ASSESSMENT OF USE, ATTITUDES, CONSTRAINTS AND IMPACT OF CATTLE MANURE ON MAIZE FARMING BY SMALLHOLDER FARMERS IN NJOMBE TANZANIA

STEVEN SHILEMBA ENOS

A DISSERTATION SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF SCIENCE IN AGRICULTURAL EDUCATION AND EXTENSION OF SOKOINE UNIVERSITY OF AGRICU++LTURE. MOROGORO, TANZANIA.

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ABSTRACT

Maize is the most important staple food and cash crop in Tanzania. Cattle manure has become an important as a source of soil nutrients in situations where use of inorganic fertilizer is not affordable. In view of the apparent decline in soil fertility, deliberate efforts are required to promote utilization of cattle manure for crop production. The Main Objective of the study was to assess the use, attitudes, constraints, and impacts of cattle manure in maize farming in Njombe District. Specifically the study intended to (i) describe farmers' practices on the production, management and application of cattle manure on their fields, (ii) To identify farmers attitude towards cattle manure (FYM), (iii) To measure farmers attitude towards bio-slurry, (iv) To measure farmers attitude towards inorganic fertilizer in crop production, (v) To identify constraints encountered by farmers on cattle manure production, management and utilization at a farm level and (vi) To determine the impacts on yield as a result of cattle manure use. Data were collected by interviewing farmers using semi-structured questionnaires as the main tool. The questionnaire comprised of closed and open ended questions. Descriptive, reliability, and inferential analysis was conducted using Statistical Package for Social Science version 12 and 16 respectively as a tool for analysis. Results revealed that farmers have positive attitudes on FYM, however, they hold negative attitude on bio-slurry and again farmers who grow crops only have positive attitude on inorganic fertilizer. Constraints identified were few cattle, lack of labour and high cost of labour as well as lack of manure transport. Use of cattle manure (FYM and bio- slurry) shows more yield than non-use at $p \leq 0.05$ level of significant. The majority of farmers preferred cattle manure to improved soil fertility.

DECLARATION

I, STEVEN SHILEMBA ENOS do hereby declare to the senate of Sokoine University of Agriculture that this dissertation is my own original work and has neither been submitted nor being concurrently submitted for a degree award at any other institution.

Steven Shilemba Enos Date

(MSc. Agricultural Education and Extension Candidate)

The above declaration is confirmed;

Dr. F.T. Magayane Date

(Supervisor)

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TABLE OF CONTENTS

ABSTRACT .... **ii**

DECLARATION .... **iii**

COPYRIGHT .... **iv**

ACKNOWLEDGEMENTS .... **v**

DEDICATION .... **vii**

TABLE OF CONTENTS .... **viii**

LIST OF TABLES .... **xii**

LIST OF FIGURES .... **xv**

LIST OF APPENDICES .... **xvi**

LIST OF ABREVIATIONS AND ACRONYMS .... **xvii**

CHAPTER ONE **1**

1.0 INTRODUCTION **1**

1.1 Background Information 1

1.2 Problem Statement 4

1.3 Justification of the Study 6

1.4 Objectives 6

1.4.1 Main objective 6

1.4.2 Specific objectives 6

1.4.3 Research questions 7

CHAPTER TWO **8**

2.0 LITERATURE REVIEW **8**

2.1 Role of Cattle Manure in Agricultural Production 8

2.2 Characteristics of Smallholder Farmer 9

2.3 Farmers Practices on Production and Management of Cattle Manure 11

2.4 Practices and Methods of Manure Storage 13

2.5 Cattle Manure Application 14

2.6 Adoption of Cattle Manure as a Fertilizer 15

2.7 Conceptual Framework 16

CHAPTER THREE 18

3.0 METHODOLOGY 18

3.1 Location and Geographical Description of the Study Area 18

3.2 Research Design 19

3.3 Study Population 19

3.4 Sampling Frame and Sampling Method 20

3.5 Sample Size 20

3.6 Data Collection 20

3.6.1 Primary data collection 21

3.6.2 Secondary data collection 21

3.6.3 Qualitative data 21

3.6.4 Quantitative data 22

3.7 Data Collection Instruments 22

3.8 Instruments Pre-testing 23

3.9 Measurement of Attitude 23

3.9.1 Attitude towards FYM 24

3.9.2 Attitude towards bio- slurry 24

3.9.3 Attitude towards inorganic fertilizer 25

3.10 Data Analysis 25

3.10.1 Descriptive analysis 25

3.10.2 Inferential analysis 26

CHAPTER FOUR **27**

4.0 RESULTS AND DISCUSSION **27**

4.1 Characteristics of Smallholder Farmers in the Study Area 27

4.2 Farmers Practices on the Production, Management, Uses and time of Cattle Manure Application 33

4.2.1 Cattle keeping and manure production practices 33

4.2.2 Cattle management systems adopted 35

4.2.3 Constraints on manure production 37

4.2.4 Cattle manure management practices 38

4.2.5 Constraints on cattle manure management 47

4.2.6 Practices of farmers on manure application 49

4.2.7 Constraints encountered in application of cattle manure 54

4.3 Attitude towards Farm Yard Manure 55

4.4 Attitude towards Bio- Slurry Manure 57

4.5 Attitude towards Inorganic Fertiliser 58

4.6 Impact of Cattle Manure on Maize Yield 61

CHAPTER FIVE **66**

5.0 CONCLUSION AND RECOMMENDATIONS **66**

5.1 Summary 66

5.2 Conclusions 67

5.3 Recommendations 68

REFERENCES.. 71

APPENDICES 85

LIST OF TABLES

Table 1: Name of village and number of respondents 27

Table 2: Age, marital status and educational level of respondents 28

Table 3: Household size and the number of people who provide farm labour 30

Table 4: Type of farming 31

Table 5: Mode of Land acquisition and household farm size 32

Table 6: Maize farm size 33

Table 7: Cattle management system adopted 36

Table 8: Type of feeds used by cattle keeping household 37

Table 9: Constraints encountered by cattle keeping respondents in cattle manure production 38

Table 10: Major Practices adopted as a part of manure management 39

Table 11: Time for storing manure before it is applied to the farm 39

Table 12: Ways of capturing urine flowing out of the barn 41

Table 13: Other Practices used to manage cattle manure 42

Table 14: Labour source for cattle manure management practices 43

Table 15: Practices used to minimize loss of nutrients in FYM 44

Table 16: Practices for conserving nutrient in bio-slurry 44

Table 17: Number of season farmers had used FYM 45

Table 18: Farmers experience on the use of bio- slurry 46

Table 19: Awareness of farmers on manure quality loss 46

Table 20: Farmers' opinion on cattle manure management practice costs 47

Table 21: Manure management constraints 48

Table 22: Cattle manure management structures 49

Table 23: Collection of urine for manure quality improvement 49
Table 24: Farm size applied with FYM and bio- slurry in Njombe District 50
Table 25: Time of cattle manure application and reasons for variations 51
Table 26: Use of manure and equipments by crops 52
Table 27: Labour cost for manure production and management practices 53
Table 28: Methods of manure application 54
Table 29: Constraints facing Cattle Manure application 54
Table 30: Other Methods of manure application used by farmers 55
Table 31: Attitude of Farmers towards Farm Yard Manure 55
Table 32: Relationship between attitude on FYM and Farmers main occupation 56
Table 33: Relationship between attitude towards FYM and Cattle keeping 57
Table 34: Relationship between attitude towards FYM and extension training on cattle manure 57
Table 35: Attitude towards bio- slurry manure 58
Table 36: Attitude towards Inorganic Fertilizer 59
Table 37: Relationship between attitude towards inorganic fertilizer and Farmers main occupation 60
Table 38: Relationship between attitude towards inorganic fertilizer and Farmer cattle keeping status 60
Table 39: Relationship between attitude towards inorganic fertilizer and Farmers extension training on cattle manure 61
Table 40: Comparison on yield of maize per hectare before application of cattle manure and yield of maize after application of manure 62
Table 41: Yield of maize per hectare before application of bio-slurry and after application of bio-slurry 63
Table 42: Maize yield per hectare under FYM and bio-slurry application 63

Table 43: Importance of using cattle manure to the smallholder farmer 64

Table 44: Advice of farmers to the Government on best use of manure in Njombe …………………………………………………………………...........................65

LIST OF FIGURES

Figure 1: Smallholder farmers attitude, use and impact of cattle manure on maize farms 17
Figure 2: Map showing Njombe District, the study area 18
Figure 3: Cattle keeping in the study area 34
Figure 4: Training of farmers on cattle manure Production, Management and Application 35
Figure 5: Importance of urine 41

LIST OF APPENDICES

Appendix 1: (a) Farmers-Interview Schedule 85

Appendix 1: (b) Checklist for village key informants: chairperson, VALEO, VEO…...100

Appendix 2: Items used in computing attitude towards FYM 102

Appendix 3: Items used in computing attitude towards Bio - slurry 102

Appendix 4: Items used in computing attitude towards inorganic fertilizer 103

LIST OF ABREVIATIONS AND ACRONYMS

AAAE	African Association of Agriculture Economics
AATF	African Agricultural Technology Foundation
AEASA	Agriculture Economists Association of South Africa
AIDS	Acquired Immune Deficiency Syndrome
AJAR	African Journal of Agricultural Research
ATTBIOS	Attitude towards Bio-slurry
ATTFYM	Attitude towards Farm Yard Manure
ATTIORG	Attitude towards inorganic fertilizer
BGP	Bio Gas Plant
C/N	Carbon-Nitrogen ratio
CAN	Calcium Ammonium Nitrate
CIMMYT	International Maize and Wheat Improvement Centre
COSTECH	Commission for Science and Technology
DAP	Di Ammonium Phosphate
DEFRA	Department of Environment, Food and Rural Affairs
EPINAV	Enhancing Pro-poor Innovation in Natural Resources and Agricultural Value Chains
FAO	Food and Agriculture Organisation
FASID	Foundation for Advanced Studies in International Development
FASID	Foundation for Advanced Studies in International Development
FFS	Farmer Field School
FFS	Farmer Field School
FOA	Faculty of Agriculture
FSA	Farming System Assessment

FYM	Farm Yard Manure
GDP	Gross Domestic Product
GRIPS	Graduate Institute for Policy Studies
ha	hectare
HIV	Human Immune deficiency Virus
IAEA	International Atomic Energy Agency
ICRAF	International Centre for Research in Agro forestry
IFAD	International Fund for Agriculture Development
K	Potassium
KATC	Kasisi Agricultural Training Centre
MDGs	Millennium Development Goals
MSc	Master of Science
N	Nitrogen
NDC	Njombe District Council
NGOs	Non Governmental Organisations
NH_3	Ammonia
NJOLIFA	Njombe Livestock Farmers Association
NPK	Nitrogen Phosphorus Potassium
NSRGP	National Strategy for Growth and Reduction of Poverty
NTC	Njombe Town Council
PANTIL	Programme for Agricultural and Natural Resources Transformation for Improved Livelihoods
PhD	Doctor of Philosophy
RCA	Regional Cooperative Agreement for Asia and the Pacific Region
SA	South Africa

SPSS	Statistical Package for Social Science
SRS	Simple Random Sampling
SSA	Sub-Saharan Africa
SSMP	Sustainable Soil Management Programme
SUA	Sokoine University of Agriculture
TAS	Tanzanian Shilling
TDBP	Tanzania Domestic Biogas Plant
TDV 2025	Tanzania Development Vision 2025
TM	Targeting Method
UK	United Kingdom
URT	United Republic of Tanzania
USA	United States of America
VALEO	Village Agriculture and Livestock Extension Officer
VEO	Village Executive Officer
Vol.	Volume
WEMA	Water Efficient Maize for African Project
WFP	World Food Programme
YACATTLE	Yield After cattle manure application
YASLURRY	Yield After Bio-slurry application

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background Information

Maize is the most important staple food and also a cash crop in most parts of Tanzania (Katinila *et al.,* 1998; Isinika *et al.,* 2003). Production of maize in Tanzania is still low with average yields in farmers fields of one point two metric tonnes per hectare compared to the estimated potential yield of four to five metric tonnes per hectare (AATF and COSTECH, 2010). The low yield is partly due to low soil fertility (FAO, 2001; Karaya *et al.,* 2012). The steady fall in soil nutrients appears to be linked to poor soil fertility management driven by continuous cropping under ever-increasing population pressure (Waithaka *et al.,* 2007). The increase of human population in Tanzania calls for the need to increase crop production and since the arable land area cannot be expanded, land productivity has to be increased (Makokha *et al.,* 2001).

Increased crop production can be achieved either through expansion of the area under cultivation by a farmer or through agricultural intensification. The former is easily carried out when there is enough land. However, due to land scarcity expansion of area under cultivation is not feasible (Enhu and Afuoku, 2011). Intensification involves application of different intensification technologies to improve yield without land expansion. Such technologies include fertilization of crop land, pesticide application and use of improved seeds. Fertilizer use is one among the technologies used to improve soil fertility for increased production of crops. Fertilizers used in agricultural production are either inorganic or organic. Inorganic (chemical) fertilizers are industrially manufactured and are very expensive and beyond the reach of resource-poor farmers. They are therefore not readily available when needed by the resource-poor farmers (Enhu, 2010). Some of the inorganic fertilizers which are important are UREA, NPK, CAN and DAP. Organic fertilizers on the other hand are very feasible especially under mixed farming and they include manure of all types of livestock and compost manure from vegetation materials. By mixed farming of a farmer is where there are interactions of agro-livestock activities. Livestock manure includes cattle manure, poultry manure, pig manure. Cattle manure includes Farm Yard Manure (FYM) from normal cattle dung and bio-slurry from biogas plant (TDBP, 2009). One type of cattle manure is Farm Yard Manure and the other is bio - slurry. In a domestic biogas installation, manure is immediately discharged from biogas plant (TDBP, 2009). The by-product of a biogas installation is bio-slurry manure which is the digested dung that is discharged from the biogas plant after the fermentation process.

To get slurry, a slurry ditch/chamber is constructed and divided into two ways where two pits are made. The length of chamber is estimated to be two to four metres long from the end of slurry canal. Chambers help to discharge bio-slurry outside ready for use. When applied correctly, the fertilizing value of bio-slurry even surpasses that of raw manure. Therefore, bio-slurry is a good organic fertilizer that can replace or reduce application of chemical fertilizer (TDBP, 2009). Cattle manure provides nutrients for proper plant growth and is readily available to a large extent as cattle population is sufficient in some areas of smallholder farmers in Njombe. Cattle manure is expected to represent a valuable resource that if used appropriately, can replace significant amounts of chemical fertilizers (FAO/IAEA, 2008). Properly processed, stored and utilized cattle manure can supply major macro nutrient requirements of the crops, and also acts as a valuable soil conditioner (MSU Cares, 2003). This is due to the fact that cattle manure has the important residuary effect of soil macro and micro-organisms for plant growth (FAO and IAEA, 2008). Nutrients supplied by cattle manure include nitrogen, phosphorus, potassium and some micro nutrients essential to plant growth such as zinc, aluminum and copper. All these macro and micro nutrients need good management to provide the required nutrients. It is therefore important to ensure that there is optimum management of manure for sustainable crop production (DEFRA, 2010). Because the amount of nutrients excreted by livestock and contained in cattle manure is of low level, good management is important to ensure retention of these nutrients. Poor handling and storage of cattle manure will lead to both agronomic and economic losses of crops to the farmer (KATC, 2004). For example when cattle manure is left in the open air as most farmers do, it may lose most of its potassium, some of its phosphorus but much of its nitrogen and varying amounts of other nutrients through volatilization and leaching (Kwakye, 1980). Therefore, effective manure management is required to reduce nutrient losses from manure (Jackson and Mtengeti, 2005).

