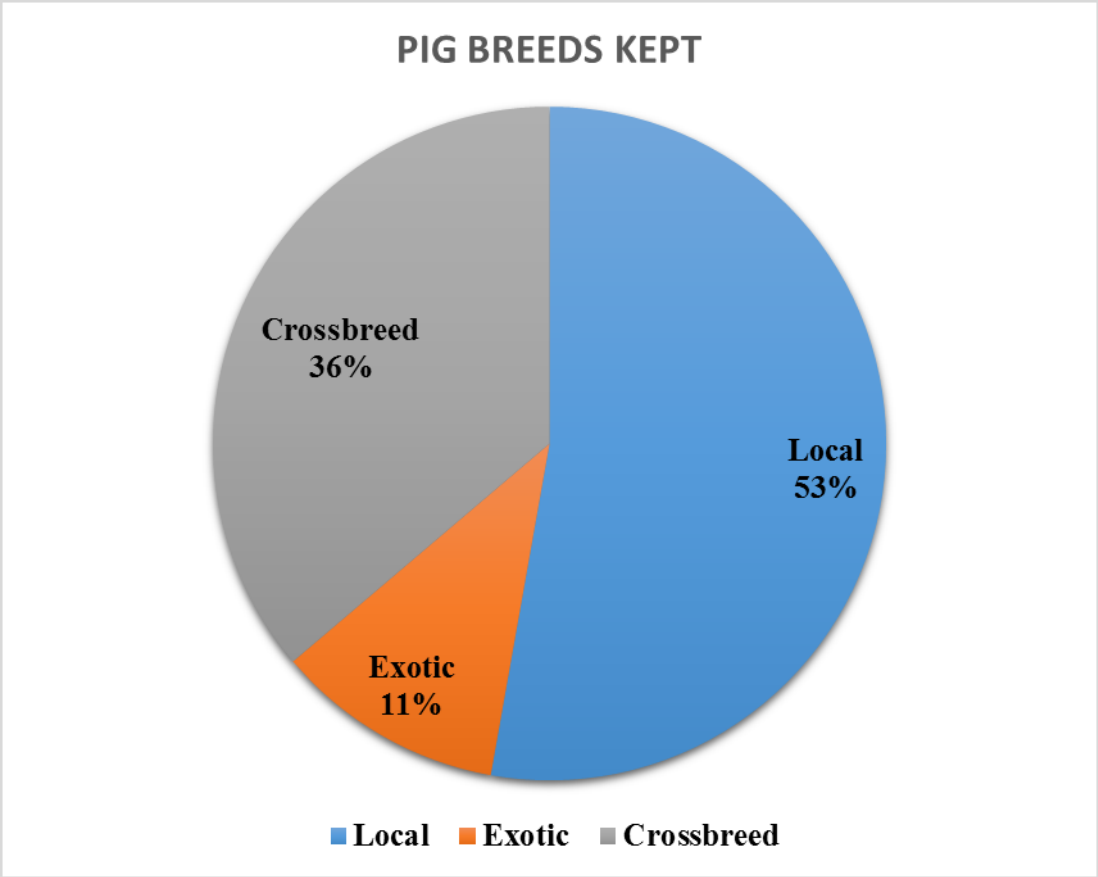

Figure 2: Breeds of pigs kept by farmers of Morogoro Municipality

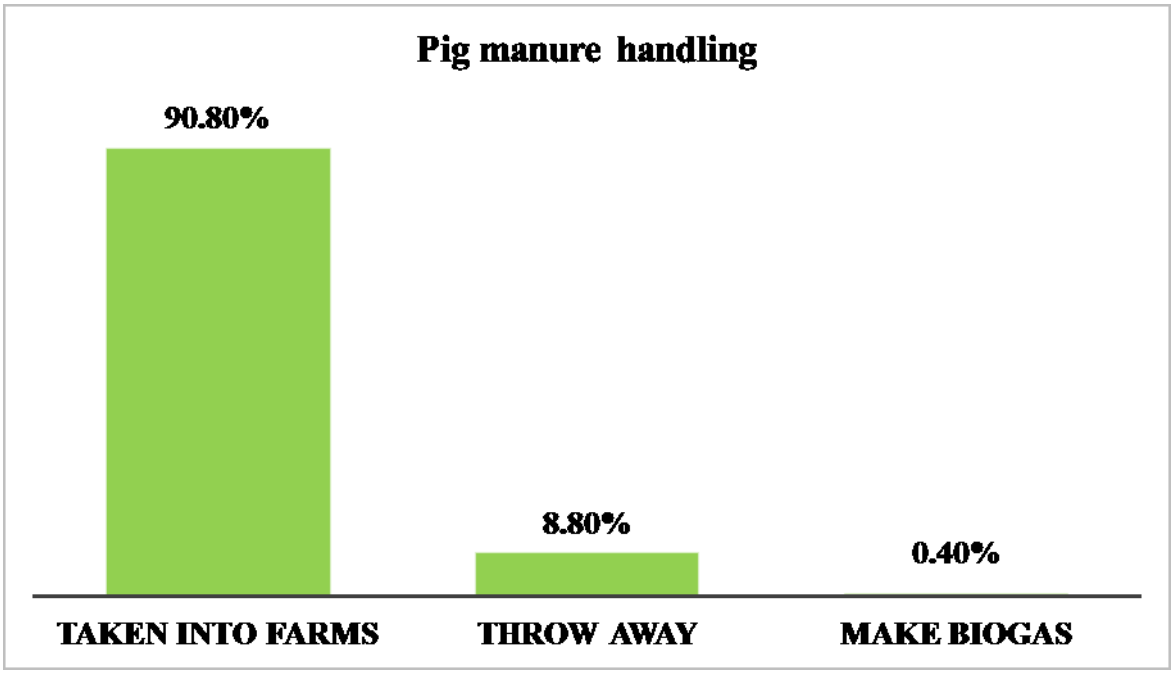

Figure 3: Pig manure handling by farmers of Morogoro Municipality

Table 1: Correlations

		Farmer's location	Awareness of health risks in pig production	Sex of the respondent
Farmer's location	Pearson Correlation	1	.081	-.004
	Sig. (2-tailed)		.173	.943
	N	282	282	282
Awareness of health risks in pig production	Pearson Correlation	.081	1	.155**
	Sig. (2-tailed)	.173		.009
	N	282	282	282
Sex of the respondent	Pearson Correlation	-.004	.155**	1
	Sig. (2-tailed)	.943	.009	
	N	282	282	282

**. Correlation is significant at the 0.01 level (2-tailed).

Table 2: Correlations

		Common disease found in keepers	Screened diseases
Common disease found in keepers	Pearson Correlation	1	.500**
	Sig. (2-tailed)		.000
	N	282	282
Screened diseases	Pearson Correlation	.500**	1
	Sig. (2-tailed)	.000	
	N	282	282

**. Correlation is significant at the 0.01 level (2-tailed).

Common diseases found in livestock keepers are significantly correlated with those screened in animals $p<0.01$

Table 3: Correlations

		Keepers health	Presence of Biosecurity training	Sanitary measures	Protective measures in the husbandry	Use of sick animal's meat
Keepers health	Pearson Correlation	1	.128*	.240**	-.058	.127*
	Sig. (2-tailed)		.032	.000	.329	.033
	N	282	282	282	282	282
Presence of Biosecurity training	Pearson Correlation	.128*	1	.144*	-.126*	.039
	Sig. (2-tailed)	.032		.015	.035	.517
	N	282	282	282	282	282
Sanitary measures	Pearson Correlation	.240**	.144*	1	-.168**	.093
	Sig. (2-tailed)	.000	.015		.005	.117
	N	282	282	282	282	282
Use of sick animal's meat	Pearson Correlation	.127*	.039	.093	-.045	1
	Sig. (2-tailed)	.033	.517	.117	.453	
	N	282	282	282	282	282

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

The presence of biosecurity training, sanitary measures in place and use of sick animal's meat had a significant influence on the keepers' health at p=0.032, p=0.000 and p=0.033 respectively. Also there was a correlation between the presence of biosecurity training and the sanitary measures at p=0.015.