

**ADOPTION OF CATTLE MANURE FOR BANANA PRODUCTION BY
FARMERS IN MBARARA DISTRICT, UGANDA**

BY

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Declaration

I, Hope Namara, declare that this piece of work is original in form and outlook, and has never been submitted to any other institution of higher learning for any award. Scholarly work of others was cited and acknowledged throughout the entire text.

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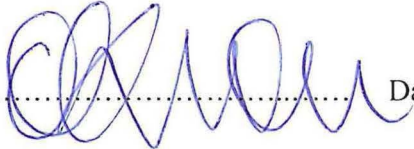
Approval

This research report titled “*Adoption of Cattle Manure for Banana Production by Farmers in Mbarara District, Uganda*” has been submitted with our approval as University supervisors.

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List of Abbreviations and Acronyms

ð	:	Standard deviation
DOI	:	Diffusion of Innovations
EBO	:	Ebirungi Biruga Omutuutu
FAOSTAT	:	Food and Agriculture Organization Corporate Statistical Database
FGDs	:	Focus Group Discussions
FYM	:	Farm Yard Manure
GDP	:	Gross Domestic Product
GOM	:	Government of Malawi
GOU	:	Government of Uganda
IFAD	:	International Fund for Agricultural Development
Kg	:	Kilogram
Mn	:	Mean
NAADS	:	National Agricultural Advisory Services
NGOs	:	Non-Governmental Organizations
pH	:	Potential of Hydrogen
SACA	:	Smallholder Agricultural Credit Administration
SACCO	:	Savings and Credit Co-operatives
SD	:	Standard deviation
SPSS	:	Statistical Package for Social Scientists
TRA	:	Theory of Reasoned Action
UBOS	:	Uganda Bureau of Statistics
UNDP	:	United Nations Development Programme
WTO	:	World Trade Organization

Abstract

Bananas are the main staple food crop grown in Mbarara District but production is threatened by Mbarara's declining soil fertility. Cattle manure has a potential of improving soil fertility as it is available and affordable through the good supply from the high cattle population of the area compared to scarce & costly inorganic fertilizers. In addressing the problem, the aim was to find out the rate of cattle manure adoption for increasing banana yields. A sample size of 226 respondents was used for the study consisting of 214 banana farmers randomly selected and 12 change agents deployed in the area taken whole. The four sub counties used were selected through stratified sampling picking the best performing in banana production. Data was collected using interview guides, questionnaires, and focus group discussion guides. Statistical package for social scientists Version 21.0 was used to compute frequencies, percentages, means and r values. Qualitative data from interviews and focused group discussions was analyzed through open coding according to themes. The findings revealed that 77% of the banana farmers regularly applied cattle manure with more than half (50%) of them applying it with kitchen refuse. The study also revealed a relationship between farmers' socio-economic characteristics and cattle manure adoption by farmers which was largely determined by farmer's age, education level, marital status, income source and sex of the farmer. Additionally, others were perceived benefits of cattle manure, distance to the road for ferrying manure and produce, desire to improve soil fertility and land ownership. Using Pearson r values, the results further revealed that cattle manure adoption had a relationship at 0.05 alpha with banana bunch size in kg ($r=.632^*$) and with yield in kg ha⁻¹ ($r=.740^*$). The associations of cattle manure adoption with socio-economic characteristics gave further r values as: age ($r=.914^*$), education level ($r=.878^*$), and distance to the road for ferrying manure and produce ($r=.906^*$). The study concluded that 77% of the banana farmers regularly applied cattle manure. Based on qualitative data and r values, cattle manure adoption by farmers was influenced by key factors such as age, education level, marital status, income source, and distance to the road for ferrying manure/produce. Adoption of cattle manure was certainly an advantage in increasing banana yields. The study recommends more collective efforts by relevant agencies supported by the government in training the farmers to adopt more use of cattle manure.

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CHAPTER ONE

INTRODUCTION

1.1 Background to the study

Worldwide, manures have been incorporated into soils in order to improve their fertility. Applications of organic materials such as livestock manure and crop residues have proven to bring about a gradual improvement in soil productivity and crop performance especially banana yields (Morteza *et al.*, 2011). Currently, global production of bananas is estimated at more than 67.5 million metric tonnes, with average global yields estimated at 16,463 kilograms per hectare per year (Giller *et al.*, 1997). However, while this productivity is partly attributed to improved banana innovations like fertilizer use in countries such as Netherlands and Japan, it is still limited to serve the world market as nearly 80 percent of all bananas are produced and sold or consumed in local or regional markets in the producing countries (Nyamangara *et al.*, 2003). In situations where the supply of industrial fertilizers is limited, applications of organic matter have proved to promote root growth and development and nutrient absorption, resulting in improved yields (Ebewore & Emaziye, 2016).

In sub-Saharan Africa (SSA), livestock manure is the principal soil amendment available to a large number of smallholder crop-livestock farmers because of inaccessibility and cost of manufactured fertilizers such as NPK (Muhereza *et al.*, 2014). However, minimal use of nutrient inputs in Sub-Saharan Africa (SSA) has contributed to a decline in soil fertility coupled with low crop yields (Kanonge *et al.*, 2009). Cattle manure is an important and cheaper source of nutrients for many smallholder farmers in SSA, who cannot afford or use only

limited amounts of manufactured fertilizer to attain more productive farming systems (Onduru *et al.*, 2008). Cattle manure has offered a number of benefits to the agricultural sectors of several countries in SSA where Uganda is not exceptional (Naramabuye *et al.*, 2008). Some of the benefits include; increased water holding capacity of soils or buffering low pH soils (Hulugalle *et al.*, 2008). In this case, farmers need to adopt good use of cattle manure in order to improve the soil fertility thereby improving banana productivity (Ebewore & Emaziye, 2016).

In Uganda where agriculture is the dominant source of income, smallholder farmers value cattle highly for the production of manure to support their plantations especially for bananas (Kimani & Lekasi 2004; Randolph *et al.*, 2007). The national cattle herd is estimated to be 11.4 million of which 2.5 million (22.3 %) was in western Uganda and 149,990 in Mbarara District. Adoption of organic fertilizers such as cattle manure helps in improving the physical, chemical and biological soil properties which are suitable to plant growth in the long term, reduce the cost of production, and they stay beneficial to plants longer in the soil (Ketema *et al.*, 2011).

In Western Uganda, the banana-coffee-cattle system is one of the key areas in Uganda with potential of cattle manure for soil conservation and nutrient replenishment especially in the production of bananas. Bananas are one of the most important staple food crops for human consumption in Uganda and in particular, Mbarara (Nkwiine *et al.*, 2004). Bananas can be consumed in various forms such as beer, juice, dessert, roasted and steamed. The country produces about 8.5 metric tonnes of bananas per hectare annually; most of it for domestic use (Muhereza, 2012). Livestock is herded on pastures or fed with

forage from the outfields. For much of the time they are kept in kraals close to the home, which also favours the easy allocation of manure to the banana plantation (Bekunda, 1999).

Mbarara is among the leading Districts in cattle keeping in Uganda (National Livestock Census, 2009). Each animal (of about 600kg) on average produced about 21.9 tonnes (Midwest Plan Service (MWPS-18) and University of Wisconsin-Extension (Publications A3411 and A3557). This leads to a possible quantity of cattle manure produced in Mbarara District of about 3,284,781 tonnes per year. Cattle manure has become widely believed in this area as an essential farm input to the extent that institutions such as NAADS and EBO SACCO in Mbarara provide loans to support farmers to buy dung and urine (Kabahenda & Kapiriri, 2010). Among the organic sources, farmyard manure (FYM) is the most important as it contains all the nutrients needed for crop growth including trace elements (Achieng *et al.*, 2010).

Although this was the case, the ideal use of farmyard manure ha⁻¹ in Mbarara was not known. This provided a gap that needed to be established by determining the levels of adoption of manure and the rates to apply it to get good yields of bananas. Through the survey among banana farmers, the study set out to establish that.

1.2 Problem statement

In Uganda, the banana yields are low (5–30 tonnes per ha per year) compared to potential yield of 70 tonnes per ha per year (Van Asten, *et al.*, 2010). Soil fertility has been reported to be one of the major yield constraints (Van Asten, *et al.*, 2010). In Mbarara, cattle manure has been used as a means to improve yields in crops especially in bananas (Kushaba, 2017). According to Van Asten,

et al. (2010), application of cattle manure in crops increases the tonnage from 15.6 tonnes per hectare to 22.8 tonnes per hectare. In Mbarara, cattle manure has been used in bananas and evidence shows that banana yields can increase significantly when cattle manure is used (Kushaba, 2017). Despite its importance in improving banana yields in areas with nutrient deficiency, its adoption by banana farmers remains as low far as 4% compared to 14.7% of those who apply crop residues and domestic rubbish as manure to the plantations (Nkwiine *et al.* 2004). However, the reasons remain largely unknown for low uptake of cattle manure. Limited studies have examined the reasons for the limited adoption of cattle manure in Uganda. This study therefore examined the adoption of cattle manure on banana production by farmers in Mbarara District.