According to KATC (2004), the best way to get most of the nutrients out of cattle manure for crop growth and weed reduction is to compost the manure. Composting is the process of speeding up the breakdown of manure materials (KATC, 2004). Composting enables the process of breaking down plant materials to be controlled and the compost can then be applied and utilized by plants. This process has several advantages over applying fresh manure to the soil. Composting manure improves quality of manure, which when applied to soil it improves soil properties. The aim of making compost is also to produce the dark, crumbly substance called humus from materials that would otherwise be considered as ‘waste’ on the smallholder farm (KATC, 2004). A prerequisite for manure to have a positive impact on soil fertility is that of being properly decomposed under recommended processing or handling (SSMP, 2007). An important aspect of sustainable manure management is to develop housing and manure storage systems that help to conserve the plant nutrients and maintain a high concentration of plant nutrients in manure (FAO and

IAEA, 2008). However, use of manure is constrained by its bulkiness during transportation, low awareness on its use and storage and extensiveness of livestock production systems (URT, 2006). Furthermore, mismanagement of manure often leads to direct discharge of liquid manure to waterways FAO and IAEA (2008) and loss of important nutrients required by the plant. Moreover, types of livestock housing structure determine the quality of cattle manure produced by a farmer. Therefore, there is need to have accepted and cost effective method of manure management including housing. Because of this then, it is important to know how farmers perceive methods of manure management and application technologies for better understanding of their choice decision to practice or not (Ngoc Chi and Yamada, 2002). Cattle manure technology has to be increased at the farmer's level. Because of low innovation of the technologies coupled with abandonment of previously adopted agricultural technologies disseminated to farmers there are low impacts of improved technologies in extension service programmes (Michelle 2005).

1.2 Problem Statement

Cattle manure has become more important as a source of soil nutrients in situations where use of inorganic fertilizer is not affordable, such as in Sub-Saharan Africa, as they are often the source of carbon, nitrogen and other nutrients (Rufino *et al*., 2006). In view of the apparent decline in soil fertility, deliberate efforts are required to promote utilization of cattle manure for crop production (Maerere *et al.,* 2001). Different types of cattle manure have been identified such as FYM and bio-slurry from bio gas plant. However, not much is known on management practices and application methods of the two types of manures in maize production in Njombe.

In the Wedza smallholder farming area of Zimbabwe, manure is placed in small heaps all over the field and then uniformly spread (Wuta and Nyamugafata, 2012). In Tanzania, cattle manure application methods include broadcasting, dibbling direct to the plant, placing on ridges or use of liquid manure to the plant. However, it is not well known yet which manure application methods in the study area (Njombe District) is better in maize production, and whether the method is efficiently practiced for the plant to get required nutrients. This therefore calls for research that will reveal the right method and convenient time of transferring the processed manure to the field. In Wedza Zimbabwe for example, farmers have to apply manure from August to October; with 72% applying manure during the month of October (Wuta and Nyamugafata, 2012).

According to Jackson (2005), 40% of nitrogen and 60% of potassium is lost from cow urine due to poor urine collection during manure management, which ends up with low availability of nitrogen from manure. However, the means of preserving nutrient loss from urine are not much understood. The problems on production, management and applications of cattle manure at a farmer level has not been established yet, and therefore, there are no recommendations which have been made to help a farmer to use cattle manure efficiently for sustainable soil productivity. Studies conducted by (Jackson 2005; Lisuma and Mrema 1999; and Maerere *et al.,* 2001) concentrated on availability of nutrients per unit of different types of manure source and management. There has also been little research on manure management and manure storage in Africa where most studies of soil N- mineralization from manures comprise mainly laboratory incubations (Rufino *et al*., 2006). Hence, there is a need for conducting research on manure use and its impact on maize yield for sustainable soil productivity and farmer level recommendation and understand the farmer's attitude towards cattle manure. The information obtained from this study will therefore be important to researchers, extension change agents and policy makers as well as the farmers.

1.3 Justification of the Study

This study attempted to give information on farmers' practices in the production, management and application of cattle manure on maize fields in Njombe District for improving maize yields. The study is therefore expected to be useful to animal scientists and veterinarians, researchers, planners, policy makers, extension agents, ministries and donors as agriculture development stakeholders. The study is in line with Millennium Development Goals (MDG's) and first cluster of National Strategy for Growth and Reduction of Poverty (NSRGP) of Tanzania. Therefore this study addresses income growth and reduction of poverty focusing on equitable growth, sustainable development principle and food security as stated in the 2025 Tanzania Development Vision (TDV).

1.4 Objectives

1.4.1 Main objective

To assess use, attitudes, constraints, and impact of cattle manure in maize farming in Njombe District.

1.4.2 Specific objectives

i. To describe activities performed by farmers on manure production, management and application in maize production

ii. To identify farmers attitude towards using cattle manure (FYM) for improving maize yields

iii. To measure farmers attitude towards using cattle bio-slurry manure for improving maize yields

iv. To measure farmers attitude towards using inorganic fertilizer in maize production

v. To identify constraints encountered by farmers in cattle manure production, management and utilization at the farmer level

vi. To determine the impact of using cattle manure on maize yields.

1.4.3 Research questions

i. What activities do farmers perform on manure production, management and application in maize farming?

ii. What is the farmer's attitude towards use of cattle manure (FYM) in maize farming?

iii. What is the farmer's attitude towards the use of cattle manure bio-slurry in maize production?

iv. What are the impacts of application of cattle manure on maize yields?

v. What are the problem encountered by farmers in the production, management, and utilization of cattle manure?

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Role of Cattle Manure in Agricultural Production

In mixed agriculture systems, livestock can maintain some level of sustainability of heavily cropped land by providing incentives for increased nutrient inputs via imported feeds and fodder and through nutrient cycling with reasonably efficient management of manure (Shepherd and Soule, 1998). Cattle manure use is widespread in areas where cattle are a component of the mixed cropping systems and more so in those areas that have intensive livestock systems (Waithaka *et al.,* 2007). Cattle manure is collection of animal feces and urine from cattle. Common forms of cattle manure include farmyard manure (FYM) and farm slurry (liquid manure or bio-slurry). FYM also can contain plant material (often straw), which has been used as bedding for animals and has absorbed feces and urine. Agricultural manure in liquid form, which also is known as slurry, is produced by more intensive livestock rearing systems where concrete or slats are used, instead of straw bedding (TDBP, 2009).

Manure releases nutrients to the soil slowly and helps soils to build organic matter with long-term benefits (Place *et al.,* 2003; Palm *et al*., 1997). It also reduces soil erosion, restores eroded croplands, and improves solar heat absorption; increases water infiltration rates, reduces nutrient leaching, and increases crop yields. High soil organic matter contents especially from cattle manure tend to reduce infestation of *Striga hermonthica,* a parasitic weed which causes major losses to maize yields, (Waithaka *et al.,* 2007). In areas that are susceptible to drought, adequate organic matter helps to retain soil moisture. Concern about the sustainability of food production has been leading to a revival in the use of organic inputs such as cattle manure in modern agriculture as this is seen as an appropriate way to maintain soil health by providing soil organic matter and micronutrients (Kajisa and Palanichamy 2009). Cattle manure impacts positively on soil and eventually crop yields (Enhu and Ofuoku, 2011). Farmyard manure (FYM) and other types of manures maintain long-term soil productivity besides meeting timely requirement of nutrients (Khaliq *et al.,* 2006). Apart from its role as a storehouse of plant nutrients, organic manure is a major contributor to the cation exchange capacity and a buffering agent against unstable pH fluctuations. The soil capacity to store and release nutrients is also improved by farmyard manure application (Enhu and Ofuoku, 2011).

Manure can be applied on the farm in different ways, such as broadcasting, spreading on the farm surface and incorporate with soil, putting in dibbled holes and others. The rate of application of FYM depends on the chemical composition and water content of the manure (Lisuma and Mrema, 1999). Recommended application rates by the Ministry of Agriculture in Vihiga (Kenya) for all crops are 10 tons per ha (Salasya, 2005). In Tanzania the national recommended rate of FYM has not been established because of variations in the composition and quality of the manure from different places (Lisuma and Mrema, 1999).

2.2 Characteristics of Smallholder Farmer

Sub-Saharan Africa's rural economy remains strongly based on agriculture (Livingston *et al.,* 2011). Agriculture in SSA (excluding South Africa) employed 62% of the population and generated 27% of the GDP of these countries in 2005 (Livingston *et al.,* 2011). According to Wiggins (2009), smallholder farms are defined as being two hectares or less, and that smallholder farms represent 80% of all farms in SSA, and that they contribute up to 90% of the production in some SSA countries. The key long-standing challenge of smallholder farmers is low productivity stemming from lack of access to markets, credit, and technology. In recent years this has been compounded by the volatile food and energy prices and very recently by the global financial crisis (Salami *et al.,* 2010). Tanzania's agriculture is dominated by smallholder farmers (peasants) cultivating an average farm size of between zero point two and two ha (Livingston *et al.,* 2011). However, in the study conducted in Njombe and Nkasi districts by REPOA (2013) it was reported that smallholder farmers were cultivating an average farm size of between zero point nine hectares and three hectares. About 70% of Tanzania's crop area is cultivated by hand hoe, 20% by ox plough and 10% by tractor (URT, 2013). Tanzania is among the SSA countries with farming system termed as rain fed agriculture, as most of her agricultural production activities are run by use of natural fall of rainfall. A large percentage of these smallholders are women, responsible for key components of household production such as weeding, harvesting and processing (Livingston *et al*., 2011). Further, women often independently grow non-cereal crops for income and are increasingly heading rural households due to male urban migration (Oxfam, 2008).

The major constraint facing the agriculture sector is the falling labour and land productivity due to application of poor technology and dependence on unreliable and irregular weather conditions. Both crops and livestock are adversely affected by periodical droughts in SSA including Tanzania (Salami *et al.,* 2012). Other characteristics of Tanzania smallholder farmers include agriculture activities dominated by old farmers with low level of education which results into low productivity and finally poor income at the household level (AATF and COSTECH, 2010). According to Isininika *et al*. (2003), among the causes of low agricultural productivity is the low use of research-based technologies.

Increased agricultural production may occur largely through expansion of the cultivated land in areas with relatively abundant land rather than increases in land productivity (Livingston *et al.,* 2011). The pursuit of an extensification strategy by farmers reflects the relative availability and lower costs of land relative to capital inputs required for intensification which include credit, fertilizer and irrigation. The opportunities facing smallholder farmers in the agricultural sector is growing global and regional demand for agricultural products for food, industrial and fuel requirement. But the continued population and income growth combined with urbanization; particularly in developing countries is placing pressure on the current food supplies (Livingston *et al*., 2011). SSA's smallholders are positioned to be significant beneficiaries of the improving opportunities in agricultural markets. The primary challenge now is a move from extensification towards greater intensification in the supply response strategies of smallholders (Livingston *et al.,* 2011).

Continued smallholder production growth will require increased investments in intensification. In order for smallholders to increase production with less additional land and without major increases in labour inputs, they will need to increase their own productivity through greater capital and technology investments. Smallholder agriculture in Tanzania is lacking satisfactory extension service. For example Makokha *et al*. (2001), revealed that the logistic regression of their study showed that extension contact and off-farm incomes were significant factors influencing the adoption of manure use by smallholder farmers.

2.3 Farmers Practices on Production and Management of Cattle Manure

Cattle manure has received greater attention because it is more available in larger amounts and is widely used in SSA countries (Wutta and Nyamugafata, 2012). Use of manure as a fertilizer increases yields and can avoid total crop failure of a farmer. Manure quality is important because it indicates the ability to supply nutrients and improve yields. For example FYM used to be available where cattle are kept, but due to distribution of cattle, it has become more uneven and therefore manure availability becomes a problem (Kajisa and Palanichamy, 2009).

The nutritive value of cattle manure for crop growth and production depends on the type of housing from which the cattle manure comes, its age, physical condition and the food that the cattle eat. Estimates of the quantities of excreta produced by cattle are useful for calculating manure storage needs, and manure nutrient contents for nutrient planning at the farm level (Kew, 2010). By adding materials to the manure, for instance in the kraal, such as maize stover or other bedding materials, urine from cattle will be soaked up as well as any rainwater enriched with liquid from the manure (KATC, 2004). Bedding and how the animals are kept also contribute to manure management needs (Bradley, 2008).

According to Jackson and Mtengeti (2005), beddings use is a practice which is used by farmers to add volume of manure so as to meet the requirement in relation to area where manure is to be applied as well as satisfying the soil nutrient needed. Use of beddings was a reflection of the importance of manure production in the area since it was done in the dry season, possibly so as to increase the amount of manure for the subsequent cropping season because beddings preserves a lot of urine nitrogen in manure (Raussen, 1997). Cattle urine is very important because it adds significant proportions of the nutrients to cattle manure, specifically nitrogen. Urine therefore must be retained and prevented from leaching away whenever possible. Thus, adding bedding materials will also make the manure a better quality material allowing it to compost (KATC, 2004). According to

KATC (2004), composting is a controlled and managed aerobic ("with air") decomposition process for manure, bedding, and other organic materials (farm yard manure, food scraps etc). Composting manure provides more benefits to the soil than direct application of pure manure. The nutrients contained in the bedding material (leguminous plants like pigeon pea stalks, bean stalks, groundnuts and sunflower residues, fodder tree stalks, and cereal stalks like maize stalks) itself will also add to the nutritive value of manure.

2.4 Practices and Methods of Manure Storage

In mixed farming systems, manure and nutrient availability vary temporarily and spatially, due to variations in crop/livestock ratio and livestock and manure management (Paul *et al.,* 2009). For example, use of bedding material widened the Carbon Nitrogen ratio, while turning of manure increased mineral nitrogen content. KATC (2004) outlined methods of cattle manure storage as follows: The first method for storing manure is to leave it within the kraal until it is required for farm use. In order to maintain its quality, the kraal should be covered with a simple roof to prevent the loss of crop nutrients through volatilization and leaching. The second method for manure storage involves constructing a building purposely for placing manure, which is then left for composting before being used on the farm. The third method of storing manure is to dig a pit leading off from the kraal into which any rainwater or run-off can flow. This is an important method because it reduces nutrient losses from manure in the kraal. The forth method of manure storage involves daily collection of manure from Kraal taking it into a pit made for manure storage, and then mixing it with other materials and left without being covered. This is a normal by most free grazing system. The fifth method of manure storage is similar to number four, but the difference is that, the pit is either covered by soil or plant materials. In all methods crop residues are incorporated into the pile to soak up liquids. Additionally, different equipments are required to practice various management practices. Examples of equipments include equipment for manure removal is a pitchfork or manure fork, shovel, metal rake (a grading or spreading rake works well), and wheelbarrow or handcart. A pick-up truck can also be useful in case it is available (Bradley, 2008).