1.3 Purpose of the study

The purpose of the study was to establish the adoption of cattle manure by banana farmers in Mbarara District, Uganda.

1.4 OBJECTIVES OF THE STUDY

1.4.1 General objective

The general objective of the study was to establish the extent of adoption of cattle manure for banana production by farmers in Mbarara District.

1.4.2 Specific objectives

The specific objectives of the study were to;

- i. Establish the levels of cattle manure adoption in banana production using evidence from farmers.

H₀₁: There was a high level of adoption of cattle manure in banana production among banana farmers in Mbarara District

H₀₂: Socio-economic characteristics of the banana farmers influenced adoption of cattle manure

H₀₃: Use of cattle manure has greatly improved banana yields of banana farmers in Mbarara District.

H₀₄: On-farm factors that influenced cattle manure adoption in banana production among banana farmers in Mbarara District

1.7 Significance of the study

The findings of this study benefit the following parties;

Farmers: Having realized the benefits of cattle manure use, the study findings provided a motivation for farmers to increase on the extent of cattle manure for banana production.

Extension workers and Policy makers: The study findings exposed the plight of farmers whose attempts to apply cattle manure in their farming operations have not been successful and therefore helped to inform the stakeholders who promote organic farming to design strategies for promoting the large scale use of cattle manure.

Future Researchers: The study findings may be used by scholars carrying out research in a related area as a source of secondary data on cattle manure use by small holder farmers.

1.8 Scope

The study concentrated on the adoption of cattle manure. The study covered farmers of the period between 2010 and 2017 using cattle manure in banana

production. This study period was selected because it was long enough to enable the researcher capture comprehensive data about changes in the adoption of new agronomic practices in the area. NAADS and other developmental partners, in this period, promoted the cattle manure adoption and use of productivity enhancing agronomic practices in Mbarara and other parts of Uganda.

1.9 Assumptions

The researcher assumed that the respondents were honest in their responses pertaining to the questions that were set in the questionnaire. It was further assumed that the respondents were objective as they participated in the Focus Group Discussions that were organized and held by the researcher. The researcher also assumed that cattle manure was available and easily accessed by banana farmers.

1.10 Limitations of the study

The interaction with the respondents might have been affected by the levels of literacy. The limitation was overcome by translating the questionnaire to Runyankore for the farmers that are illiterate. This was done by using research assistants who translated the questions for the illiterate and also assisted them on how to fill the questionnaire. The busy schedules of the farmers interrupted the programmed periods of interaction and therefore delayed the researcher in collecting the data. The researcher overcame this limitation by opting to interview the respondents at the time they found most convenient to them.

The study was limited to only banana farmers in Mbarara District. However, the findings would have possibly been different if carried out from a wider scope such as all districts in south western Uganda.

The study was limited to only cattle manure as one of the organic manures which improved banana yield. However, there is need to consider both organic and inorganic/industrial fertilizers in banana production.

The study concentrated on only cattle manure as a factor that influences banana yield. However, it did not consider the influence of other factors such as mulching, pruning, thinning, water supply and weeding among others on banana yields. These factors need to be assessed in detail to determine their relationship with banana production.

1.11 Definitions of terms

The following terms were operationally defined as used in the study;

Adoption: This was operationally used in the study to mean the decision of the farmer to make full use of an innovation/technology (cattle manure) as the best course of action available (Rogers,1995).

Change agents:Change agents referred to personswho introduce innovations into a client system/users that they expect will have consequences that will be desirable direct and anticipated (Rogers, 1995).

Characteristics: These referred to features that differ among farmers for example age sex, education level, and income level.

Diffusion: it is a process by which an innovation is communicated through certain channels over time among the members of the social system (Rogers, 1995).

Household: This was operationally used in this study to mean a group of people living in one unit as a family.

Manure: This was used in this study to mean cattle manure.

Output: This is used in this study to mean the number of bunches of bananas produced by a given farmer in kilograms.

Social systems a set of interrelated units that are engaged in joint problem solving to accomplish a common goal which in the case of the study included banana farmers, farmer groups and all forms of change agents in Mbarara District (Rogers, 1995).

Tonne: This is used to mean weight of one ton expressed in Metric tonnes (SI Units) equal to 1000kg.

CHAPTER TWO

REVIEW OF RELATED LITERATURE

2.1 Introduction

In this chapter, literature related to adoption of cattle manure is reviewed. The literature reviewed thus covered the determinants of adoption, new agronomic practices and new technologies. The gaps in the reviewed literature are indicated and the attempts to fill them by the proposed study are reflected.

2.2 Overview of farmer technology adoption

Studies on composts and farm yard manure (FYM) for crop production in East Africa have been reported since the 1930s (Beckley, 1934; Beckley, 1937). Many crop response trials have looked at rates and methods of application, effects on soil chemical and physical properties and effects on soil moisture dynamics (Dagg *et al.*, 1965) and more recently biological properties and soil organic matter dynamics have attracted some interests (Kapkiyai *et al.*, 1999). Literature on the factors affecting technology use is fairly well established (Adesina & Zinnah, 1993).

Manure use has shown to have a positive impact on crop production and is one of the yield-enhancing technologies which were promoted under the Plan for Modernisation of agriculture (PMA) to address the problems of land degradation, low agricultural productivity and poverty in Uganda.(Nkonya *et al.*, 2005). Recently, there has been increased interest in analyzing the determinants of farmers' choice and level of use of agricultural technologies. Empirical research identifies farm and farmer associated attributes as important determinants of technology use. They include; household size, education,

farming experience, age, sex, and farm size, to mention but a few. (Bisanda *et al.*, 1998; Shapiro and Brorsen 1988; Colman and Young 1989; Doss and Morris 2001; Huffman 1997; Kataike, 2003; Mwanjuba, 2002;Ogwal, 2003 and Kongai, 2005).

2.3 Cattle manure adoption on crop productivity

Manure can supply nutrients required by crops and replenish nutrients removed from soil by crop harvest and any other means. Since manure contains multiple nutrients, applications should consider not only what is needed for the crop to be grown but also how the ratio of nutrients in manure could affect soil test levels. This ensures adequate nutrient supply and reduces potential for over or under-application and subsequent buildup or depletion in the soil.

Grant (1981) observed that manure application to granitic sands overcomes or prevents deficiencies of micronutrients, including S, Mg, Zn and B, and enhances soil available N, P and K. Livestock manure has been an asset to crop production since the beginning of organized agriculture. These excretions from cattle contain several essential plant nutrients which include; N, P, K., S, Mg, Zn B. They contribute to increased crop yields when properly applied to soils. Thus, dairy and other livestock producers can use manure as a valuable source of fertilizer nutrients for crops. Manure can benefit a farm fertilization program. Besides providing valuable nutrients to the soil, including many micronutrients, manure also supplies organic matter, which improves soil quality, aids in the retention of water and nutrients, lessens wind and water erosion and promotes environmental temperature. All of these factors affect the

amounts of nitrogen (N), phosphorus (P) and potassium (K) in the soil (Pennington *et al.*, 2015).

Livestock manure such as cattle manure contains organic nutrients such as amino acids, nucleic acids, sugars, and vitamins, and is also a valuable source of organic matter with nutrients such as nitrogen, phosphorus, potassium, and some micronutrients. The recycling of livestock manure in cropping systems is considered to enhance soil fertility and crop productivity by ameliorating soil properties. This increases the capacity for nutrient retention and by gradually improving the soil macronutrient status which also determines the availability of micronutrients to plants. Responses of Wheat Yield to Macro- and Micro-Nutrients, and Heavy Metals in Soil following the Application of cattle Manure was high in North China Plain (Wang *et al.*, 2016).

Intisar *et al.* (2015) indicated that there were significant differences in weights of banana bunches, number of hands, number of fingers and earlier times of flowering in gardens where cattle manure was applied. Gangwar and Niranjana (1990) reported increased yield from the use of inorganic fertilizers and farm yard manure in the rain-fed fodder sorghum.

Giller *et al.* (1997) reported that crop response to manure N in the first season depended on the amount of mineral N and available N in the manure. Nitrogen absorption from manures in the second and subsequent seasons also depended on manure quality. In old manures much of the N is in stable forms that are only mineralised slowly, and N absorption efficiency can be greater after the first season. However, the more stable N pools may not be mineralised within a useful time scale, and it is more common to see greater absorption efficiency

during the first season. Powell et al. (1993) compared the N absorption efficiency from legume leaves with that from faeces from sheep fed with the legume leaves as a supplement. All faeces, except those, which came from supplementing with *Vigna unguiculata*, resulted in higher N absorption efficiencies (5-14%) than the corresponding leaves (1-9%). However, there were no clear relationships between measured faecal chemical components and N absorption. This needs to be evaluated in cattle manure.

Von Wirén (1997) in a study on the regulation of mineral nitrogen absorption reported that the form of N absorption is mainly determined by its abundance and accessibility, which makes NO₃⁻ and NH₄⁺ the most important forms of N for plant nutrition under agricultural conditions. It was further noted that N absorption is also subject to plant preferences, by which plants maintain their cation/anion balance during absorption, thus affecting its form. However, some plant species seem to have an obligatory preference, which even prevents their growth on certain other N sources.

Banana is a crop that requires a high quantity of fertilizer for every growth stage. Generally, farmers apply a chemical fertilizer as the main fertilizer for its growth, or apply the chemical together with organic fertilizers (Nuntagij, 2009). The application of chemical fertilizer results in a high yield. Negatively, chemical fertilizers deteriorate the environment, affect soil life, farmers' health suffers, and production costs go high which then are not worthy with their investment, eventually farmers' debts increase. On the other hand, the use of organic fertilizer helps in the soil improvement. It helps in improving the physical, chemical, and biological soil properties which are suitable to plant growth in the long term, reduce the cost of production, and stay longer in soil

(Sanyakamthon, 2009). The use of organic fertilizer could reduce the use of chemical fertilizer, which is more environment-friendly, more suitable to the farmers' health, and safer for consumption.

Boonnap *et al.*, (1985) found that the application of 12,500 kg/ha of animal manure and 625.0 kg/ha of lime plus 312.5 kg/ha of inorganic fertilizer (15-15-15) yielded the highest corn production which ranged from about 2.00 – 2.96 tonnes/ha while the plot that had no application of fertilizer and lime yielded only 0.39 tonnes/ha. Jin (1993) found in his study that the response of the plants to the use of animal manure in low fertile soil was better than those plants grown in intermediate and high fertile soils. Nakviroj *et al.* (2002) found that the application of chemical fertilizer (complete compound fertilizer; 3 main elements (NPK) together with animal manure contributed to high yield of banana which increased by 50.1% compared with that had only chemical fertilizer. This is in agreement with Wargiono and Ispandi (2002) who reported that the application of chemical fertilizer plus animal manure gave the highest yield of cassava due to the microelements that the organic fertilizer provided for the plants' growth. Suddhiyam *et al.* (2011) studied the use of various kinds of fertilizer in producing the aromatic fresh leguminous soybean. He found that the use of animal manure together with chemical fertilizer resulted in higher standardized soybean product than that with chemical fertilizer only in both wet and dry seasons.

In Uganda, some farmers have adopted a farming system that integrates dairy and crop production (Yamano, 2008). In this farming system, farmers adopt improved dairy cattle. Typically, the improved cattle are kept in stalls all day or at least at night. While the improved cattle are kept in the stalls, they drop

manure and urine in the stalls. The manure and urine in the stalls can be easily collected and applied on banana and other crops (Buresh, 1999). In fact, the total amount of nutrients likely declined because of the export of nutrients from the plant-soil-animal system through harvested products and milk. Such a system, however, enhances the internal cycling of nutrients, and the efficiency depends on farm management at various steps starting from feeding animals to crop (Rufino *et al.*, 2006).

Another growing trend is the use of cow dung in producing biogas, a cheap alternative source of energy that can be used as a fuel for cooking or to even produce electricity. Biogas has become an increasingly important energy source in Denmark over the last 25 years. Being a carbon neutral energy source, it has already helped make a significant contribution to the reduction of Danish carbon emissions. Today, biogas accounts for approximately 12% of world energy consumption. Yet the potential of using biogas has so far been unexploited, especially in the form of livestock manure in the agriculture system. Denmark is well known for its farming industry; approximately 65% of the land is used for agriculture, emitting 18% of all greenhouse gases through methane and nitrogen. So farming has an important part to play in the transition to a fossil fuel free society. The Danish government now wants up to 50% of livestock manure to be made into this green energy supply and use slurry in the crop gardens (Von Moltke *et al.*, 1997).

2.4 Adoption of cattle manure and banana production

According to the Food and Agriculture Organization of the United Nations (2002), 122 countries produce bananas outside Africa. In 2000, there were 4.1

million hectares devoted to banana production worldwide as follows: Brazil (521,285 ha), India (490,000 ha), the Philippines (383,387 ha), Burundi (295,000 ha), Indonesia (285,000 ha), and China (258,260 ha) led all producers in area of land devoted to banana production. While these six countries account for 54 percent of the global area devoted to banana production, production of bananas is done, first and foremost, as a food crop for domestic consumption (FAO, 2002).

Within sub-Saharan Africa, the Region of East Africa (most notably the Great Lakes region covering portions of Rwanda, Burundi, Tanzania, Kenya and Democratic Republic Congo (DRC) is the largest banana producing and consuming region in Africa (Smale and De Groote , 2003). Banana is largely grown as a food crop and is the most important food crop in Uganda, Rwanda and Burundi. Other important food crops in the region include cassava, maize, sweet potato, Irish potatoes and beans. Banana is also an important cash crop within the region. It is said to be the most traded food crop in Uganda (Aliguma and Karamura, 2006). Uganda is the second largest producer of bananas in the world after India, with an estimated production of 10.6 million metric tonnes per year.

Uganda is the world's largest consumer of bananas (Sergeant *et al.*, 2004). Banana yields in the region have however been on the decline due to a number of diseases and pests with reduced fertility levels. In eastern Africa, in general, production fell by over 40% in the 1990s. During the 1970s, for instance, Uganda produced 15 to 20 tonnes of bananas per hectare and by 2000 banana yields had declined to 6 tonnes per hectare. (Kanonge *et al.*, 2009). The main banana growing areas in Uganda include south western and central Uganda

regarding the banana yield. They found out that the banana yield in Uganda is about 11 tonnes per ha per year, which is much higher than the yields at 4 to 5 tonnes per ha in the other regions in East Africa. The high banana yield is partly due to the high elevation and favorable rainfalls and manure use in the Western region (Kalyebara *et al.*, 2007). They found yields of 9 and 5 tonnes per ha per year in medium and low productivity among subsistence farmers respectively. Another study by Bagamba *et al.* (2007) also found the average banana yield to be 6 tonnes per ha per year as a result of application of cattle manure of about 218kg/ha/year among smallholder banana farmers.

Soil fertility reduction contributed to declining banana yields in central Uganda (Masefield 1949; McMaster (1962). This hypothesis has been repeated so often (Bekunda and Woomer, 1996; Sseguya *et al.* 1999), which has virtually been accepted as an established fact. The average banana production soils in Uganda have optimum soil fertility according to the guidelines by Rubaihayo *et al.*, (1994); Bananuka and Rubaihayo, (1994) and Rufino, (2003). This might partially explain why Bananuka and Rubaihayo (1994) found such correlation between soil fertility parameters and banana bunch yields. Zake *et al.*, (2000) found marked increases in highland banana yields over time when different K applications (25-200 kg ha⁻¹yr⁻¹) were combined with a standard 100 kg ha⁻¹N and P application and cattle manure is rich in these nutrients.

Organic fertilizer application increased in the West region over the years where the improved cattle adoption increased significantly where at least each farmer applied cattle manure at one point in time. This suggests that the adoption of cattle has a positive impact on the organic fertilizer application, which may

have contributed to the increased banana yield. The high average yield is a result of bigger sizes of bunches and more numbers of bunches produced among the households with some improved cattle (Yamano, 2008).

2.5 Socioeconomic characteristics of banana farmers that affect cattle manure adoption

Farmer characteristics will covered farm attributes that affected the cattle manure adoption. They include; age of the farmer, sex of the farmer, education level of the household head, fear of risks, size of the household, and income of the household.

2.5.1 Age of the farmer and of organic manure

Age of the head of household has been found to be a significant factor affecting the use of new technologies. Kaliba *et al.*, (2000) found that older heads of household were more likely to use manure in Tanzania. Several other studies of manure use in Sub-Saharan Africa found age of the head of household to be insignificant (Green and Ng'ong'ola, 1993). Older farmers are expected to command more resources and hence have wider investment options including use of cattle manure. It is also expected that older household heads would have relatively large farms while younger household heads would own smaller holdings. Older household heads were expected to be less educated and so may not be able to work well with complex fertilizer management but were more comfortable with using organic manures (Omamo *et al.* 2002; Omamo & Mose, 2001).