2.5 Cattle Manure Application

In many traditional agro-ecosystems, smallholder farmers use cattle manure to collect and concentrate plant nutrients. In this way, the management of manure causes a transfer of plant nutrients from grazing land or house to cropping areas which results in substantial contribution to the crop nutrient supply (FAO and IAEA, 2008). Cattle manures are valuable when used carefully as fertilizer for crop production and improvement of soil quality. The composition of manures is variable due to factors of housing, beddings and feeds, this being true even for the manure of one animal category. When manure is applied to the surface of grassland soils, the manure materials will normally be incorporated by soil fauna, particularly earthworms. This organic matter and the activities of soil fauna will have a positive effect on the soil physical properties (FAO and IAEA, 2008). This is because the nutrients contained in cattle manure are not immediately available for use by plants, but must first be broken down by soil microorganisms in order to release the nutrients in a form that plants will be able to utilize, a process called mineralization (KATC, 2004).

Time of application, method and rate of manure application are very important for efficient nutrient uptake and for minimizing environmental risk in farming system. This means that applying the manure just before the start of crop growth activate nutrient uptake. The rate of manure application does not exceed the nutrient requirement of the crop. Either application method does not limit nitrogen losses in form of ammonium ions. Also rate of application should avoid damaging the soil (*e.g.* compaction) and crop development. Moreover application should consider other requirements of the farm such as cost of manure storage, manure application equipment, and manure processing (e.g. separation of solids and liquid). For example, KATC (2004) recommends that cattle manure should be applied to the soil two to three weeks prior to planting the crop. In order to avoid losing nutrients from manure, it should be applied in furrows and then covered with soil. Then seeds can be sown above the soil/manure mix. For good effect from cattle manure or compost, 5-10 manure oxcart loads (5-10 tonnes) per hectare are recommended (KATC, 2004). However, application of cattle manure differs among smallholder farmers depending on the crop type. For example, in the study by Jackson and Mtengeti (2005) in Njombe, it was reported that 58% of respondent farmers utilized most of their manure on maize plots. This could be due to the importance of the maize crop in food security and high economic return to farmers.

2.6 Adoption of Cattle Manure as a Fertilizer

According to Dasgupta (1989), the term adoption is the continued use of recommended idea or practice by individuals or groups over a reasonable long period. Technology generation and development is an interactive process and the supply of technologies needs to be driven by demand from the users (Liberio, 2012). The choice of technologies adopted more recently by farmers may be partly dependent on earlier technology choices (Kassie *et al.*, 2012). The speed of adoption of an innovation is important in various aspects (Odendo *et al.,* 2010). For example innovations that are adopted rapidly are more profitable than those with low rates of adoption because the benefits occur faster and the ceiling of adoption is achieved earlier, all other things being equal (Batz *et al.*, 2003). Therefore, farmers tend to accept innovations only when the innovators offer them a clear, fast and visible improvement or benefit (Muller-Samann and Kotschi, 1994). The length of time farmers wait before adopting a new technology is a complicated process that may be influenced by interactive effects of many factors, some of which vary with time, whilst others may not vary over time.

2.7 Conceptual Framework

The conceptual framework of this study is based on the principle of innovation decision process described by Rogers (1995). Farmers go through a stage of being aware or knowledgeable of a new technology to forming a positive or negative attitude towards it and ultimately deciding whether to adopt the technology or not. According to Rogers (1995) the technology is passed from its source to the end users through a medium (e.g. news media, opinion leaders, on-farm or on-station demonstrations, and farmers' field days) and its diffusion to potential users is dependent to a great extent on the personal attributes of the individual user. This adoption behavioural framework has frequently been used to examine adoption of various technologies by farmer and was also adapted to this study.

This conceptual framework is about the use of cattle manure and its impact on maize farming by smallholders in rural areas of Tanzania. Farm productivity is the function of various factors including farmers economic and social characteristics, farm characteristics, farmers' perception and attitudes and technology adoption decision by the farmer. Farmer characteristics such as gender, age, household size, have impact on technology adoption decisions which then impact maize productivity and consequently household income. Likewise socio economic characteristics such as education level of the farmer, the capability of the farmer to hire labour, perception/ attitude on manure use also determine maize productivity and thus household income and food security assurance to the farmer. On the other hands, awareness about the particular technology advantages and profitability determines the decision to adopt or not adopt a particular technology by the farmer. For example the use of cattle manure on maize farms by maize farmers will depend on whether farmers have had experience in using this type of organic manure. The impact of using cattle manure is so great that farmers who have used it have improved their farm productivity. This is because cattle manures have been a potential source of nutrients due to their availability to small-scale farmers (Baitilwake *et al*., 2011).

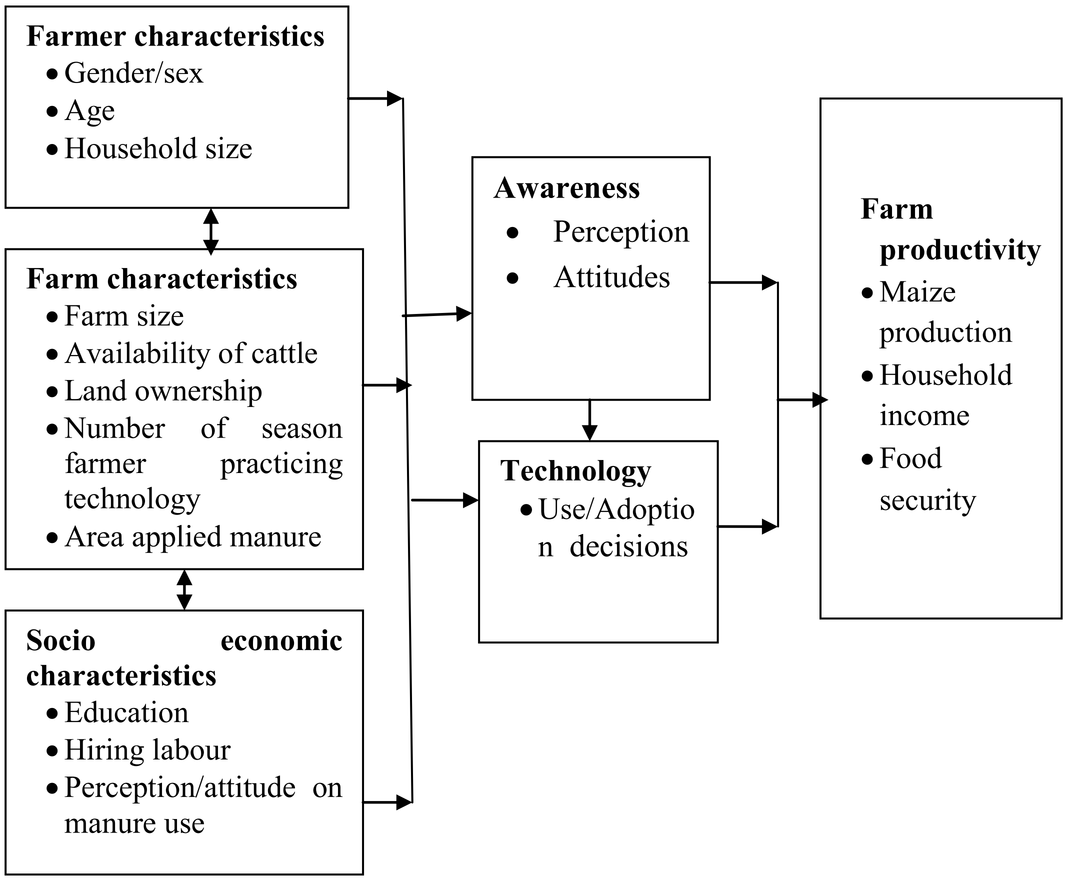

Figure 1: Smallholder farmers attitudes, use and impact of cattle manure on maize farms

CHAPTER THREE

3.0 METHODOLOGY

3.1 Location and Geographical Description of the Study Area

The study was conducted in Njombe District (Fig. 2) which is found in Southern Highlands of Tanzania. This district lies between Latitudes eight point eight and nine point eight degrees (8.8^{0} and 9.8^{0}) south of the Equator, and between Longitudes 34.5^{0} – 35.8^{0} east of Greenwich. To the South it borders Ludewa District and Ruvuma Region, while to the east and west it bordered by Morogoro Region and Makete District respectively.

Figure 2: Map showing Njombe District, the study area

Specifically the study was conducted in three divisions of Makambako, Njombe town, and Igominyi, and four wards of Ikuna, Ramadhani, Kichiwa and Uwemba. Additionally, one village area was selected from each of the four wards namely; Matiganjola, Ibumila, Itulike and Magoda. Based on climate, the study area has two zones which are the highlands and lowlands based its climate (NDC, 2010). Temperature for the highlands zone lies below 15^0 C. The amount of rainfall in this zone varies between 1200mm and 1400mm per annum. However, the lowlands experience hot and dry weather conditions with unreliable rainfall ranging from 1000mm -1200mm per annum**.** Economic activities carried out in Njombe District are dominated by agricultural production whereby to a large extent all households are engaged on farming specifically mixed farming. Mixed farming is in the study area also has prominence and is relatively a predominant farming activity (Jackson and Mtengeti, 2005). Crops grown include maize, beans and Irish potatoes, while the livestock kept were cattle, sheep and goats.

3.2 Research Design

The study employed cross sectional survey method for data collection. The method entails collection of data at one point in time. According to Babbie (1990) and Creswell (1994), cross sectional design is quick and appropriate. It was also more favorable due to limited time and resources.

3.3 Study Population

The study population for this study was all farmers in the study villages of Njombe District.

3.4 Sampling Frame and Sampling Method

Stratified sampling procedure was used to get three categories of farmers who keep local breeds, dairy cattle and farmers who grow maize only. A Simple Random Sampling (SRS) technique was used in each stratum. However, selection of divisions, wards and village areas involved a purposive sampling technique which was based on free grazing system, presence of dairy cattle project as well as location of maize farms and maize farming systems. Villages selected for the study were Itulike, Matiganjola, Ibumila and Magoda. Key informants in each sampled village were selected; these included the village chairpersons, Village Agricultural and Livestock Officers (VALEO) and Village Executive Officers (VEO) from each surveyed village.

3.5 Sample Size

From each of the four village areas, 30 respondent farmers were randomly selected to make a sample of 120 farmer respondents. From each village, farmers' village roaster was used as sampling frame from which SRS technique was used to obtain the sample of 30 farmer respondents per village area. The sampled 30 respondent farmers obtained from each village area included farmers who benefited from dairy cattle project, local cattle keeping farmers and non cattle keeping farmers forming total number of respondents of 120. Matata *et al.* (2001) reported that having a sample size of 80 - 120 respondents is adequate for most household socio-economic studies in Sub-Saharan Africa.

3.6 Data Collection

Data collection is the process of gathering and measuring information on variables of interest in an established systematic fashion that enables one to answer stated research questions, test hypotheses, and evaluate outcomes (Dodge, 2003). Primary data are the data observed or collected directly from first-hand experience, but secondary data are the data that are collected by someone else or for a purpose other than the current one (Dodge, 2003). In this study, both primary and secondary data were collected to get qualitative and quantitative information required for answering established research questions of the study to address the objectives.

3.6.1 Primary data collection

In this study primary data were collected by means of interviews conducted in the study area using farmers interview schedule (Appendix 1a) whereby households were interviewed to obtain information on respondent's socio-economic characteristics, cattle manure production, management and use practices as well as attitude towards FYM, bio-slurry and inorganic fertilizer. Additionally, data on constraints facing manure production, management and use, and impacts of cattle manure use on maize production and yields at a farmer level were collected. Moreover 12 key informants were interviewed using checklist (Appendix 1 b) to obtain additional information on the primary data on manure production, management, use and impact in maize production.

3.6.2 Secondary data collection

In this study secondary data such as past records on use of cattle manure were collected through reviewing literatures from various sources such as journals, books, reports from Njombe District offices, internet service and research publications from Sokoine National Agricultural University Library (SNAL).

3.6.3 Qualitative data

These are data which describe quality or category of certain variables. These are data which cannot be quantified numerically (Dodge, 2003). In this study, qualitative data collected included: whether a farmer keeps cattle and the system of cattle keeping used by a farmer, uses of manure or not, type of manure a farmer use, type of extension training a farmer have received or not on production, management and application of manure, manure application skills a farmer is using, reasons for using manure bedding materials and how have a farmer helped to increase production of manure, estimation of manure requirement for a season, sources of labour to farmer for manure practices, equipments the farmer used on manure practices, time of manure application used by a farmer, methods a farmer use to apply manure on the field and preference for an individual farmer, problems encountered by farmers on manure production, management and application.

3.6.4 Quantitative data

Quantitative data are the data in which items are described in terms of quantity and in which a range numerical values are used without implying that a particular numerical value refers to a particular distinct category (Dodge, 2003). The following quantitative data were used in this study: sex of respondent, marital status of respondent, education level of respondent, number of individuals in the household, number of individuals who provide full labour, type of occupation of respondent, land ownership of respondent, farm size of respondent and area under maize production, attitude of a farmer on use of FYM, bio-slurry and inorganic fertilizer.

3.7 Data Collection Instruments

Structured and semi structured questionnaire with closed ended and open ended questions were used to collect both quantitative and qualitative data from the sample of 120 respondent farmers. The questionnaire was designed to address the specific objectives of the study. In addition, a checklist was used to collect other relevant information from 12 key informants.

3.8 Instruments Pre-testing

A pre survey was done in all the selected villages in the study area outside the study sample and was followed by pre-testing in Itulike village with 10 sampled farmers. The 10 sampled farmers who took the pre-test were not included in the final study interview. Pre-testing results provides the basis for the validity and reliability of the instruments used in this study as highlighted by Svotwa *et al*. (2009) that, before data collection, a pilot survey to pre-test the questionnaire should be conducted onto farmers who will not be in the final interview list.

3.9 Measurement of Attitude

Attitude is the degree of positive or negative inclination associated with psychological objects. Attitude is predisposition to behavior of a person. A predisposition towards a certain behavior implies indication to performing the behavior. A negative attitude towards a certain behavior implies indication against performing the behavior. Thus, based on the attitude behavior relationship the major approach to determine the impact of extension service is to begin with the farmers' attitude (Ayaode, 2012). Attitude is measured by a set of items administered to a respondent. The respondent agrees or disagrees with each of the item. The items are then summed up into an index. The index shows ones favourableness or unfavourableness towards the idea or object. Prior to summing the items, reliability is conducted to measure the internal consistence of the items that are to be summed up into the index. In order to classify respondents as to whether they have positive or negative attitude, the median score on the index is taken as the cut-off point. Thus, a respondent whose score on the attitude index is below the median is considered as having a negative attitude .On the other hand, a respondent with a score from the median onwards is considered to have positive attitude.

3.9.1 Attitude towards FYM

For measuring attitude towards FYM, 10 items were used (Appendix 2). Four of the items were negatively worded while the remaining six were positively worded. Reliability analysis was conducted to get the final number of items required. The final six items had a Cronbach's alpha value of 0.829 (Appendix 2). The final six specific items used in computing the index on attitude towards FYM were as follows:

(i) I can do away with farm yard manure

(ii) Life will still ok without farm yard manure

(iii) I will be poor if I do not use farm yard manure

(iv) To me farm yard manure is life

(v) My survival depends on farm yard manure

(vi) I would be miserable if it weren't for farm yard manure.