2.5.2 Sex of farmers and adoption of organic manure

Male headed households are associated with being in command of productive resources. Even where women play key roles in farming decisions, they may lack access to inputs, cash incomes, credit and technical information. It was expected that female-headed households were negatively associated with organic manure use, because women would not command the resources that would allow them access to organic manure. Different rates of manure and other technology use are typically observed between male and female heads of household (Doss and Morris 2001). The sex of the household heads influence the use of a new technology for various reasons. Male and female household heads have different levels of access to credit or to transportation assets. They also differ in the types of crops they grow and as a result in their preferences for using certain technologies.

Results from studies in Ethiopia by Croppenstedt and Demeke (1996) indicate that sex of the household head was not significant. Doss and Morris (2001) also found no significant influence of sex upon use of modern varieties of maize or manure use among farming households in Ghana. Despite results to the contrary, Doss and Morris (2001) suggested that sex played a role through other institutional constraints such as access to extension visits and other resources. Furthermore, Muhereza *et al.*, (2014) revealed a difference between gender responses with many men not willing to apply cattle manure; and some commented on the length of time required to gain satisfactory crop response. Men did not see the point in applying manure to benefit the owner of the land or the next farmer in the subsequent seasons. Women were more willing to

apply cattle manure to obtain higher yields as they were responsible for preparing meals and the low crop yield disadvantaged them directly.

2.5.3 Fear of risks

Risk can be a great limitation for adoption of environmental practices. Often environmental innovations may require farmers to give up their income during transition, so cost of adopting increases. Many farmers may not be in a situation to take the risk of failure. Souza (1997) found that farmers perceived an increase in risk when trying to convert to organic farming and hence became a significant barrier to adoption of organic farming by Brazilian farmers. Souza (1997) further noted that the financial risk of the transition time represented a significant barrier to adoption of organic farming, hence will also limit the cattle manure use.

2.5.4 Level of education and training

Education enhances the allocation ability of decision makers by enabling them to think critically and use information sources efficiently. Bisanda *et al.*, (1998) observed that education level increased the probability of adoption of recommended technologies because it increased farmers' ability to obtain processed information of a given technology. Khanna (2001) found similar results: higher levels of education led to higher rates of use of new technologies in high-input agriculture. Huffman (1997) concluded that farmers' allocation efficiencies in changing optimal manure rates were significantly related to education. The rate of adoption of reduced tillage production techniques rose with increased education. Goodwin and Schroeder (1994) observed a 3.1% rise in adoption of a new or improved agricultural technology for each additional year of formal education attained. Education of the

household head is assumed to have an important, positive impact upon the adoption and use of new technologies. The results of research by Nkonya *et al.*,(1997) showed education to be an important factor in the household's decision to use improved seeds. It is generally believed that education makes a farmer more receptive to new technologies or is more able to deal with technical recommendations that require a certain level of literacy (CIMMYT, 1993).

Farm-families with higher levels of education should be aware of more sources of information and are more efficient in evaluating and interpreting information about innovations than those who are less educated. Education was found to positively affect the adoption of improved maize varieties in West Shoa, Ethiopia (Alene, Poonyth& Hassan, 2000). Education is underscored by Alene *et al.* (2000) as a major factor influencing the adoption of new agronomic practices. Literate and enlightened farmers are thus more receptive to new innovations in the area as compared to their counterparts. Education is thus a strong predictor of adoption of new farming innovations.

2.5.5 Membership in a farmer group

Kelly, Crawford, and Jayne (2003) reported that farmer associations in the irrigated rice zone of Mali reduced costs for their members by using transparent bidding procedures for sourcing inputs and by securing bank loans to guarantee timely repayment to suppliers. Additionally, to decrease the transaction costs of inputs acquisition and output marketing, some NGOs have promoted the establishment and consolidation of farmer associations.

Jackson & Watts (2002) reported that learning through social networks is an important determinant of technology adoption. Suri (2011) demonstrated that aggregate adoption rates may remain low or stagnant despite high average returns to new maize technologies, either because marginal returns to adoption are low, or because the farmers with comparative advantage in adoption have already done so. This finding implies that farmers' organizations provide fora through which a farmer can copy and implement the activities copied from fellow farmers. Suri, however, used the context of Kenya, where farmers could be having individual characteristics different from those of Mbarara District farmers, hence, leaving a gap needing study.

Munshi (2004) compared wheat and rice growing villages in India to demonstrate that adoption based on observing neighbors is less likely in areas with heterogeneous populations where a farmer may not be able to control for differences in neighbors' characteristics

2.6 On-farm factors influencing cattle manure adoption

2.6.1 Access to credit

Access to credit has been found to contribute significantly to adoption of cattle manure. In countries like Malawi, the government through the Smallholder Agricultural Credit Administration (SACA), started providing joint liability loans to smallholder farmers as far back as 1973 before the Grameen Bank was created (Diagne *et al.*, 2000). The credit whose main purpose was to promote smallholders' production of high value crops was mainly given to farmers in the form of in-kind loans such as fertilizer and seed. However, the finding

indicated that even when credit was made available to the farmers, they would not adopt a given set of technology (Government of Malawi [GOM], 2004).

Feleke and Zegeye (2006) found that about 68% did not use credit in their operations although the physical distance between farms and credit centers such as bank, finance company and cooperatives were not more than 5-7 kilometers. This was due to the reasons that credit provided by financial institutions as well as credit cooperative groups was not so encouraging due to unfavorable policies, delay in timely transactions, higher interest rates which caused high cultivation cost and period of repayment. This indicates that easy access to credit may possibly influence the farmer's decision to adopt cattle manure. According to Matiya *et al.* (2005), access to credit helped the farmers, to buy/hire transport equipment, buy manure, and hire labour to apply manure among other things which increased on the level of adoption of cattle manure.

2.6.2 Perceived advantages of cattle manure use

Agricultural technology adoption models are based on farmers' utility or profit maximizing behaviors (Pryanishnikov & Katarina, 2003). The assumption here is that farmers adopt a new technology only when the perceived utility or profit from using this new technology is significantly greater than the traditional or the old method. The discussions that follow indicate some perceived advantages of cattle manure use. In a study by Van Asten, *et al.*, (2010), 39% of the farmers adopt cattle manure when they perceive increased yields, thirty three percent (33%) perceived increased harvest frequency while 29% perceived improved banana quality. Other important benefits perceived by farmers from adoption of cattle manure include improved looks of the bunch and improved taste and texture of cooked banana.

2.6.2.1 Effect of cattle manure on soil chemical properties

The effect of cattle manure on soil properties has been well documented (Rekhi *et al.*, 2000; Nyamangara *et al.*, 2003; Lithourgidis *et al.*, 2007; Hulugalle *et al.*, 2009; Nyiraneza *et al.*, 2009). Cattle manure application increases the soil organic matter pool that may lead to higher cation exchange capacity (CEC) and a higher soil pH (de Ridder & van Keulen, 1990; Naramabuye *et al.*, 2008) thus enabling it to exert immediate and wider ranging beneficial effects on soil quality properties than inorganic fertilisers alone (Min *et al.*, 2003; Khan *et al.*, 2007). The use of cattle manure as organic amendments to improve soil quality is important where soil moisture and organic matter maintenance under conventional tillage are major constraints for economic crop production (Min *et al.*, 2003). This was true in Mbarara district as most banana farmers applied cattle manure in order to improve the soil quality of their banana plantations.

Various studies (Pocknee and Sumner, 1997); Mokolobate and Haynes, 2002) and Fronning *et al.*, 2008) have established that cattle dung has a pH between 7.0 and 8.0 and its large Ca²⁺ and Mg²⁺ content contributed to improved soil quality providing a medium for plant growth and biological activity, regulating water flow and storage in the environment. It served as a buffer in the formation and destruction of environmentally hazardous compounds (Stockdale *et al.*, 2002; Van der Vossen, 2005). Manure exhibits variation in its pH value depending on the type and diet of the animal. For example, the pH of cattle manure in Alberta, Canada, was found to be around 9 (Schoenau *et al.*, 2002), while an average pH value of 7.2 was reported for cattle feedlot manure in southern Alberta (Chang *et al.*, 1991). Farmers, therefore, adopt cattle

manure to improve the soil pH to enable plant growth and regulate water flow and storage.

The ability of manure application to induce a change in soil pH depends on its content of buffering agents including carbonates and organic matter, as well as the production of organic acids and acidity during decomposition (Assefa *et al.*, 2002; Panda, 2008; Kumar & Shivay, 2008). Because the effect of manure on soil pH is variable, repeated applications of fertilizer containing N may lead to soil acidification due to acidity produced in the nitrification process (microbial oxidation of ammonium to nitrate). For instance, Chang *et al.*, (1991) observed a decrease in soil pH with time and suggested that some soils might eventually become acidic with continued application of fertilizer. In this case, farmers adoption of cattle manure because it acts as a conditioner for the soils which will favor banana growth.

Whalen *et al.* (2000) in an eight week short term laboratory study also revealed that the effects of manure on soil pH would depend on the manure source and soil characteristics. Castillo *et al.* (2003) also found that manures of high organic matter and carbonate content are most effective in raising the pH of an acid soil and buffering against changes in soil pH. Well-made farmyard manure is a useful source of nitrogen, phosphates and potassium to crops (Russell, 1973). These nutrients are also essential in banana production and can be a pull factor to the adoption of cattle manure. Twenty five tonnes per hectare of farm yard manure, a fairly common dressing, will contain about 160 kg N, 22 kg P and 110 kg K but if given to a responsive crop will only be equivalent to about 45 kg N, 22 kg P and 90 kg K supplied as normal fertilizers, showing that most

of phosphate and probably all the potassium it contains is as effective as fertilizer phosphate and potassium (Cooke, 1973).

2.6.2.2 Effects of cattle manure on soil physical properties

Smallholders' farms in Sub Saharan Africa region are on inherently infertile sands. They are therefore subject to widespread degradation and declining fertility caused by loss of organic matter, breakdown of soil structure and erosion (Elwell & Stocking 1988; Smalling *et al.*, 1997). Added organic matter coats clay particles and increase adhesion between soil particles (Addiscott *et al.*, 1991). There are general views that inorganic fertilizers, when applied alone, only improve soil nutrient status. By contrast, organic materials such as cattle manure contribute positively to the soil nutrient pool, improve soil physical conditions, increase soil biological activity, encourage vigorous plant rooting systems and enhance crop performance (North Carolina Agricultural Extension Service, 1973; Gollin, 1991). Other benefits include reduced compaction and surface crusting and increased C sequestration (Khan *et al.*, 1975; Min *et al.*, 2003; N'Dayegamiye, 2009).

Further, they help to retain moisture and bind nutrients against leaching, especially if applied as mulch, smother small weeds and prevent soil from drying out, hence reducing soil erosion. Compared to inorganic N fertilisers, which are quickly converted into soluble N forms, and are therefore susceptible to leaching, organic inputs release nutrients more slowly and continuously throughout the growing season. Some inorganic fertilizers may not only acidify the soil, especially in the rhizosphere, but also affect its physical properties adversely (McCauley, Jones & Rutz, 2017).

2.6.2.3 Effect of cattle manure on soil biological properties

Additions of cattle manure can stimulate the activity of micro-organisms because they contain readily mineralisable organic compounds, such as sugars, organic acids, cellulose, and hemicellulose. Cattle manure application improves soil structure, by creating soil conditions (aeration and moisture) favourable for the growth of micro-organisms for an increase in their biological activities result in an increase in soil fertility (Chantigny *et al.*, 2009). This is because microorganisms eat the carbon from manure as an energy source. However, the ability of organic wastes to promote soil aggregation is linked to the rates at which they are decomposed by micro-organisms and therefore, their capacity to stimulate the soil micro flora and to produce humic substances (Cheshire & Chapman, 1996). Organic manure/wastes that are rich in N and with C/N ratios below 20 are accompanied by high levels of microbial activities and decomposition in the soils which increases soil productivity. Farmers therefore adopt cattle manure when they perceive its benefits on the above biological properties.

N'Dayegamiye (2009) reported that dairy cattle manure in addition to mineral fertilizer applications significantly increased mineralised soil N levels, which improved biological properties of the soil thereby enhancing microbial activity. It should be noted, however, that where there are large soil mesofauna populations present, a significant portion of manure applied as a soil amendment may be degraded and/or displaced by the soil insects (Seastedt, 1984; Kaneko & Salamanca, 1999). This is relevant for many areas in SSA including Uganda with large indigenous populations of termites and ants in the soil. Termites have gut cellulases used to degrade the fibrous manure material.

Termites and ants use the fibrous manure material in their mounds, so the activity of these insects may result in the relocation of manure from the soil as they transport it to their mounds (Potts & Hewitt, 1973; Diamond, 1998).

A key determinant of sustained adoption is the profitability of agricultural enterprises. The changing prices for agricultural products are shown to be a major factor in agricultural technology adoption (Kijima *et al.*, 2011). Initially attracted by higher product prices, farmers can abandon the technologies if the expected benefits from adoption are lower than the prevailing costs. There are a number of ways through which profitability of products may be lowered. For cash crops, changes in the international trade regime may negatively affect world prices and consequently depress local prices. The global decline in cotton prices due to cotton subsidies in developed countries best illustrates this fact (Minot & Daniels, 2005). The changing profitability of agricultural enterprises also introduces the time dimension as a driver of adoption households may adopt technologies for some but not all periods.

A study on the key factors associated with the adoption of hybrid maize in Latin America and the Caribbean region by Kosarek, Garcia, and Morris (2001) reported that farmers' decision to adopt hybrid maize was determined by the expected returns from the technology, the availability of hybrid seed, and risks associated with uncertainty regarding the expected outcomes of the new technology. Kosarek *et al.*, (2001) further found that the structure of the seed market, the organization of the seed industry, and the cost of technology generation and development were key determinants of the profitability of supplying hybrid maize seed.

2.6.3 Cost of inputs

The decision to adopt is often an investment decision. According to Caswell *et al.* (2001), this decision presents a shift in farmers' investment options. Therefore, adoption can be expected to be dependent on cost of a technology and on whether farmers possess the required resources. Most farmers' lack experience with these technologies leads to a low quality of implementation, a higher risk of trial failure, and an unavailability of resources required for implementation (Marra *et al.* 2004). According to Muhereza *et al.*, (2014), 37.5 % of the farmers adopt cattle manure because of the low cost of purchasing the manure. Kushaba (2017) also found that a medium sized lorry of manure goes for 80,000 shillings while a big lorry goes for shillings 100,000 shillings and is cheaper than manufactured fertilizers.

2.7 On-farm factors in Mbarara that affect cattle manure adoption

2.7.1 Availability of cattle manure

The Mbarara cattle herd population growth rate is 11% per year (Ministry of Agriculture, Animal Industry and Fisheries (MAAF), 2009). Therefore by 2017, the cattle population is estimated to be 151,358 heads of cattle. This leads to high availability of cattle manure of about 3,314,740 tonnes using the rate of 21.9tonnesper hectare produced per animal (of about 600 kg) per year(Midwest Plan Service (MWPS-18) and University of Wisconsin-Extension (publications A3411 and A3557). This means that Mbarara has a potential of availing cattle manure which banana farmers may be able to use in their production. The study establishes the amount of cattle manure available for these farmers to use.

Yamano (2008) established that the number of improved cattle per ha increases the organic fertilizer application on banana plots by 232 kilograms per ha. However, number of animals may not solely determine the availability of cattle manure in a certain area. Manure production and nutrient excretion value varies by body weight of the animal and often does not account for large variations in feeding types and amounts. Other factors such as animal species, age, feed ration, bedding characteristics, storage structures and manure handling will greatly affect manure production and nutrient levels (Masoud *et al.*, 2017).

2.7.2 Ownership of Land

In some situations, farmers might be compelled to use conventional and sustainable systems at the same time for example when working with own and rented land. Bell *et al.* (2001) found that the having to manage both rented plots and owned plots, in different ways was less cost effective and took farmers more time and effort. Ownership of large tracts of land can facilitate experimentation with new agricultural technologies, and also determine the pace of adoption as large land owners are more likely to be the early adopters (de Janvry *et al.*, 2011). In Mbarara District, most farmers own land and have rights of using the land the way they want. This may enable them to adopt cattle manure.

In a study by Muhereza *et al.*, (2014), it was revealed that farmers mostly used their own manure, but some farmers obtained it for free or purchased it from neighbours as quantities of their own manure were not adequate. Farmers were reluctant to buy cattle manure for use on rented land, as manure was not considered beneficial for one season's rental. However, farmers who rented

large plots of land were willing to apply more manure but reiterated that transport was a big issue, in addition to temporary land ownership.

Households with large farms are expected to practice land management practices and easily adopt new technologies such crop rotation and fallowing (Crowley *et al.*, 1996). Farm size is expected to be positively related to intensity of cattle manure adoption. According to the study by Bagamba (2007), the average farm size was approximately 2.5 acres(1 ha)in southwestern Uganda and the largest proportion of land under cultivation was allocated to bananas (51.3%).This is because bananas serve as both a staple food and cash crop and farmers would be compelled to adopt cattle manure to increase production since they have limited land .