3.9.2 Attitude towards bio- slurry

For measuring attitude towards bio-slurry, 10 items were used (Appendix 3). Five of the items were negatively worded while the remaining five were positively worded. Reliability analysis was conducted to get the final number of items required. The final five items had a Cronbach's alpha value of 0.935 (Appendix 3). The five items used in computing the index on attitude towards bio- slurry were as follows:

(i) My survival depends on bio- slurry

(ii) To me bio -slurry is life

(iii) I would be miserable if it weren't for bio- slurry

(iv) I am proud of bio- slurry use on my farm

(v) Bio- slurry means my family life enhancement

3.9.3 Attitude towards inorganic fertilizer

For measuring attitude towards inorganic fertilizer 10 items were used (Appendix 4). Four of the items were negatively worded while the remaining six were positively worded. Reliability analysis was conducted to get the final number of items required. The final six items had a Cronbach's alpha value of 0.943 (Appendix 4). The six specific items used in computing the index on attitude towards inorganic fertilizers were as follows:

(i) My survival depends on inorganic fertilizer

(ii) To me inorganic fertilizer means life

(iii) I would be miserable if it weren't for inorganic fertilizer

(iv) I would be poor if I do not use inorganic fertilizer every season

(v) Inorganic fertilizer means my family life enhancement and

(vi) I am proud of inorganic fertilizer use on my farm.

3.10 Data Analysis

This was done to evaluate data using analytical and logical reasoning to see whether data supported the study objectives. For this study descriptive and quantitative analysis conducted.

3.10.1 Descriptive analysis

Descriptive analysis was conducted to get descriptive statistics like frequencies, percentages, and means were obtained to summarize the information on qualitative and quantitative data collected from farmers. For this purpose the software programme of Statistical Package for Social Sciences (SPSS) version 12 and 16 respectively was employed.

3.10.2 Inferential analysis

Impact of manure on yield was computed to get yields of maize before manure use (YBCATTLE) and after use (YACATTLE). Two types of manure were used (FYM and bio- slurry). In each case farmers were required to state the yield before the use of manure and after use of manure. To test for impact of manure a paired t-test was computed.

CHAPTER FOUR

4.0 RESULTS AND DISCUSSION

4.1 Characteristics of Smallholder Farmers in the Study Area

The distribution of respondents in each village is presented in Table 1, where the results show that 25% of the respondents were coming from Itulike village, 25% from Magoda village 25%, from Matiganjola village and 25% from Ibumila village.

Table 1: Name of village and number of respondents (n= 120)

Name of village	Number of farmers	Percentage
Itulike	30	25
Magoda	30	25
Matiganjola	30	25
Ibumila	30	25
Total	**120**	**100.0**

Age of a farmer has been described by many scientists as an important factor in determining the success or failure in agricultural production activities. For example Waithaka *et al.* (2007) asserted that older farmers have more power of command on their resources than younger farmers and hence, they have wider investment options. But the older the farmer becomes, the more he /she possess less capability to work on the farm. According to Kassie *et al.* (2012), old farmers have great exposure to production technologies and environments and greater accumulation of physical and social capital. However, age can also be associated with loss of energy and short planning horizons, as well as being more risk averse. Thus, the impact of age on technology adoption is indeterminate. Study findings in Table 2 show 45 years as the mean age of the respondents. The findings further show that 11.7% of the respondents were aged between 20 - 35 years, 41.7% were aged between 36 - 45 years and 46.7% were aged between 46-83 years.

Table 2: Age, marital status and educational level of respondents (n=120)

Demographic variables	Categories	Frequency	Percent
Age	20 – 35	14	11.7
	36 – 45	50	41.7
	46 – 83	56	46.7
Mean age = 45 years			
Total		**120**	**100.0**
Sex	Male	74	61.7
	Female	46	38.3
Total		**120**	**100.0**
Marital status	Married	107	89.2
	Widowed	10	8.3
	Single	3	2.5
Total		**120**	**100.0**
Education level	No formal education	6	5.0
	Adult education	8	6.7
	Primary education	99	82.5
	Secondary education	7	5.8
Total		**120**	**100.0**

The age bracket of between 20 -35 years constitute the young people who have enough energy and therefore expected to provide labour for conducting farm activities such as manure management and use. However, it lacks farming experience owing to their age.

The group falling within the 36 – 45 years age bracket constitute the economically active individuals who have full household responsibilities which make them fully occupied with on farm activities. The last group is that falling within 46 – 83 years (46.7%) of the respondents, this is the mid to old people.

Results presented in Table 2 also show that 61.7% of the respondents were male and 38.3% were female. Table 2 also shows that 89.2% of the respondents were married while about five percent were single. The findings show that 82.5% of the household heads within the study area have primary level of education. However five percent did not attend any formal education. CIMMYT (1993) also found the same findings with regard to education.

Study findings show that the average household size in the study area was five point five (5.5) members which is above the national average household size of four point eight (4.8) people reported in the 2012 population census (URT, 2013). Findings from the study show that 60% of the households had family sizes falling between five and eight household members, while only three point three percent (3.3%) had more than eight household members. Those who had one to four household members represented 36.7% of the respondents (Table 3). Further findings in Table 3 show that the average number of household members who were providing labour on farm activities was about three. However, 56.7% of the households had labour size falling between one to two household members. Only 11.7% had household labour size of more than four household members.

These results show that there were many household members who were supported by very small number of the labour force. Many SSA countries including Tanzania and specifically in the study area do not have enough labour at household. For efficient manure production, management and application a household need to have at least three people so as to run all activities smoothly.

Table 3: Household size and the number of people who provide farm labour (n=120)

Household characteristics	Categories	Frequency	Percent
Household size	1-4	44	36.7
	5-8	72	60.0
	More than 8	4	3.3
Mean household size = 5.5			
Total		**120**	**100.0**
Number of People who provide farm labour			
	1-2	68	56.7
	3-4	38	31.7
	More than 4	14	11.7
Mean household labour size = 3.2			
Total		**120**	**100.0**

The need for more labour in manure activities was also remarked by Waithaka *et al.* (2007) who reported that delivery of manure to the field is cumbersome and labour intensive. According to Odendo *et al.* (2010), availability of enough labour at household level to provide farm labour accelerates adoption of manure practices. This confirms the fact that household labour is very important for speeding up the adoption of labour intensive technologies such as manure management practices. Respondents with labour force of between three and four (3-4) members in one household constituted 31.7%. Findings on labour availability showed that labour is not enough for manure management activities. This could be due to the reason that some household members could have been below 15 years old, the age considered as children who are supposed to be in school and therefore not expected to participate in farm activities. Another cause of low labour force that was revealed by NTC (2011) was the high (15.7%) percentage HIV/AIDS prevalence whose effects include reduced labour force. The activities affected include manure management and application. This was also confirmed through the study by Meijerink and Roza (2007) who reported that HIV/AIDS increasingly impacted many rural areas in developing countries and that it greatly affected agricultural production.

Findings in Table 4 show that 70.8% of the respondents were both crop growers and livestock keepers. Only two point five percent of the respondents were engaged in keeping livestock only as their main activity. Livestock farming undertake by households is an important means for increasing crop production and reduce constraints of manure availability. Availability of manure serve as a major conduit of nutrient flows on farms through nutrient re-cycling (Odendo *et al.,* 2010).

Table 4: Type of farming (n=120)

Type of farming	Frequency	Percent
Both Crop and livestock production	85	70.8
Crop production only	32	26.7
Livestock keeping only	3	2.5
Total	**120**	**100.0**

Table 5 show methods of land acquisition and farm size among respondents. More than half of the responses (58.6%) had reported to have inherited their farmlands. This was affirmed during village key informants discussion that the farmlands owned under this category mostly belong to all the relatives within a particular clan or family. Under such land ownership it is very difficult for an individual clan or family member to make long term decision on its use. Similarly, agreements among relatives have to be reached before one can make use of the land. Yet, 19.7% and 15.3% of the responses purchased and owned their farmlands through village government respectively. These kinds of ownership give flexibility to the farmer to plan whatever seems to be important and profitable without any intervention from others. Hence, adoption of important production technologies such as manure application is possible under such ownership arrangements.

Table 5: Mode of Land acquisition and household farm size (n=120)

Item	Type/Categories	Frequency	Percent
Land acquisition	Inherited	92	58.6
	Purchased	31	19.7
	Village government	24	15.3
	Rented	10	6.4
Total		**157**	**100.0**
Farm size (ha)	0.4- 2.0	83	69.1
	2.4- 4.0	26	21.7
	More than 4	11	9.2
Total		**120**	**100.0**

Mean farm size: 0.96 ha

Other category of land acquisition as reported in Table 5 show that only 6.4% of the responses had rented their farmlands. Famers under this arrangement may suffer a similar circumstance to those under inheritance since they could not make a long term plan to adopt fully the use of farm manure. Findings in Table 5 further revealed that, the average farm size of the respondents is zero point nine six ha. This result was in line with what was reported by Livingston (2011) that agricultural production systems in SSA are largely dominated by smallholder farms of two hectares or less. Also, the study findings show that about 69% of the households had farm size ranging from zero point four to two ha

(0.4 - 2 ha), while 21.7% of them had farm size ranging between two point four and four hectares (2.4 – 4) ha. However, only nine point two percent (9.2%) of the households had farm size above four hectares (4 ha). Thus, farm plots size in Njombe is dominated by smallholder farmers who have small farm plots.

The study findings show that the mean maize farm size is about one hectare. Further, results on Table 6 show that 69.2% of the respondents had maize farm size falling between zero point four to zero point nine (0.4 - 0.9) ha. About 23% of the farmers had maize farms size of between one point one to one point six (1.1 – 1.6) ha. Only seven point five percent of the farmers had farm size above one point six (1.6) ha. Thus maize production in Njombe is dominated by small farm plots run by households to sustain their livelihoods. Using small farms in production requires an increase of production efficiency or intensification of land than expansion of farms. Thus, to increase production per unit area, manure application is required for the farmers on their farm plots.

Table 6: Maize farm size (n =120)

Farm size (ha)	Frequency	Percent
0.4-0.9	83	69.2
1.1-1.6	28	23.3
More than 1.6	9	7.5
Total	**120**	**100.0**

Mean: = 0.96

4.2 Farmers Practices on the Production, Management, Uses and time of Cattle Manure Application

4.2.1 Cattle keeping and manure production practices

Study findings in fig 3 show that 71% of the households in the study area were keeping cattle while only 29% were not cattle keepers. This indicated farmers had access to cattle manure if other factors remained constant. It shows that cattle keeping can be an important livelihood activity that has multiple benefits to the farmer as reported by Odendo *et al.* (2010) that livestock keeping ease cash constraints, increase availability of manure and act as a major conduit of nutrient flows on the farms through nutrient re-cycling. However, more specialization in livestock rather than cropping may reduce investment in crops. Thus, cattle ownership increases the availability of manure and also leads to income generation through sales of the cattle or its products and is therefore hypothesized to accelerate adoption of manure and mineral fertilizers from the cash generated (Odendo *et al*., 2010).

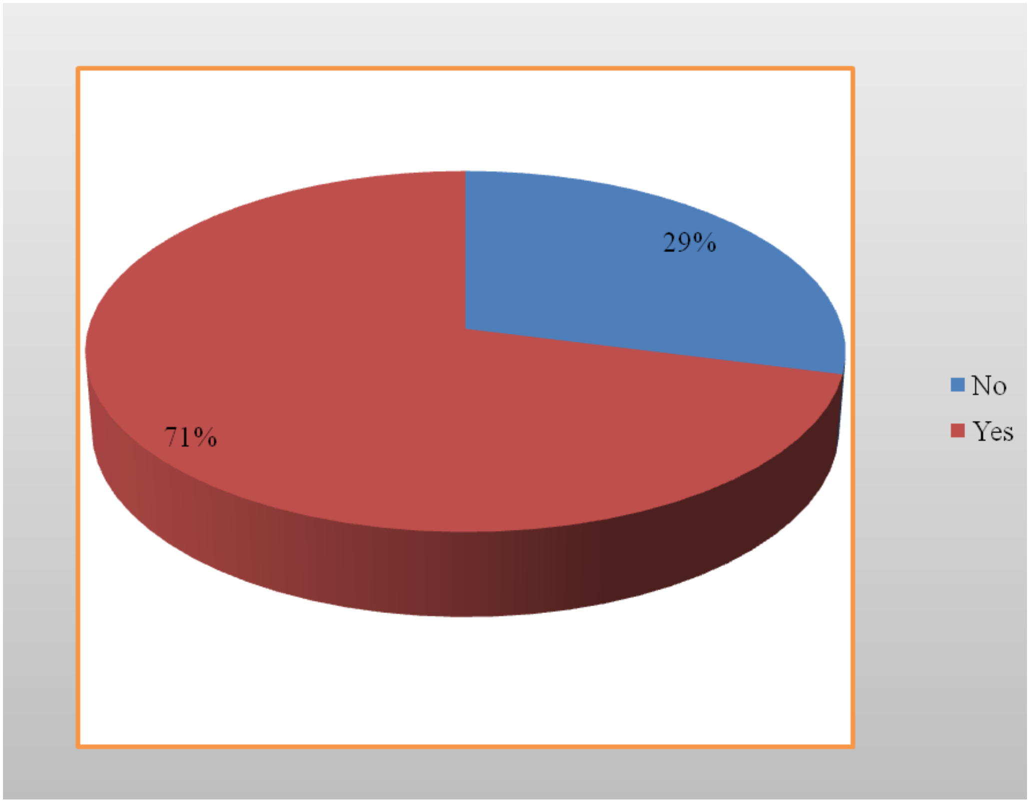

Figure 3: Cattle keeping in the study area

Study findings in Fig 4 present training programmes on cattle manure production for cattle keeping households in the study area. The findings show that 57% of the respondents had received training on cattle manure production, management and application, whereas 43% never had any training on the same content. Interview with key informants revealed that the trained farmers were those from the dairy cattle projects. Farmers who had not received training were those from outside the project and specifically those who kept free grazing system. However, some farmers who had never received training were those who did not have cattle.

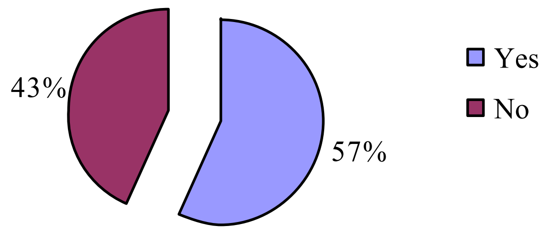

Figure 4: Training of farmers on cattle manure Production, Management and Application

4.2.2 Cattle management systems adopted

Findings in Table 7 show that 75.3% of the cattle keepers use zero grazing management system while the remaining 24.7% use free grazing system. The large numbers of farmers practicing zero grazing were those from the EPINAV programme of Sokoine University of Agriculture (SUA) through dairy cattle project. The project is called integrated dairy productivity through value chain and innovation system approaches in enhancing adoption of technologies and best practices to improve livelihood and food security. This project aimed at increasing the capacity of farmers to fully utilize their resources such as land, livestock and human to increase agriculture productivity. Another project supporting zero grazing in the district is Heifer project Tanzania. This project is under the support of Roman Catholic and Anglican Church Missions. Moreover, there were other NGOs such as NJOLIFA, and the Igeri Agriculture research station which also deal with dairy projects in Njombe District. Presence of the above projects and their interventions to farmers led to training of farmers on various agricultural production methods including manure production.