2.7. 3 Availability of labour

Availability of casual labour allows farmers to open more land or improve management practices such as land preparation, weeding and application of fertilizers or organic manure (Crowley *et al.*, 1996). Thus availability of casual labour was expected to be positively related to organic manure use. The Mbarara study indeed revealed that availability of casual labour was one of the influencing factors especially where the farmers' plots of land are fragmented.

2.7.4 Distance to road from farm and to the market

It is expected that short distances to the market reduce the relative costs, increases availability of inputs and improves access to output markets hence generate better incomes (Waithaka *et al.*, 2007). Thus distance to the market is

expected to be negatively related to fertilizer use and positively related to organic manure use, since farmers located far away from supply sources are likely to incur higher transportation and search costs. This is so because organic manure markets do not exist as such and thus distance to markets has a bearing only on fertilizer costs. However, since organic manure and fertilizer also have complementary effects, we would expect that increasing distance would raise fertilizer costs, which would tend to make farmers turn to organic manure. Livestock is herded on pastures or fed with forage from the outfields. For much of the time they are kept in kraals close to the home, which also favored the easy allocation of manure to the banana plantation (Bekunda, 1999).

2.7.5 Household size

Household size or family size (which provides family labor) typically has a positive effect upon a household's decision to use new technologies; larger families would theoretically have more family members available to work on the household crops (Croppenstedt and Demeke, 1996; Green and Ng'ong'ola, 1993). Doss and Morris, (2001) reported the number of adult males do significantly affect use of improved varieties of maize in Ghana. Feder *et al.* (1985) revealed that adoption was less attractive for those with limited family labour or those in areas with less access to hired labour. Kato (2000) reported an increase in adoption of K131 bean variety in Uganda as a result of increased family and hired labour. However, family size was not found to be significant by Nkonya *et al.*,(1997) and Kaliba *et al.*, (2000).Households with many members dependent on the farm are expected to use less fertilizer but rely more on organic manure. This is based on the assumption that such households were

more concerned with meeting food security needs before pursuing income related objectives (Omamo *et al.*, 2002).

2.7.6 Availability of advisory services

2.7.6.1 Effect of social networks

According to Dearing (2004), Kincaid (2004) and Haider and Kreps (2004), social influence is more likely to occur through opinion leaders of the social systems and can influence people's attitudes towards adoption of new practice/innovation. When opinion leaders show a passive or active rejection of the innovation, adoption may be hindered and the reverse is true for positive attitude (Dearing, 2004). Another reason highlighted in the literature, which drives agricultural technology adoption, is peer effects or learning from other farmers. According to Oster and Thornton (2009), in any technology adoption process, peer effects work in three major ways: (i) individuals profit from activities of friends/neighbours; (ii) individuals gain knowledge of the benefits of the technology from their friends; and (iii) individuals learn about how to use a new approach from peers. With regard to agricultural technology adoption, peer effects can lead to economies of scale by lowering transportation costs but can also lead to increased competition and banana prices (Carletto *et al.*, 2007). Indeed, some studies, for example Conley and Udry (2010) in Ghana, showed that learning by doing influenced technical change in pineapple cultivation.

One of the reasons for non-adoption reported by Norman *et al.*, (1997) is that sustainable agriculture practices are management intensive and require great commitment to constant learning. Nowak (1991) states that one reason for

farmers being unable to adopt is their inadequate managerial skills. He explains that the issue is exacerbated by the fact that residue management systems often are designed for average or above average managers, and local assistance networks are also oriented to this group. Similarly, farmers in Brazil found lack of knowledge as a barrier to adopt organic farming (Souza, 1997). The case study of Mbarara District filled this gap since case studies above used the context of Brazil, the spokes nation of all developing countries. In Mbarara, most farmers are illiterate. Continuous learning would thus materialize if it is preceded by Functional Adult Literacy (FAL) classes in the area.

Katungi (2007) used a probit model to estimate the probability of using improved banana management practice and participation in an association. He also demonstrated that information generated by early adopters diffuses through sparse social networks contrary to the assumption of free availability in the whole village. It was identified that some factors associated with levels of knowledge of innovation included innovation proneness and of mass media influences.

2.7.6.2 Interaction with change agents

Haider and Kreps (2004) point out that a very important component of the diffusion of innovations (DOI) model is the change agent. They define change agent as an “individual who influences clients’ innovation decisions in a direction deemed desirable by a change agency”. The change agent is considered to play the following roles: “develop a need, establish the information exchange relationship, diagnose problems, create an intent in the client to change, translate an intent to action, stabilize adoption and prevent discontinuance, achieve a terminal relationship”(Haider & Kreps 2004).

According to a change agent “two drivers determine whether a farmer will adopt a new technology: if he thinks it is profitable and if his peers accept it” (Bearenklau, 2005). The degree to which this type of influence will affect adoption of technologies may depend upon the degree of risk of the technology. Bearenklau (2005) specifies that the neighbor effect may have more importance for smaller, less costly and reversible decisions. According to Vanclay *et al.*, (1993), for innovations high in apparent risk or uncertainty, diffusion occurs through an interpersonal process. In such a process social influence will either facilitate or impede adoption. However, Marra *et al.*, (2004) argue that social influences are not as relevant as others state. In their study about adoption of transgenic cotton, they found that potential adopters were more likely to be affected by information they consider as important (effective) in their decision than by neighbor effects or popularity of the innovation.

2.7.6.3 Access to information

Information is acquired through informal sources like the media, extension personnel, visits, meetings, and farm organizations and through formal education. It is important that this information be reliable, consistent and accurate. Thus, the right mix of information properties for a particular technology is needed for effectiveness in its impact on adoption. Adoption, defined as a mental process in which an individual passes through a series of stages from first hearing about an innovation, called an awareness stage, to collecting information about the technology's perceived benefits in terms of its profitability and fit into the farmer's operation, the evaluation stage (Caswell *et al.*, 2001).

Acquisition of information about a new technology demystifies it and makes it more available to farmers. Information reduces the uncertainty about a technology's performance hence may change individual's assessment from purely subjective to objective over time (Caswell *et al.*, 2001). Prior to trialing, the farmer's assessment of a technology or practice relies strongly on information from outsiders. At this stage, social and information networks would be important influencers on the decision to proceed to trial, but after training has commenced, personal experience gained in that way is likely to be the main influence on further decisions (Marsh *et al.*, 2000). This has implications for the role of extension to promote adoption, as previously discussed.

The introduction of new technologies creates demand for information useful in making decisions. Agricultural extension organizations supply useful information about agricultural technologies. Access to such sources of information can be crucial in the adoption of improved varieties. Furthermore, risk associated with the adoption of agricultural technologies has been an important factor in adoption decisions (Shiyani, Joshi, Asokan & Bantilan, 2002).

2.8 Theoretical framework

The diffusion of innovations is the most widely used framework to explain and predict adoption of new technologies. It was formulated in the United States by the rural sociologist Everett Rogers in the 1940s. Rogers defines diffusion as "the process by which an innovation is communicated through certain channels over time among the members of a particular social system. This process

includes both planned and spontaneous spread of new ideas” (Haider & Kreps, 2004).

The innovation decision process is characterized by five stages: knowledge, persuasion, decision, implementation and confirmation. In the knowledge stage the individual or household is exposed to the innovation’s existence and gains understanding of how it functions. However, even after knowing about an innovation, individuals may need to be persuaded to use it because they do not regard it as relevant to their situation. The outcome of the persuasion stage is either adoption or rejection of the innovation. The implementation stage is when an individual puts an innovation into use. The final stage is confirmation during which the individual seeks reinforcement for the decision made.

From Figure 1, Rogers postulated that innovations spread gradually over time and among people resulting in various adopter categories. The result is an adoption process that forms a normal bell-shaped curve when plotted over time (Rogers, 1995). Rogers attributes this distribution of adoption to the role of information, which reduces uncertainty in the diffusion process. Based on this argument, Rogers has classified adopters into six categories: innovators, early adopters, early majority, late majority and laggards, and rejectors.

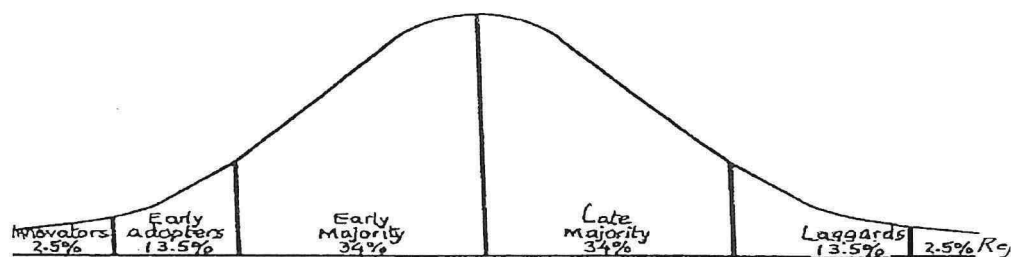


Figure 2.1: Adopter categorization on the basis of relative time of innovations

Source: Rogers (1995)

Innovators are described as individuals who are venturesome, eager to try new ideas and willing to take risks. Early adopters are described in the system as local opinion leaders who function as the role models and are quick to see the value of innovations. The early and latest majority constitute the largest category of adopters. These people only make a decision after they are convinced of the benefits. The late majority is cautious and skeptical persons who do not adopt until majority others have done so. They are usually the relatively poor and are averse to risk. Laggards are suspicious of innovations and change agents. They are usually poor and seldom take risks. The last group of adopters is the rejectors. It is possible for an innovation to cause consequences for individuals other than its adopters. For instance, rejectors of a new idea may be affected because the innovation gives a boost to the other members of a system that adopt it, thus widening a socioeconomic gap over the rejectors. Skeptical that consequences might not occur exclusively to those individuals or systems that decide to adopt an innovation, the rejectors of an innovation are opposed to the development because they have a conviction that everyone in the system is touched by the consequences of the innovation.

Rogers postulated that innovations spread gradually over time and among people resulting in various adopter categories. The result is an adoption process that forms a normal bell-shaped curve when plotted over time (Rogers, 1995). According to Rogers (1995), underpinning this adopter classification are individual demographic and other characteristics such as economic power and interaction with relevant change agents, relevant training and so on which was exploited in this study in explaining the adoption and of cattle manure in Mbarara District.

This theory was adopted in this study because it was the most widely used framework to explain and predict adoption of new technologies such as cattle manure. This theory assumes that the rate of diffusion of an innovation is affected by an innovation's relative advantage, complexity, compatibility, trialability and observability. Basing on this theory, it was indeed revealed that farmers adopted cattle manure in their banana plantations because they expected it to have a relative advantage over other fertilizers. The perceived advantages included easy application, compatibility with soils, easy triability and observable output.

2.9 Conceptual framework

The conceptual framework as in Figure 2.2 hypothesized that there is a positive relationship between socio-economic characteristics of the farmers and adoption of cattle manure by banana farmers in Mbarara District. The conceptual framework further showed that favorable on farm increased on the proportion of farmers utilizing cattle manure (dependent variable) in terms of using cattle manure alone and farmers using cattle manure with other forms of fertilizers. The conceptual model further hypothesized that when adequately, correctly and effectively adopted and utilized, cattle manure had the potential of increasing on the productivity of the bananas (dependent variable). The intervening factors were introduced in the conceptual model because they had a moderating effect on the way how the said factors (independent variables) influenced cattle manure adoption by the farmers.

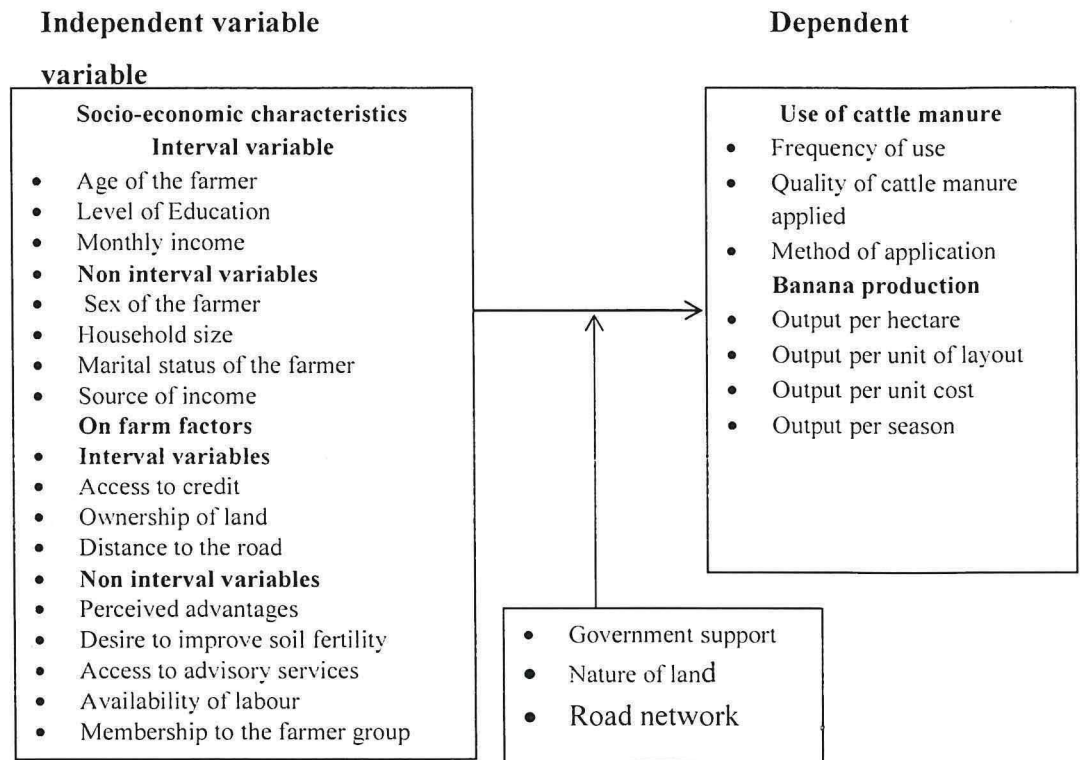


Figure 2.2: Conceptual framework

2.10 Summary of the literature reviewed

From the preceding literature reviewed, it was revealed that favorable socio-economic characteristics of the farmers and selected factors as well as the availability of advisory services played an immense role in steering or inhibiting cattle manure adoption for banana production in particular and other crops in general. The authors cited in the literature acknowledged the superiority of the already discussed factors. However, most of the scholars used case studies of both developed and developing countries, with limited reference made to Uganda and Mbarara District in particular. Their findings had methodological, contextual and subject gaps. For example, Katungi (2007) used probit model in estimating the probability of farmers using improved banana management practices but did not mention use of cattle manure. Kosarek *et al.*, (2001) investigated the factors associated with the adoption of

hybrid maize in Latin America and Caribbean which were relevant to cattle manure use and adoption, Feleke *et al.*, (2006) acknowledged the positive effects of access to credit on the adoption of new agronomic practices. Intervening variables were tested and revealed that nature of land in terms of soil fertility and ownership as well as distance to the road network to all markets including for cattle manure influenced cattle manure adoption as well as banana productivity.

CHAPTER THREE

METHODOLOGY

3.1 Introduction

This chapter outlines the methodology that was used to conduct the research. It comprises the research design, population of study, sample size and selection, data collection methods and instruments, reliability and validity of instruments, data management and analysis.

3.2 Research design

The research design refers to the overall strategy used by the researcher to integrate the different components of the study in a coherent and logical way, thereby, ensuring effective addressing of the research problem. It is a set of methods and procedures used in collecting and analyzing measures of the variables specified in the research problem. It constitutes the blueprint for the collection, measurement, and analysis of data (Labaree, 2009). The study used a cross-sectional survey design which measures differences between or from among a variety of people, subjects, or phenomena at a particular point in time rather than a process of change (Iacobucci & Churchill 2010). A cross-sectional survey allowed the researcher to get perceptions on the levels of cattle manure adoption, socioeconomic characteristics of farmers affecting it, banana yields arising from it, and on-farm factors influencing cattle manure adoption in Mbarara District, which further assisted the researcher to understand relationships particularly associations between interval variables found in cattle manure adoption . Using a cross-sectional survey enabled the researcher to

collect both qualitative and quantitative data from many respondents simultaneously and in a relatively short amount of time.

3.3 The study area

The study was carried out among banana farmers in Mbarara District located in Western Uganda and named after its chief municipal centre, the Municipality of Mbarara, where the District headquarters are located. Mbarara District is bordered by Ibanda District to the north, Kiruhura District to the east, Isingiro District to the southeast, Ntungamo District to the southwest, Sheema District to the west and Buhweju District to the northwest. Mbarara is the largest Municipality in the sub-region of Western Uganda located approximately 290 kilometers (180 miles) by road, southwest of Kampala, Uganda's capital city (Globefeed, 2014).

Mbarara District consists of Mbarara Municipality, and nineteen rural sub-counties, namely Kashari, Bubaare, Bukiro, Kagongi, Kakiika, Kashare, Rubaya, Rubindi, Rwanyamahembe, Biharwe, Kakoba, Kamukuzi, Nyamitanga, Rwampara, Bugamba, Mwizi, Ndaija, Nyakayojo, Rugando organized into two counties, Rwampara County and Kashari County. For the purposes of this study, only one county, Rwampara County was targeted as the area of study which has four sub counties namely Rugando, Ndeija, Bugamba and Mwizi. This is because it is the area where banana growing is most dominant and is therefore expected to have banana farmers who had adopted cattle manure to boost banana productivity.