Table 7: Cattle management system adopted (n=85)

Cattle management adopted	Frequency	Percentage
Zero grazing system	64	75.3
Free grazing system	21	24.7
Total	**85**	**100.0**

Manure production require farmers' knowledge on the type of feed to provide to cattle as this determines the quality of manure produced in terms of nitrogen, phosphorus, and potassium content. Table 8 show types of feeds that farmers gave to their cattle in the study area. The findings show that 63.5% of farmers give their cattle feeds which combined of concentrates, minerals, grasses, and legumes. However, five point nine percent of the respondents gave their cattle concentrates, legumes and grasses. According to Jackson and Mtengeti (2005), the nutritive level of cattle manure under local grazing system is not sufficient as much of it is lost through grazing. The feeding system of free grazing cattle and goats through free range system results in a loss of 60 - 70% of manure. Also as it was indicated on feeding of cattle that not all farmers give their cattle all types of feeds required, this was probably due to lack of knowledge on feeding cattle the required types of feeds.

Table 8: Type of feeds used by cattle keeping household (n =85)

Types of feeds given to animals	Frequency	Percent
Concentrates, minerals, grasses and legumes	54	63.5
Grasses and legumes	20	23.5
Concentrates and grasses	6	7.5
Concentrates, legumes and grasses	5	5.9
Total	**85**	**100.0**

4.2.3 Constraints on manure production

Table 9 presents major constraints encountered in cattle manure production as revealed by respondents in which it is shown that 38.3 % of the responses cited few cattle raising as a constraint. This was the main cause for their failure to fulfill their needs using manure on their farms. The same constraint was reported by Svotwa *et al.* (2009) that in SSA specifically Zimbabwe the small size of most livestock herds was the main cause for manure farming challenges. Among the reason for a farmer to own few cattle was the high cost that the farmer incurred for buying one live cow which was said to be between TAS 600 000 and 1 200 000 (NTC, 2012). This was not affordable for most farmers unless a farmer is a dairy cattle project beneficiary. The findings further indicated another constraint of lack of knowledge on manure production as this constituted 14.3% of the responses. This was evident among farmers who were keeping free grazing cattle and who therefore missed livestock husbandry training from extension agents and thus, lost the opportunity of being visited by extension agents. In the study area extension agents normally visited only dairy cattle farmers. Other constraints included inadequate of labour (12.0%), high cost of labour were nine percent (9.0%) and lack of feeds were seven point five percent (7.5%) High cost of transport (9%), Poor income (4.5%), No implements (3.0) and Pest, lack of manure and lack of space found to constitute two point three percent (2.3%).

Table 9: Constraints encountered by cattle keeping respondents in cattle manure production

Constraints encountered by farmers on cattle manure production,	Frequency	Percent
Few cattle	51	38.3
Lack of knowledge	19	14.3
Lack of labour	16	12.0
High cost of labour	12	9.0
Lack of feeds	10	7.5
High cost of transport	6	4.5
Poor income	6	4.5
High cost of transport	6	4.5
No implements	4	3.0
Pest, lack of manure and lack of space	3	2.3
Total	**133**	**100.0**

4.2.4 Cattle manure management practices

Findings in Table 10 show that 39.2% of the responses manage manure by using cubicles. Personal observation revealed that one of the management practices involved is use of cubicles, the commonest being that of four to five cubicles. Manure managed under this practice is assured of having complete decomposition and ready for farm use (KATC 2004). The study further revealed that about three percent of the responses cited heaping manure and changing it from one point to another. Many farmers did not practice heaping and changing heaps from one point to another due to the high labour demand for the practice. Similarly, 24.5% of the responses reported of adding urine to stored manure for improving nutrient availability (Table 10). Adding urine is useful because urine contains high quantity of nitrogen and potassium which is an important component on plant nutrition. Wuta and Nyamugafata (2012) reported that urine contains most of the important nutrients like potassium. A study by SSMP (2007) confirmed that adding nitrogen in the form of urine improves the carbon to nitrogen ratio. Five percent of the responses practiced putting shade on cattle barn to reduce nutrient loss.

Table 10: Major Practices adopted as a part of manure management

Major practice adopted as part of manure management	Frequency	Percent
Change of manure in cubicles to improve nutrient availability	40	39.2
Putting manure on holes for easy decomposition	29	28.4
Addition of urine to stored manure to improve nutrient availability	25	24.5
Putting shade on cattle barn to reduce nutrient	5	5.0
Heap manure and change from one point to another	3	2.9
Total	**102**	**100.0**

Table 11 shows the time manure is stored before being transferred to fields. About 46% of respondents stored manure for a period of between one and two months, 43.5% for the period of above four months and 10.6% for a period of between three and four months. These differences could be due to lack of common understanding and knowledge among farmers on the required time for manure storage before taking it to the field. Lack of common understanding could have been also due to minimal extension training given to farmers. Management of manure includes other activities a farmer has to undertake so as to come up with good manure.

Table 11: Time for storing manure before it is applied to the farm (n =85)

Time (months)	Frequency	Percent
1 – 2	39	45.9
3 -4	9	10.6
More than 4	37	43.5
Total	**85**	**100.0**

These management practices include storage by covering manure with soil; putting manure under shade, adding ashes and crop stalks to speed up decomposition and increase volume. One of the most important practices for assuring quality manure is use of cattle urine as nutrient rich compound. The study revealed that 61.7% of farmers keeping cattle said that it was important for them to add urine on manure in order to improve manure quality (Fig.5). The important of urine is supported by a statement of Vahanka *et al.* (2010) who states that cows' urine have two point five percent urea, and two point five percent minerals, hormones, salts and enzymes. The practice of retaining urine in manure is necessary to a farmer as they improve manure quality. Farmers' local knowledge on the importance of urine was also reported by Jackson and Mtengeti (2005) in their report that 71.7% of cattle keeping farmers had knowledge on the important of urine as a fertilizer.

Table 12 shows ways used by farmers to capture urine from cows. Among the methods was that of constructing a urine ditch that direct urine into a pit. This method constituted 70.8% of the responses. This method is where farmers get urine and incorporate it with cattle manure. Similar findings were reported by Jackson and Mtengeti (2005) in Njombe who showed that 71.7% of the households use beddings or constructed concrete chambers besides the animal barn to capture urine.

Is urine important as a source of addition nutrient?

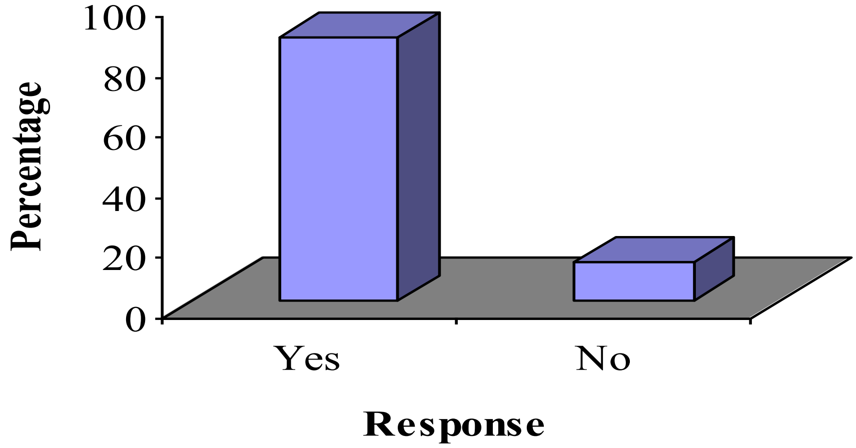

Figure 5: Importance of urine

On the other hand 14.6% of the responses reported to use bio- slurry mixed with residual bedding materials and locally mixed manure. Bio – slurry is the digested dung that is discharged from the installed biogas plant after cattle manure has fermented. TDBP (2009) supported bio – slurry that bio – slurry is an important by-product from biogas plant. Households who had biogas plant have access to use bio-slurry. When correctly applied the fertilizing value of bio-slurry, surpasses that of raw cattle manure.

Table 12: Ways of capturing urine flowing out of the barn (n= 85)

Ways for capturing urine from flowing out of the barn	Frequency	Percent
A ditch directing urine into a pit	68	70.8
To use bio slurry mixed with kraal	14	14.6
To use locally mixed manure direct with gas production	14	14.6
Total	**96**	**100.0**

Another manure management practice is pit treatment which is used by 31.8% of the respondents (Table 13). Four point seven percent of the respondents were practicing heap pilling of manure. Manure heap pilling method control evaporation of nutrients and moisture in manure. Changing manure in cubicles was found to be important in manure management because the method cited by 34.1% of the respondents. This method is important because it contributes to increased manure decomposition. Other practices are as shown in Table 13.

Table 13: Other Practices used to manage cattle manure (n =85)

Practices do you use to manage your cattle manure	Frequency	Percent
Changing manure in cubicles	29	34.1
Pit treatment	27	31.8
Pilling heap on kraal and cover	14	16.5
Open heaping on kraal	11	12.9
Heap pilling	4	4.7
Total	**85**	**100.0**

Table 14 presents sources of labour for cattle management. Results show that 81.7% of the respondents depended on family labour. According to Makokha *et al*. (2001), most of the farmers in SSA are relatively poor and that among the main constraints in using manure is its high labour requirement. From this study, findings have revealed that labour hiring was only done by three point three percent of the respondent farmers. Farmers who were using FYM have big labour requirement compared to other types of cattle manure such as bio-slurry because every practice on manure management needed presence of many people to supply labour in order to be done timely. On the other hand, use of bio-slurry was cheaper in terms of labour requirement because bio-slurry is discharged from the plant in the form which made it ready for being used in the field and thus, needed no further management practices. High labour demand implies high manure management operation costs. These difficulties in manure management and labour requirement were also reported by Baitilwake *et al*. (2011) who reported that manure cannot meet crop nutrient demand over large areas because of limited quantities available, low nutrient content for most of the materials, and high labour demand for processing and application. However findings also show that 15% of respondents use both family labour and hiring labour on manure management.

Table 14: Labour source for cattle manure management practices (n=120)

Labour source for manure management practices	Frequency	Percent
Family labour only	98	81.7
Both hiring and family labour	18	15.0
Hiring labour only	4	3.3
Total	**120**	**100.0**

Findings presented in Table 15 show cattle manure management practices that aim at minimizing loss of nutrients where 41.6% of the interviewed cattle keeping farmers said they were using the cover shade to protect nutrient loss. Nevertheless, very few (11.7%) of the cattle keepers heap cattle manure outside cattle kraal and cover the heap with grasses. Other methods include turning and change of manure in cubicles as reported by 18.2% of the farmers and collection of urine and mix with manure to quantify nitrogen reported by 26.8%. Other management practices are as presented in Table 15. Findings presented in Table 16 show that bio-slurry nutrients were mostly conserved through mixing both FYM and bio-slurry (40.6%).

Table 15: Practices used to minimize loss of nutrients in FYM (n= 77)

Practice	Frequency	Percent
Use of cover shade to protect loss of nutrients	32	41.6
Collection of urine and mix with manure to quantify nitrogen	22	26.8
Turn and change of manure in cubicles to speed up decomposition	14	18.2
Heap outside and cover with thatched grasses	9	11.7
Total	**77**	**100.0**

In Bio-slurry, urine as a component, is used in order to activate high amount of gas in the biogas plant. Another practice of nutrient conservation used by respondents in bio-slurry management was heaping the fermented slurry, which was reported by three point one percent of the respondents. However, 28.1% of the respondents' reported no treatment being done to conserve nutrients in bio-slurry and this is probably due to lack of extension services.

Table 16: Practices for conserving nutrient in bio-slurry (n =32)

Method used to conserve nutrients on bio-slurry manure	Frequency	Percent
Mixing FYM and bio slurry	13	40.6
No treatment	9	28.1
Use of cubicles	7	21.9
Use of bio prepared manure	2	6.3
Heap treatment slurry	1	3.1
Total	**32**	**100.0**

Table 17 presents findings on number of cropping seasons farmers had used FYM where it is revealed that 45% of maize respondents had used FYM for one to two cropping seasons, while 23.3% had used FYM for three to four cropping seasons. Two seasons were not enough for a farmer to gain enough appreciation of the practice and therefore fully adopt an innovation.

Table 17: Number of season farmers had used FYM (n= 120)

Number of Seasons	Frequency	Percent
1-2	54	45.0
3-4	28	23.3
5-6	8	6.7
7-8	13	10.8
9 -10	17	14.2
Total	**120**	**100.0**

About seven percent had used FYM for five to six cropping seasons. The variations in using FYM resulted from having different donors who had different policies regarding the projects promoted in the study area. Donor interventions differ from one to another. They also use different extension agents to transfer technology to farmers. There are those who use farmer facilitators, others use private extension agents and others use government extension agents and government researchers. The projects have different calendar of activities.

Farmers' experience in bio – slurry management practices were as presented in Table 18. Results show that about 69% of the respondents had the experience of two production season in the use of bio-slurry, three point one percent had experience of only one cropping season with others having experience for one, four and eight cropping season (Table 18).

Table 18: Farmers experience on the use of bio slurry (n =32)

Number of season (experiences)	Frequency	Percent
1	3	9.4
2	22	68.8
3	1	3.1
4	3	9.4
8	3	9.4
Total	**32**	**100.0**

Using biogas from cattle manure was among the ways of protecting the environment through reduction of use of firewood. This intervention was also promoted by EPINAV project through Tanzania Domestic Biogas Programme (TDBP) as expertise capacity building facilitators. Findings on farmers' awareness on manure quality loss minimization were as presented in Table 19. The findings show that 83.3% of the respondents know methods for minimizing losses of quality of manure. The study also shows that 16.7% of the respondents did not know how to minimize losses of nutrients in manure. Not knowing of how to control manure quality may be attributed to extension services including farmers training demonstration and visits. According to Akpan *et al*. (2012), increase in agricultural extension visit increases the probability of adopting fertilizer technology by 11.74% because an extension agent creates awareness on technology use by providing reliable information to farmers' during extension visits.

Manure management practices should be effective in terms of maintaining quality. Study results presented in Table 20 show that 76.7% of the respondents agreed that manure management practices have normal and reasonable low cost of operation compared with other soil management technologies such as tree planting, contouring etc.

Table 19: Awareness of farmers on manure quality loss (n = 120)

Awareness	Frequency	Percent
Know to minimize loss of nutrients	100	83.3
Don't know how to minimize nutrient losses	20	16.7
Total	**120**	**100.0**

However, 10% of the respondents said manure management practices have high cost. Such cost is like high labour demand for carrying out the management practices as some farmers depended on hiring labour. On the other hand 13.3% of the farmers did not show whether management practice led to high or normal cost.

Table 20: Farmers' opinion on cattle manure management practice costs (n = 120)

Farmer opinions on manure management practices cost	Frequency	Percent
Normal cost/low cost	92	76.7
Undecided	16	13.3
High cost	12	10.0
Total	**120**	**100.0**

4.2.5 Constraints on cattle manure management

The major constraint mentioned by respondents on manure management in the study area was lack of enough labour which was reported by 38.3% of the respondents. Other constraints included expensive labour having (25.9%), lack of space (6.7%) and low knowledge (1.7%). According to Svotwa *et al*. (2009) inadequate inputs, high labour demand, and little technical backup are farmers' common problems on manure management. Increase in shortage of farm labour is also because of rural to urban migration, coupled with competition from growing imports of cheaper food items is a constraint for addressing internal food production rates (WFP, 2012).

Table 21: Manure management constraints (n =120)

Constraint	Frequency	Percent
No enough labour for all activities on manure management	46	38.3
Not understand	33	27.5
Hiring labour is very expensive	31	25.9
No enough space for management practices	8	6.7
Low knowledge	2	1.7
Total	**120**	**100.0**

Results on manure management structures in the study area were as presented in Table 22. According to these results, 26.7 % of the respondents households use manure cubicles in which they turn manure from one cubicle to another. This exercise takes three and four weeks for manure to be ready for use. Roofed house structures were used by only 13.3% of the respondents while those who used an open house manure management structure were 15.8% of the respondents. Farmers who had no structures for manure management were 24.2 % of the respondents. However, 20.0% of the respondents were using manure earth pit structures. Earth pit structures are not good for managing manure according to Jackson and Mtengeti (2005) as earth pit causes leaching of nutrients in the ground which are thus washed by running water. Farmers who use open cattle structures produce poor manure and therefore get low crop yield. Respondents who had no any structure for manure management are those with no cattle and those keeping free grazing system.

Table 22: Cattle manure management structures (n = 120)

Type of structure	Frequency	Percent
Cattle manure cubicles	32	26.7
No structure	29	24.2
Earth pit	24	20.0
Open house	19	15.8
Roofed house	16	13.3
Total	**120**	**100.0**

Free grazing cattle with shifting style of keeping lead to getting poor crop yields. Findings in Table 23 present results on structures for urine collection in cattle manure management. Results show that 60.4% of the respondents were using cattle urine collection pits. Findings also show that 39.60% of the respondents have no urine collection pit.

Table 23: Collection of urine for manure quality improvement (n = 120)

Type of structure	Frequency	Percent
Farmers with urine collection pits	55	60.4
Farmers with no urine collection pits	36	39.60
Total	**91**	**100.0**

4.2.6 Practices of farmers on manure application

Table 24 presents findings on farm sizes over which farmers used manure. The study reported that 79.1% of the respondents apply FYM on farm size ranging between zero point four and zero point nine hectare (0.4 -0.9). The findings further show that 11.7% of the respondents apply FYM on the land of between one and one point six ha. Only one point seven percent (1.7%) of the respondents was applying FYM to a farm size of more than two ha and seven point five percent did not record the farm size on which they applied FYM since they had small fragmented land. Many of those who applied manure had small plots which were scattered in more than one place such that it was very difficult for them to apply manure on distantly located plots because of high cost of transport. Farmers who were using land from elders (inherited land) said they lack incentives for using some inputs such as manure because that the land does not belong to them. According to the study findings in Table 24, 12.5% of farms had applied bio-slurry on the on farm land sizes falling between zero point two and zero point eight ha. Results also show that 87.5 % of the respondents had no records of the farm size they applied bio - slurry. Absence of records on bio-slurry is probably due the fact that the technology is still new among farmers.

Table 24: Farm size applied with FYM and bio slurry in Njombe District (n = 120)

Farm size (ha) Applied FYM	Frequency	Percent
0.4-0.9	95	79.1
1.1-1.6	14	11.7
More than 2	2	1.7
No records	9	7.5
Total	**120**	**100.0**
Farm size (ha) Applied bio-slurry		
0.2 0.8	4	12.5
No records	28	87.5
Total	**32**	**100.0**

Farm size applied with bio slurry (n = 32)

Results on the time of application of cattle manure and reasons for variations in manure application were as presented in Table 25. About 48% of respondent have been applying manure four weeks before planting. However, one point seven percent (1.7%) responses applies two weeks before planting. Other application time period were as shown in Table 25.

Table 25: Time of cattle manure application and reasons for variations

Time of application	Frequency	Percent
Four weeks before sowing	57	47.5
Three weeks before sowing	26	21.7
One week before sowing	14	11.7
Apply during sowing	10	8.4
Before starting of rainfall	5	4.2
Two weeks before sowing	3	2.5
Don't know	3	2.5
Three weeks after sowing	2	1.7
Total	**120**	**100.0**
Reason for the time differences (multiple responses)		
Decomposition of manure	46	37.7
Labour availability	36	29.5
Right time for application, lack of space, and cost of transport	33	27.0
Don't know the reason	7	5.8
Total	**122**	**100.0**

Discussion with respondents revealed that differences in time of manure application were due to lack of common understanding on specific time period for manure application. These differences emanated from the different recommended dates given by the extension agents promoting various technologies under different projects sponsored by different donor agencies. Reasons given by respondents as to the specific period at which they applied manure included having enough time for manure decomposition (37.7%) to respond to labour availability (29.5%) and waiting for right time for application, lack of space and cost of transport which constituted (27%) (Table 25). Study findings presented in Table 26 show that 96.7% of the respondents use manure on maize production. Therefore maize was found to be a major staple food crop which benefit for manure application in Njombe. Other crops on which manure was applied included vegetables, round potatoes, orchards and pasture (grasses) all of which accounted for three point three percent manure application.

The use of farm equipments and tools by farmers for manure transportation to farms are reported in Table 26 where it is show that 31.7% of the respondents were using ox-carts, while 17.5% reported using tractor. On equipments used for manure in production, management and application, the study found that the farmers had no reliable equipments. Study findings show that 43.3% of the respondents used family labour using buckets, and wheelbarrow and seven point five percent were able to hire labour.

Table 26: Use of manure and equipments by crops (n=120)

Crop	Frequency	Percent
Use of manure on crops		
Maize	116	96.7
Vegetables, round potatoes, orchards and pasture	4	3.3
Total	**120**	**100.0**
Equipments used by farmers for cattle manure production, management, and application (n = 120)		
Equipments used for cattle manure practices	Frequency	Percent
Buckets, w/barrow using family labour	52	43.3
Ox-cart	38	31.7
Tractor	21	17.5
Vehicle(trucks) with hiring labour	9	7.5
Total	**120**	**100.0**

Study findings presented in Table 27 show estimates for various labour costs on manure production, management and application. About 42 % of the respondents had no record on the cost of manure production because they used family labour. Forty percent of the respondents farmers reported labour cost falling between 50 000 – 150 000 TAS per ha. Few, (2.5%) of the respondents hired labour at a cost of 152 000-250 000 TAS per ha and four point one percent hired labour at a cost of TAS 352 000 – 450 000 respectively.

Table 27: Labour cost for manure production and management practices (n=120)

Cost per hectare (TAS)	Frequency	Percent
No record	50	41.7
50 000 – 150 000	48	40.0
152 000 – 250 000	14	11.7
252 000 -350 000	3	2.5
352 000-450 000	5	4.1
Total	**120**	**100.0**

Findings presented in Table 28 showed that 54.4% of the farmers/ responses applied manure by putting in prepared hole. This application method aim at making sure that the target plant was in contact with manure and is therefore called Targeting Method (TM). Farmers said that this method was used by many farmers because it was not complicated for farmers to use. Other benefits from this method were low cost and low amount of manure to be used per area. However, 37.6% of the responses distribute manure evenly on the farm. This method intends to make sure that every part of the farm is getting manure. This is done where a farmer has enough manure. Another method used in manure application was drawing straight lines on which they had to spread especially the part where seeds were targeted to be placed. This method was used only by eight percent of the responses.

Table 28: Methods of manure application (multiple response)

Application method	Frequency	Percent
Use of prepared hole (TM)	116	54.4
Evenly distribution/broadcasting	80	37.6
Use of line	17	8.0
Total	**213**	**100.0**

4.2.7 Constraints encountered in application of cattle manure

Table 29 presents results on constraint facing farmers in cattle manure application. Transportation as a constraint on manure application to farmers was reported by 43.2% of the respondents. Therefore transport of manure to the field found as a challenge on adoption and use of manure especially for small size households. Makokha *et al*. (2001) also reported that high requirement of labour and transports reduce manure adoption. Other constraints were: lack of labour, which was reported by 29.4% of the respondents and high cost of labour which reported by 27.4% of the respondents. According to Mwangi (1997), farmers reject technologies related to manure because of its high labour demands.

Table 29: Constraints facing Cattle Manure application (n= 95)

Constraint	Frequency	Percent
Transportation of manure	41	43.2
Lack of labour	28	29.4
High cost of labour	26	27.4
Total	**95**	**100.0**

Results in Table 30 shows that 43.3% of the respondents used the dibbling method to apply manure, 29.2% of respondents applied manure using the basal application method and 27.5% used the broadcasting method to apply their manure. Broadcasting method is where cattle manure is placed to untargeted area and is normally lost.

Table 30: Other Methods of manure application used by farmer (n = 120)

Other Method	Frequency	Percent
Dibbling manure on the plant	52	43.3
Putting on the plant base	35	29.2
Spreading manure on the surface of the farm	33	27.5
Total	**120**	**100.0**

4.3 Attitude towards Farm Yard Manure

Table 31 presents results on attitude of respondents towards FYM. Results in the Table show that 53% of the respondents had positive attitude towards FYM while the remaining 46.7% had negative attitude. The results indicate that more respondents in the study area have favoured the application of FYM to their farmlands.

Table 31: Attitude of Farmers towards Farm Yard Manure

Attitude towards FYM	Frequency	Percent
Positive	64	53.3
Negative	56	46.7
Total	**120**	**100.0**

Positive attitude of farmers is the indication of positive action of farmers on using FYM. Farmers' positive attitude of a given practice is hypothesized to hasten the adoption of the practice (Odendo *et al.,* 2010). Farmers in the study area showed positive attitude towards FYM probably because of long farm experience using FYM.

Table 32 presents the result of a Chi square test for measuring the relationship between farmer's main occupation and attitude towards FYM. Farmer's main occupation had three categories of crop farmer, livestock farmer, and crop and livestock farmer and attitude was measured into two categories, positive and negative. Results indicate that there is no statistical significant relationship between attitude towards FYM and farmers main occupation (p = 0.186). The result therefore shows that farmer occupation is independent of attitude towards FYM.

Table 32: Relationship between attitude on FYM and Farmers main occupation

Attitude towards FYM	Main occupation			Chi sq.	P value*
	Crop Farmers	Livestock farmers	Crop/livestock farmer		
Negative	13	0	43	0.173	0.186
Positive	18	2	29		

*p-value based on Fishers Exact Test

Furthermore, a test done to determine the relationship between attitude towards FYM and whether or not one keep cattle showed that there is no statistical significance relationship between cattle keeping status and attitude towards FYM (p = 0.545) as shown in Table 33.

Table 33: Relationship between attitude towards FYM and Cattle keeping

Attitude towards FYM	Do you keep cattle		P – Value *
	Yes	No	
Positive	44	20	0.545
Negative	41	14	

*P – value based on Fishers Exact

A test was done to determine the relationship between attitude towards FYM and whether or not one received training on cattle manure presented on Table 34. The result show that there is no statistical significance association between attitude towards FYM and Extension training of a farmer on FYM (p = 0.194) (Table 34).

Table 34: Relationship between attitude towards FYM and extension training on cattle manure

Attitude towards FYM	Farmer extension training on cattle manure		P- value *
	Yes	No	
Positive	40	23	0.194
Negative	28	27	

*P = value based on Fishers Exact

4.4 Attitude towards Bio - Slurry Manure

Table 35 shows the distribution of attitude towards bio slurry of respondents. The findings reveal that all 21 bio - slurry respondents showed negative attitude towards bio-slurry manure. This might have been so because using bio-slurry manure was a new technology in Njombe. Biogas plants technology is still at infant stage because the technology was introduced in the area in the year 2010 under PANTIL project (Mdegela, 2011). A report of Vasudeo (2004) concluded that the major bottle-neck faced by the

Biogas technology in its dissemination and integration is the unfavourable cost-benefit analysis done in the conventional manner. However, bio slurry acceptance by farmers is expected to improve in the future when its benefits are conspicuous. Farmers who had the knowledge on bio-slurry were those who keep dairy cattle who were in the position to get access to training on bio-slurry manure use. But probably keeping dairy cattle is not indications of attitude towards bio- slurry, a farmer also need biogas plant and enough labour to have access to bio- slurry technology.

Table 35: Attitude towards bio slurry- manure (n = 21)

Attitude towards bio slurry	Frequency	Percent
Negative	21	100.0
Positive	0	0
Total	**21**	**100.0**

4.5 Attitude towards Inorganic Fertilizer

Table 36 presents results on farmers' attitude towards inorganic fertilizers in Njombe District. Results show that 51.9% of the respondents had negative attitude on inorganic fertilizer and 48.1% had positive attitude. Negative attitude might be caused by the fact that inorganic fertilizer need money to get from agro dealers. Inorganic fertilizer is reported as expensive, as a 50kg bag of fertilizer cost about TAS 80 000 and above. Moreover because farmers have also been trained on the side effects of inorganic fertilizer to the environment, environmental concern might have accounted for the negative attitude towards inorganic fertilizer. For example Odhiambo and Magandini (2008) outlined constraints of inorganic fertilizer that majority of smallholder farmers in Vhembe district are resource poor and cannot afford the high cost of fertilizers.

Table 36: Attitude towards inorganic fertilizer (n = 79)

Attitude towards inorganic fertilizer	Frequency	Percent
Negative	41	51.9
Positive	38	48.1
Total	**79**	**100.0**

In addition respondents who had positive attitude towards inorganic fertilizers might those who did not have cattle 29% (result shown on Fig 3 page 35). Sometime high cost of inorganic fertilizer might cause the high rate of negativity. Main occupation of farmer was found to be associated with farmer attitude towards inorganic manure. Result in Table 37 show that farmer main occupation is statistically significance relationship with inorganic fertilizer application ($p = 0.003$).

Use of inorganic fertilizer should supplement efficient of crops and pasture respectively to improve production. The scenario comes because organic manure are not enough always at the farmer level. In addition, due to the limited number of animals kept by the smallholder farmers, the amount of manure produced is not sufficient. (Odhiambo and Magandini 2008).

Table 38 shows relationship of farmer attitude towards inorganic fertilizer and cattle keeping. The result in the Table show that there is a statistically significant relationship between farmer attitude on inorganic fertilizer and cattle keeping ($p = 0.001$). A Cattle keeping farmer is relatively worthy and therefore can afford to purchase inorganic fertilizer to apply cattle manure for production of crops.

Table 37: Relationship between attitude towards inorganic fertilizer and Farmers main occupation

Attitude towards inorganic fertilizer	Main occupation			Chi sq.	P-value*
	Crop Farmers	Livestock farmers	Crop/livestock farmers		
Positive	18	1	19	0.003	0.003
Negative	6	2	33		

*p-value based on Fishers Exact Test

Table 38: Relationship between attitude towards inorganic fertilizer and Farmers' cattle keeping status

Attitude towards inorganic fertilizer	Cattle Keeping		P – value *
	Yes	No	
Positive	19	19	0.001
Negative	34	8	

*P – value based on Fishers Exact

Findings in Table 39 show the relationship between attitude towards inorganic fertilizer and extension training. The results show that there is a highly statistically significant relationship between farmers attitude towards inorganic fertilizer and extension training of a farmer (p = 0.000). The results show that extension training is important in determination of attitude of a farmer towards the use of a technology such as use of inorganic fertilizer.

Table 39: Relationship between attitude towards inorganic fertilizer and Farmer extension training on cattle manure

Attitude towards inorganic fertilizer	Farmer extension training on cattle manure Yes	No	P – value *
Positive	10	27	0.000
Negative	31	10	

*P – value based on Fishers Exact

4.6 Impact of Cattle Manure on Maize Yield

Maize is a major food and cash crop to smallholder farmers in Tanzania (Aman, 2004). However maize is also important to some parts of East Africa. For example, Mignouna *et al.* (2010) reported that maize crop is a staple food of great socio- economic importance in western Kenya, while Msuya (2007) asserted that maize is an important cereal food crop in Tanzania. Njombe District is one of the districts that is potential for production and supply of maize in the country (Msuya 2007). Study findings revealed that 96.7% of the respondents were growing maize using manure (Table 26). Findings further show that maize was a major crop and staple food in the study area and farmers used different efforts including manure to maximize production. Findings reported that 95% of the respondent farmers who used manure were aware that manure was important for increasing their maize yields. Table 40 shows paired t-test results on maize yield before manure application (YBCATTLE) and after manure application (YACATTLE). The mean yield of maize before application of manure was 1403 kg per hectare whereas the yield after cattle manure application was 3022.6 kg per ha. The difference in means was highly statistically significant ($t = 20.075$, $p = 0.000$), implying that application of cattle manure lead to higher maize yields than in situation where manure is not used. Similar results were reported by Lisuma and Mrema (1999) for maize, sorghum, small grains, cotton, rice and vegetable crops. Wuta and Nyamugafata (2012) also reported increased yields on using manure. According to Emuh *et al.* (2011), organic manure including cattle manure impacts positively on soil and eventually lead to crop yield increase from 3750 - 5000kg per ha. FYM indirectly increases yield by making external nutrients more absorbable to crops (Tiessen *et al.,* 1994).

Table 40: Comparison on yield of maize per hectare before and after application of cattle manure (n=116)

Production scenario	Mean	t	Sig (2-tailled)	Std. Deviation	Std. Error Mean
YBCATTLE	1403.3	-	0.000	263.90285	24.50276
YACATTLE	3022.6	20.075*		392.55180	36.44752

* Significant at 0.05 level

Table 41 presents maize yield before and after application of bio-slurry (YBSLURRY) and (YASLURRY) respectively. Results shows that the mean yield of maize before use of bio- slurry was 1756 kg per ha while yield after use of bio- slurry was 4225 kg per ha. The difference in the two means was statistically significant (t = 6.11, p = 0.000), implying that the use of bio-slurry manure lead to increased maize yield. These findings show that biogas plants can produce fertilizers suitable for arable fields as by-products of renewable energy. These findings are in line with findings reported by Maunuksela *et al.* (2012) that, Biogas Plant (BGP) end products can be utilized as fertilizers in the production of cereal crops such as barley.

Table 41: Yield of maize per hectare before application of bio-slurry and after application of bio-slurry

Production scenario	Mean	t	Sig.	Std. Deviation	Std. Error Mean
YBSLURRY	1756.25	-6.11*	.220	250.12497	79.09646
YASLURRY	4225			638.05259	201.76995

* Significant at 0.05 level

Comparison between the impacts of FYM and bio-slurry on maize mean yield (Table 42) was also computed. The result revealed that the mean yield of maize under use of FYM was 3022.6 kg per ha while that under bio-slurry manure use was 4225 kg per ha. The difference in the mean yields under the two types of manure was not statistically significant different ($t = 1.318$, $p = 0.220$), implying that there was no significant difference on the impact of the two types of manure on maize yield at $p < 0.05$ level of significance. This result was different from what other studies reported regarding comparison between FYM and bio-slurry. This stems for the fact that owing to its properties bio-slurry accelerates root growth and inhibits weeds germination and therefore is supposed to do better than other manure types (Vasudeo, 2004; Evira, 2012). According to Vasudeo (2004), the advantages of bio-slurry over chemical fertilizers, have proven superiority in its nutrient content when compared to other manures such as FYM.

Table 42: Maize yield per hectare under FYM and bio-slurry application

Production scenario	Mean	t	Sig.	Std. Deviation	Std. Error Mean
YACATTLE	3022.6	6.3NS	0.220	583.33929	184.46808
YASLURRY	4225			638.05259	201.76995

*Not significant at p<0.05

Advantages of cattle manure as revealed farmers are presented in Table 43. About 31% of the responses said manure application increased soil fertility and 26.7% said that using manure makes it possible to get highest yield. Other advantage of using cattle manure identified by respondents include increase household income from sale of crops (23.5%), harmful chemicals in the farm reduced (nine point six percent), availability of food (five point seven percent) and produce gas and reduce cost of production (three point five five percent). The responses of farmers on the important of cattle manure indicating that cattle had multiple advantages at a farmer level application.

Table 43: Importance of using cattle manure to the smallholder farmer

Importance of using cattle manure	Frequency	Percent
Increase soil fertility	87	30.96
Highest yield is obtained	75	26.7
Income increased	66	23.5
No harmful chemical in the farm	27	9.6
Increase food availability	16	5.7
Produce gas, reduce cost of production	10	3.55
Total	**281**	**100.0**

Table 44 shows respondents suggestions to the government on improving manure use in the country as a conclusive comments from respondents. Results show that 55.8% of the respondents suggested that government should introduce regularly training programmes on manure use in order to get relevant skills on manure production, management and application to the field. About three point three percent (3.3%) of the respondents suggested the government assist through soft loan for buying dairy cattle which will increase manure availability. Other farmers requested the government to give them capital to construct manure management structures (reported by 21.7% of the respondents while others (19.2%) were in need of having demonstration plots as part of capacity building to the farmers.

Table 44: Advice of farmers to the Government on best use of manure in Njombe (n = 120)

Advice of farmers to the government	Frequency	Percent
Introduce regularly manure use training schedule for farmers	67	55.8
To give capital for farmers for construction of manure management structures	26	21.7
Introduce demonstration manure at every village	23	19.2
Government to provide loans to farmers for dairy cattle	4	3.3
Total	**120**	**100.0**

CHAPTER FIVE

5.0 CONCLUSION AND RECOMMENDATIONS

5.1 Summary

This study has shown that 71% of the respondents are aware of manure use and innovations in relation with cattle manure application, and that to a large extent many have been adopting a number of manure management practices at household level. Findings further indicate that respondents range from young to old age with enough experience in farming and have attained primary education. Fifty three percent of farmers prefer cattle manure to inorganic manure because it has advantages over inorganic fertilizers. Bio-slurry was another and very new manure which showed substantial impact on maize yield.

The mean household size was five point five percent (5.5%) but labour force is not sufficient per house hold. Majority (71%) of the respondents used mixed farming of growing crops and keeping cattle. Farmers owned small mean farm size of (0.96) ha. Owning cattle is the major problem of getting manure on their farm and high labour cost is a problem for proper manure management which is further affected by poor manure working equipments and transportation. Findings of the study have shown that farmers have positive attitude towards manure use and manure use has led to increase in maize yield. On the basis of this study some conclusions and recommendations can be drawn for development planners, researchers, change agencies, policy makers, and farmers with regard to the use of cattle manure for modern, profitable, and sustainable productivity agriculture.

5.2 Conclusions

Cattle keeping has been found to be among the main livelihood activities within the study area such that more than 70% of the households keep cattle because of the multiple benefits like income from manure, milk and cattle sales. Farmers use manure to fertilize crop land and this increase food security and household income from crop sales. Moreover, from cattle farming, farmers are also getting energy in the form of biogas from biogas plants which also give them bio-slurry, an important fertilizer for crop production. Some of the manure management practices that farmers perform were: heaping and composting manure; construction and use of manure cubicles; cattle urine collection and mixing it with manure. However, 79.1% of respondents had the ability to apply manure on small farm sizes that fell between zero point four and zero point nine ha (0.4 -0.9 ha).

More than half of the respondent farmers had shown positive attitude towards manure than inorganic fertilizers. Negative attitude on inorganic fertilizer was due to high cost such that, only few farmers were able to purchase it. Likewise the induced knowledge on side effects on soil degradation resulted in negative attitudes by the farmers. Furthermore, the attitude of farmers was influenced by the extension training farmers received on FYM and the high cost associated with purchase of inorganic fertilizers.

Study findings revealed that households who produced maize had more positive attitudes on FYM. The Chi square P – value tests revealed that, main occupation of farmers had no statistical significant relationship on attitude towards manure by the farmer ($p = 0.186$). Similar result was also obtained for cattle keeping with attitudes towards FYM ($p = 0.545$). Also extension/training was found to be independent with attitude towards FYM ($p = 0.194$). Determination of attitude towards farmer using bio-slurry has show that farmers with bio gas plants had negative attitudes towards its use. This might be associated with the reason that the technology being new to the farmers. Statistical significance results were shown on attitude towards inorganic fertilizers and farmer occupation ($p = 0.003$), cattle keeping ($p = 0.001$) and extension training ($p = 0.000$) respectively.

The study identified that constraints on using manure include transport cost and labour cost. Transporting manure to the field needs means of transport which is very expensive at farmer's level. Labour is also a constraint because management of manure from the kraal to the field was found to require intensive labour demand which also increase management cost. The high cost of labour makes some farmers find it difficult to practice management and use manure. Lack of knowledge on manure management was mentioned as a constraint on manure use.

Njombe District is one of the districts that is potential for production and supply of maize in the country. Study findings revealed that farmers use cattle manure in crop production on maize, which is the main staple food in the areas. The findings show that there were significant difference in the mean yields between farmers who use cattle manure and those who do not use cattle manure. Farmers who used cattle manure produce 1620kg per ha of maize above farmers who do not use cattle manure.

5.3 Recommendations

In view of the above discussion and conclusion, the study recommends the following

i. The government and NGOs should build the ability of farmers in terms of affording to purchase dairy cattle, and access technical support on manure production, management and use in order to improve farm productivity especially maize productions which seen to lead to increased household income and food security among the farming community.

ii. Extension services on bio-slurry production, management and use should be increased especially on use of the recommended equipments. Because of the big investment costs required for purchasing equipments to install biogas plants, farmers should be assisted with capital for construction of manure structures. Moreover, to help farmers minimize transportation problems, farmers should be advised to form groups societies to increase their ability to get loans that shall be used for purchasing transport facilities. This should be the role of the government, private sectors like NGOs and financial institutions.

iii. The government and other stakeholders should provide and improve training programmes on the use biogas and bio-slurry in order to add positive attitude to farmers who shall increase crop production while at the same time reducing environment degradation by reducing use of chemical fertilizer. This knowledge will help farmers to get sustainable energy for lighting and cooking which will lead to sustainable environment management as farmers will not cut down the trees for fuel again.

iv. Campaigns on the production, management and use of cattle manure to the farming community should be made instead of campaigns on use of the inorganic fertilizers. This should be the role of extension staff. Farmers should therefore be educated on when inorganic fertilizers are to be applied, rates of application per area and soil condition under which particular fertilizers should be applied. Moreover, farmers should be given education on soil fertility conservation measures which have low cost but sustainably increasing soil fertility without causing much harm to the soil and the environment.

v. Family planning education should be improved at community level so that the available land area satisfying community farmers.

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APPENDICES

Appendix 1: (a) Farmers-Interview Schedule

Assessment of Use, Attitudes, Constraints and Impacts of cattle Manure on Maize farming by smallholder farmers in Njombe District

A. BACKGROUND INFORMATION

Farmers Demographic Information and Socio-economic Characteristics

A1 Division …………………………………….

A2. Ward………………………………………

A3. Village …………………………………….

A4. Name of interviewer…………………………………………

A5. Date of interview……………………………………………

A6. Name of respondent…………………………………………..

A7. Age of respondent …………………………………………. Years

A8. Sex of respondent (1) male (   )

(2) Female (   )

A9. Marital status of the respondent

1. Married (   )
2. Single   (   )
3. Widowed (   )
4. Divorced/separated (   )

A10. Education level of respondent

1. No formal education (   )
2. Adult education /primary education (I-iv) (   )
3. Primary education   (   )

4. Secondary education ( )

5. Above secondary education ( )

A11. Number of individuals in the household ……………………

1. Male ( )

2. Female ( )

A12. Number of individuals who provide full labour ………………………………

1. Male ( )

2. Female ( )

A13. What is your main occupation? 1. Crop farmer ( ), 2.Livestock farmer ( ), 3. Crop and livestock farmer ( ), 4. Others specify…………………….

A14. Land ownership of the respondent1. Purchased ( ), 2. Inherited ( ), 3. Rented ( )

4. Village governmen ( ), 5. Open new land ( ), 6. Others ( ) specify……………….

A15. What is your farm size………………………………acres

A16.Which area is under maize production …………………….acres

B: FARMERS PRACTICES ON THE PRODUCTION, HANDLING, USES AND TIME OF CATTLE MANURE APPLICATION

B-Manure production practices

1. Do you keep cattle?

1. Yes ( ),

2. No ( )

2. If yes on question one above, do you use any manure from the cattle you keep?

1. Yes ( ),

2. No ( )

3. If yes on question two above, what type of manure do you use?

1. Farm yard manure ( ),

2. Bio - slurry ( )

4. Have you received any training on cattle manure?

1. Yes ( ),

2. No ( )

5. If yes on 4 above, what was that training about?

1. How to produce good cattle manure ( ),

2. Manure application ( ),

3. Both management and application ( ),

4. Others ( ) specify……………………

6. Are you applying that skill/s you have mentioned on your farm?

1. Yes ( ),

2. No ( )

7. If yes on question 6 above, what skill/s are you using?

1. How to produce good cattle manure ( ),

2. Application skills ( ),

3. Management and application skills ( ),

4. Others ( ) specify …………………………..

8. How often do you remove manure from the animal barn?

1. Every day ( ),

2. Weekly ( ),

3. Fortunately ( ),

4. Others specify ( )…………………………

9. Do you place beddings materials to animal barn?

1. Yes ( ),

2. No ( )

10. Why?

1. …………………………….

2. ……………………………..

3. ……………………………..

11. What type of bedding materials you are using?

1. …………………………

2. …………………. ……..

3. …………………………

12. Do you know how much cattle manure is required for your maize production per season?

1. Yes ( ),

2. No ( )

13. If yes on question 13 above, how much manure do you need per season? ……………

C-Manure management practices

1. What is the major practice you do as a part of manure management?

1. Addition of urine to stored manure to improve nutrients availability ( )

2. Change of manure in cubicles regularly to speed up decomposition of manure ( )

3. Putting manure on holes for easy decomposition ( )

4. Others ( ) specify ……………………………………

2. Is that management practice used for both farm yard manure and bio - slurry?

1. Yes ( ),

2. no ( )

3. If the answer is no to question three above, what management practices are used for bio slurry and farm yard manure?

1. Bio - slurry………………………………………

2. Farm yard manure……………………………………..

4. The reason for storage of cattle manure for you includes:

1. To speed up decomposition (   ),

2. To maintain nutrient content (   ),

3. To wait for the coming season (   ),

4. Others (   ) specify…………………….

5. How long do you need to store manure before it is applied to the farm?

6. Is urine important as a source of addition nutrient?

1. Yes (   )

2. No (   )

7. If yes how do you capture it as it flows away from the barn?

1. ………………………..

2. ……………………….

8. What other practices do you use to manage your cattle manure?

1. Pit treatment (   ),

2. Changing manure on cubicles (   ),

3. Piling heap with shed (   ),

4. Open heaping in kraal

9. On manure management practices, what is your labour source?

1. Family labour only (   ),

2. Hiring labour only (   ),

3. Both hiring and family labour (   ),

4. Farm machinery (   ) specify………………………………….

10. If yes on 6 above, what technology/ies are used to preserve nutrient loss from farm yard manure?

1. Use of cover/shed to protect loss of nutrients ( ),

2. Collection of urine and mix with manure to quantify nitrogen ( ),

3. Turn and change of cubicles to speed up decomposition ( ),

4. Heap outside and cover with thatched grasses ( ),

5. Others ( ) specify…………………

11. What method do you use to conserve nutrients on bio-slurry manure?

1. Use of cubicles and add urines ( ),

2. Heap fermented slurry outside and mix with urine ( ),

3. Mixing farm yard manure and bio-slurry to improve quality ( ),

4. Others ( ) specify……………………….

12. To the two types of manure, farm yard manure and bio slurry, which one have high labour demand?

1. Farm yard manure ( ),

2. bio-slurry ( )

13. To the one you have selected, how much does it cost per acre?

1. Tshs 30 000 ( )

2.40 000 ( ),

3.50 000 ( ),

4. Others ( ) specify …………………………………

14. Are you practicing the use of farm yard manure for how many seasons?

1. Two season ( ),

2. One season ( ),

3 .Three seasons ( ),

4. Others specify (   )…………………………………

15. Are you practicing the use of bio slurry for how many seasons?

1. Two season (   ),

2. One season (   ),

3. Three seasons (   ),

4. Others specify (   )……………………………………

16. Do you know any way of minimizing loss of quality of manure?

1. Yes (   ),

2. No (   )

17. If yes, how?

1. …………………………………………………….

2. ……………………………………………………

3. ……………………………………………………

18. What types of feeds you are giving to your animals?

1. Grasses and legumes (   ),

2. Concentrates and grasses (   ),

3. Concentrates, legumes and grasses (   ) concentrates, minerals, grasses and legumes (   ) 4.others (   ) specify………………………………………

19. Is the method for manure management technology you are using cost effective for you?

1. Yes (   ),

2. No (   )

D-Practices of farmers on manure application

1. What area of land is applied?

1. Bio - slurry…………………,

2. Farm yard manure…………………….

2. What is your right time to apply manure on the farm?

1. four weeks before planting ( ),

2. three weeks before planting ( ),

3. Three weeks after planting ( ),

4. Others ( ) specify…………………..

3. Why that time?

1. To speed up manure decomposition ( ),

2. Is the time people applied manure in this village ( ),

3. Time of labour availability ( ),

4 others ( ) specify…………..

4. Which crop do you apply manure every season?

1. Maize ( ),

2. Vegetables ( ),

3. Irish potatoes ( ),

4. Others ( ) specify………………

5. In which season you started applying manure in your farm?

1. 2010/2011 season ( ),

2. 2008/2009 season ( ),

3.2009/2010 season ( ),

4.2011/2012 season ( ).

6. What equipments are you using to transfer manure from storage site to the farm?

1. Ox carts ( )

2, human labour from my family ( ),

3. Hiring labour within the village ( ),

4. Tractor trailer ( )

7. If you are hiring labour, how much does it cost to complete the activity for season?

8. Mention methods you use to apply manure on the field.

1…………………………………………………

2………………………………………………….

3………………………………………………….

9. Which method/s you prefer at your farm?

1. 2 ( ),

2.3 ( ),

3. 1 ( ),

4. 4 ( )

10. Do you have reason for using that method?

1. Easy ( ),

2. Increase decomposition of manure ( ),

3. Low cost ( ),

4. Others ( ) specify……………………………

E: FARMERS ATTITUDE TOWARD FARM YARD MANURE

Answer all questions in table below (for each question tick one of the provided responses,

A=Agree, U=Undecided, D=Disagree

S/n	Farmers attitude on farm yard manure	A	**U**	D
1	My survival depends on farm yard manure			
2	To me farm yard manure is life			
3	I can do away with farm yard manure			
4	I would be miserable if it weren't for farm yard manure			
5	Life will still be ok without farm yard manure			
6	I will be poor if I do not use farm yard manure every season			
7	I do not depend on FYM for my agricultural survival			
8	I am proud of farm yard manure use on my farm			
9	Farm yard manure means my family life affairs enhancement			
10	At my family using FYM is a nightmare			

E2: FARMERS ATTITUDE TOWARDS BIO-SLURRY

S/no	Farmers attitude on bio- slurry	A	U	D
1	My survival depends on bio - slurry			
2	To me farm bio-slurry is life			
3	I can do away with bio- slurry			
4	I would be miserable if it weren't for bio - slurry			
5	Life will still be ok without bio-slurry			
6	I will be poor if I do not use bio-slurry every season			
7	I do not depend on bio-slurry for my agricultural survival			
8	I am proud of bio-slurry use on my farm			
9	Bio-slurry means my family life enhancement			
10	At my family using Bio-slurry is a nightmare			

E3: ATTITUDE TOWARDS INOGANIC FERTILIZER

S/no	Attitude of farmers towards inorganic fertilizer	A	U	D
1	My survival depends on inorganic fertilizer			
2	To me inorganic fertilizer is life			
3	I can do away with inorganic fertilizer			
4	I would be miserable if it weren't for inorganic fertilizer			
5	Life will still be ok without inorganic fertilizer			
6	I will be poor if I do not use inorganic fertilizer every season			
7	I do not depend on inorganic fertilizer for my agricultural survival			
8	I am proud of inorganic fertilizer use on my farm			
9	Inorganic fertilizer means my family life enhancement			
10	At my family using inorganic fertilizer is a nightmare			

F: CONSTRAINTS ENCOUNTERED BY FARMERS ON CATTLE MANURE PRODUCTION, MANAGEMENT AND UTILIZATION

F: manure production

1. What problems have you experienced during manure production?

1. …………………………………………………
2. ………………………………………………….
3. ………………………………………………….

2. What causes that problem?

1. Manure not available ( ),

2. Manure not enough for my farm ( )

3. Manure not enough and not available ( ),

4. Others ( ) specify……..

3. The problem of manure availability should be solved by

1. Mixing with inorganic fertilizer ( )

2. Increasing bedding materials on the kraal ( ),

3. Use of vegetation compost manure ( ),

4. Others ( ) specify ………………………………………

4. Is also manure production constraints caused by not enough cattle to produce manure for your needs?

1. Yes ( ),

2. No ( )

5. Is availability of quality animal feeds also the cause of manure production constraints

1. Yes ( ),

2. No ( )

6. Which good method of manure production you know?

1. Keeping manure produced direct on shed ( ),

2. Keeping manure direct on cubicles ( ),

3. Mixing of manure with urines to improve nutrients content ( ),

4. Others ( ) specify…………………………………..

7. Do you have any implements for manure production?

1. Yes ( )

2. No ( )

8. Are the implements used for manure production available?

1. Yes ( ),

2. No ( )

G: manure management

1. Have you received any training on manure management activities?

1. Yes ( ),

2. No ( )

2. If yes on question one above, what was that training about?

1…………………………………………….
2. …………………………………………….
3. ……………………………………………
3. What are the main problems you have experienced during manure management practices?

1. No enough labour for all activities on manure management ( )

2. Labour hiring is very expensive ( )

3. I don't have enough space for all management procedures ( )

4. Others ( ) specify…………………………….

4. What have you done to solve the above problem? …………………………………

5. Do you have the following structures for manure management at your home?

1. Manure pits ( ), 2.manure cubicles ( ), 3.manure roofed house ( ), 4 manure storage house (

6. Do you have cattle urine collection pit

1. Yes ( ),

2. No ( )

7. If no where do you reserve cattle urine

1…………………………..…..

2……………………………...

8. If yes what was that training about?

1. Storage of manure in pits ( ),

2. Using cubicles on nutrient management ( ),

3. Manure housing ( ),

4. Urine mixing on manure ( )

9. Among the trained skills, what are you implementing at your farm?

1………………………………………………

2…………………………………………………

10. Do you know the different between farm yard manure and bio-slurry?

1. Yes ( ),

2. No ( )

H: Constraints encountered on application of cattle manure

1. Do you know the time of field manure application?

1. Yes ( ),

2. No ( )

2. If yes on question 1, mention the time you are applying manure on your farm

1. Before planting ( ),

2. During planting ( )

3. After planting ( ),

4. I don’t know ( )

3. Do you have any means of manure transport to the farm?

1. Yes ( ),

2. No ( )

4. If yes, what equipment do you use to transport manure to your farm?

1. I don't have any means of transport ( ),

2. I use family labour ( ),

3 I use bicycle ( ),

4. I use ox-cart ( )

5. What method of manure application do you use?

1. Spreading on the surface of the farm ( ),

2. Putting on the plant base ( ),

3. I don't know any recommended method ( ),

4. Dibling on the plant ( )

6. What is the rate of application of manure per acre?

1.0.5 ton ( ),

2. 10 ton ( ),

3.20 ton ( )

4. I am not sure of the rate of application ( )

7. Do you use farm manure or bio-slurry?

1. I use slurry only ( ) ,

2.I use farm yard manure only ( ),

3. I don't know the type of manure I used ( ),

4. I mix the two FYM and bio slurry ( )

8. What main problems have you experienced during manure practices?

1. …………………………………………………………………

2. …………………………………………………………………

9. What practices do you do to solve the problems you have mentioned?

1. ………………………………………………………………..

2. ……………………………………………………………….

I: Impacts on maize yield as a result of manure use

1. Do you grow maize using manure as a fertilizer?

1. Yes ( ),

2. No ( )

2. Has production of maize increased, remained the same, or decreased following use of manure? 1. Increased ( ),

2. Remained the same ( ),

3. Decreased ( ),

4. Others ( ) specify………………

3. What is the yield of maize before starting applying manure?

1. Lowest yield ………………………….

2. Highest yield………………………….

4. What is the highest yield of maize you have attained?

(a). under good farm yard manure use

1. Highest yields …………………………..

2. Lowest yields …………………………….

(b). under good bio slurry use

1. Highest yields ……………………………

2. Lowest yields ……………………………

5. How many growing seasons since you started using cattle manure?

1. Two growing seasons ( ),

2. One growing season ( ),

3. Four growing seasons ( ),

4. Three growing season ( )

6. Which season did you get good harvest?

1. Second growing season ( ), 2.first growing season ( ), 3.third growing season ( )

4. The fourth growing season ( )

7. Do you apply manure every season? 1. Yes ( ), 2. No ( )

8. If no on question 7 above, how often do you apply manure on your farm?

1. Every after two season ( ),

2. Every after one season ( ),

3. Every after three season ( ),

4. Others ( ) specify……………………….

9. What is your advice to the government to improve manure use of farmers?

1. To introduce regularly manure use training schedule for farmers ( ),

2. To give capital for farmers for construction of manure management structures ( ),

3. To introduce demonstration plots on manure at every village ( )

4. Others ( ) specify…………………………………….

10. Mention other benefits you have attained as results of manure use

1. ……………………………………….

2. …………………………………………

3. …………………………………………

Appendix 1: (b) Checklist for village key informants: chairperson, VALEO, VEO

1. Is cattle manure have the contribution role of the farmers 1.yes ( ), 2. No ( )

2. If yes what advantages /role cattle manure have contributed to the farmers?

1………………….2……………………. 3………………………………….

3. How many farmers are using cattle manure in the village in their farms and other uses?

4. What is the yield of maize as a result of manure use in this village?

5. What is milk production per cow? 1. Dairy cattle … lts 2. Local breeds ………….lts

6. Do farmers use inorganic fertilizer? Yes/no

7. If yes on question 6 how many kg are used per hectare? i. for planting …………….kg

ii. For top dressing ……………….kg

50kgs = 1bag =enough for one acre per season

8. Do you have biogas plant in this village? Yes/no

9. If yes how many household have biogas plant?

10. What is the rate of using cattle manure in this village? 1. High utilized ( ), 2. Medium utilized ( ), 3. Underutilized ( ), 4. Others mention ……………..

11. Mention the causes of 10 above

12. Which fertilizer is more used than the other?

1. Cattle manure ( ), 2. Inorganic manure ( ), 3. Mixing animal manure and inorganic manure ( )

13. How many types of manure used in this village? 1. Two ( ), 2.one ( )

14. Will you mention the type?

1……………………………………………

2……………………………………………

15. Is cattle manure increase production of crop yes/no?

16. If yes on 15, what is the average yield of maize using cattle manure per hectare?

17. Do cattle production have relation to production of manure? Yes/no

18. If yes what is the production of manure per cow? (Litres of milk per cow)…………………………

19. What constraint encountered on use of cattle manure among the farmers?

20. What is the suggested solution to the problem you mention?

Appendix 2: Items used in computing attitude towards FYM

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
I can do away with farm yard manure	11.99	10.731	.587	0.804
Life will still be ok without farm yard manure	12.02	9.815	.725	0.773
I will be poor if I do not use farm yard manure every season	11.77	10.769	.581	0.805
To me farm yard manure is life	11.73	10.332	.689	0.782
My survival depend on farm yard manure	11.53	11.797	.524	0.816
I would be miserable if it werent for farm yard manure	11.96	10.914	.502	0.823
Overall reliability statistics Cronbach's Alpha =0.829		No of Items 6		

Appendix 3: Items used in computing attitude towards Bio - slurry

Items	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
My survival depend on farm yard manure	8.41	11.281	0.896	0.907
To me bio - slurry is life	8.34	11.459	0.872	0.911
I would be miserable if it weren't for bio - slurry	8.28	11.757	0.830	0.919
I am proud of bio - slurry use on my farm	8.38	11.597	0.821	0.921
Bio - slurry means my family life enhancement	8.59	12.443	0.717	0.940
Overall reliability statistics Cronbach's Alpha =0.935			No of Items 5	

Appendix 4: Items used in computing attitude towards inorganic fertilizer

Items	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
My survival depends on inorganic fertilizer	9.82	17.319	0.864	0.927
To me inorganic fertilizer is life	9.83	17.223	0.863	0.927
I would be miserable if it weren't for inorganic fertilizer	9.82	17.337	0.829	0.932
I will be poor if I do not use inorganic fertilizer every season	9.87	17.703	0.786	0.937
Inorganic fertilizer means my family life enhancement	9.85	17.157	0.886	0.925
I am proud of inorganic fertilizer use on my farm	9.56	18.699	0.733	0.943
Overall reliability statistics Cronbach's Alpha = 0.943			N of Items 6	