Mbarara District covers a land area of 1,778.4 square kilometers (686.6 sq mi), with an average elevation of about 1,800 meters (5,900 ft) above sea level. The District receives an average annual rainfall of 1,200 millimeters (47 in).

Temperatures range from 17 °C (63 °F) to 30 °C (86 °F) (UBOS, 2014).As is the case with the majority of Ugandan districts; agriculture is the mainstay of the economy of Mbarara District. Both crops and livestock are raised, primarily on a subsistence level but several commercial farms are also found. Crops grown include: matooke (cooking type of bananas), sweet Bananas, beans, sweet potatoes, Irish potatoes, millet, cabbage tomatoes, pineapples, avocado, passion fruit, papaya, and mangoes. The livestock raised in the district includes: Ankole cattle, exotic cattle, hybrid cattle, goats, sheep, pigs, rabbits, chicken, ducks, guinea fowl and turkeys. Mbarara District was selected because it is one of the most populous districts where bananas are grown and produced in large quantities (UBOS, 2014)

3.4The study population

Population refers to the group of people, events or things or elements of interest that a researcher wishes to investigate (Denscombe, 2003). Oso and Onen (2005) put that population is the total number of subjects or the total environment of interest to the researcher while Amin (2005) looks at population as a complete collection or the universe of all the members or units of a group that are of interest in a particular study. Banana farmers in Mbarara District were the targeted population by the study.

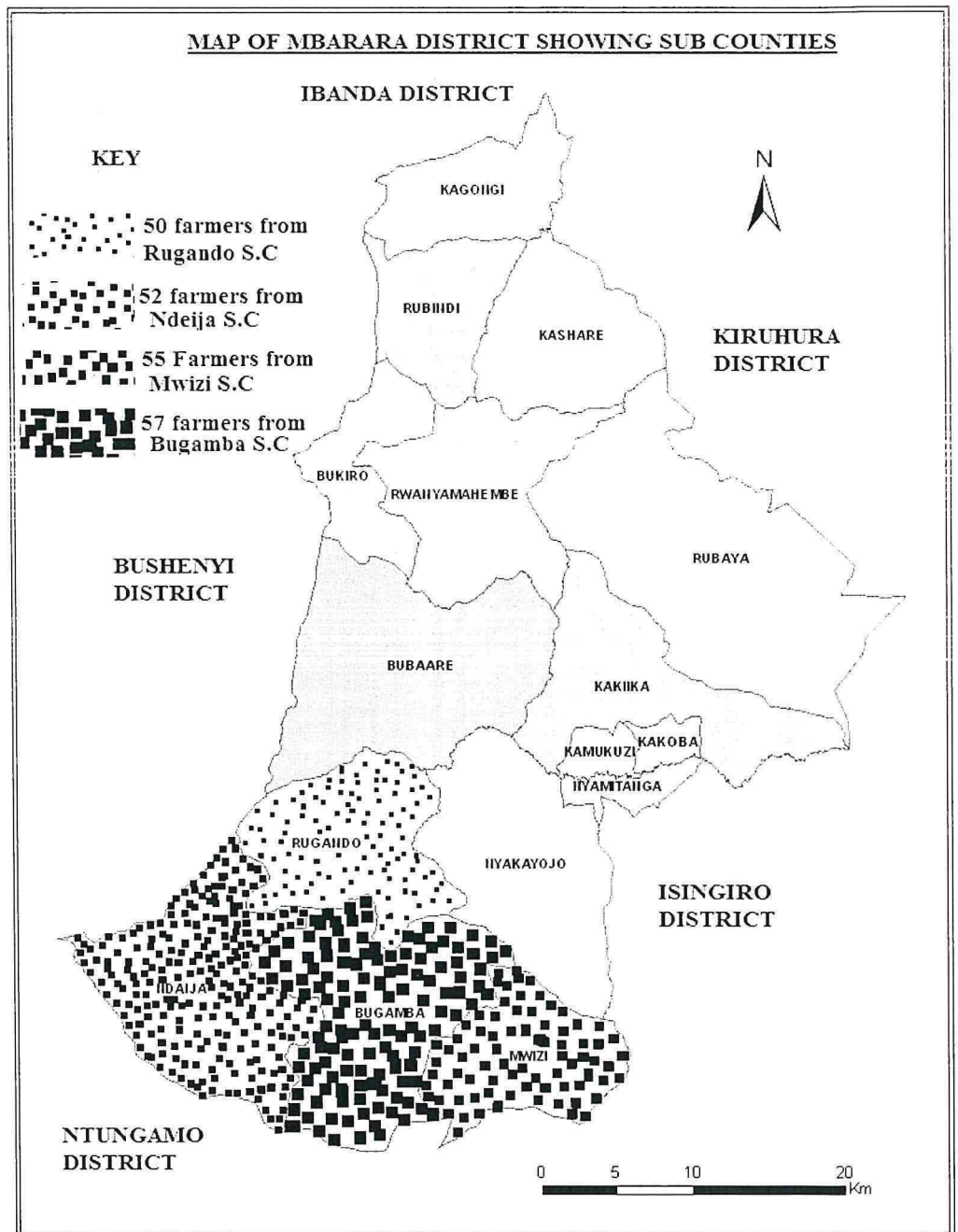


Figure 3.1: Map of Mbarara District showing the area of study (dotted area)

Source: (Mbarara District Local Government Statistical Abstract, 2016)

3.5 Sample size determination

About 82% percent of the total population in Mbarara District is engaged in agriculture (UBOS, 2012). This makes the proportion of those farmers to be

0.82. The estimated sample size was calculated using the formula below for agricultural surveys stipulated by IFAD (2005). The formula was used because IFAD gave it as the best to use for determining sample sizes from farming populations proportionately in a study area.

$$\text{Formula is: } n = \frac{t^2 \times p(1-p)}{M^2}$$

Where:

N = required sample size

t = confidence level at 95% (standard value of 1.96)

p = estimated proportion of farmers in the study area

m = margin of error at 5% (standard value of 0.05).

Therefore substituting into the formula:

$$\frac{(1.96)^2 \times 0.82 \times (1-0.82)}{(0.05)^2}$$

Therefore, the calculated sample size was 226.

3.6 Sampling procedure

Stratified sampling technique was used to select sub counties (strata) of the District because it enabled the researcher to identify the sub counties which predominately grow bananas in the District. The researcher purposively selected four sub counties which represented 21 % of the nineteen sub counties in the study area. The selected sub counties are Rugando, Ndejja, Bugamba and Mwizi where banana production is abundant in Mbarara District. In the sub counties, a sampling frame listing all banana farmers in each sub county separately according to the records of the extension agents deployed in the sub counties. Using the sampling frames constructed for the four sub counties, simple random sampling was then used to select the banana farmers who

participated in the study for each sub county. It is those farmers who were regarded representative of the banana growers in the study area, whose responses were solicited to provide data on the adoption of cattle manure who gave a total of 214 banana farmers. Random sampling was done using a simple ballot box which contained the number of farmers of each sub county with coded names of farmers on pieces of paper. This meant that each farmer had an equal chance of participating in the study in each of those sub counties. The box was shaken several times and after each shaking one piece of paper was picked to select a farmer. This cycle of shaking and picking was done until the required number of farmers was selected for each sub county. After finishing one Sub County another sub county would be enrolled until all the four were done. According to Amin (2005), for correlation study it was generally desirable to have a minimum of 30-50 participants in each sub county which meant that the four sub counties could go to 200 participants taking the maximum desirable as 50. Nonetheless, three sub counties had 2-7 more participants to take into their population sizes and dropouts from the study. A total of farmers 214 farmers were selected to accommodate those changes that could influence sample size.

The key informants, who were different extension agents of the area, were selected purposively. The whole population of 12 of them deployed in the sub counties was included in the sample. According to Katebire (2007), this technique is sometimes referred to as judgmental sampling where a researcher on his/her own judgments targets specific subjects to participate in the study because they have perceived knowledge or experience in relation to the study under investigation. The key informants were four sub county Agricultural

officers, four extension staff, four NAADS staff and four Community Development Officers. This part of the sample was included because of their perceived expert knowledge about growing bananas and farmers' adoption of cattle manure in banana production.

The total sample size used was 226 which was generally desirable for the study and supported by IFAD (2005) whose formula was used to determine the sample size

3.7 Data collection Methods

The researcher used the following methods and techniques to collect data for the study;

3.7.1 Face-to-face interviews

An interview is a purposeful discussion between two or more people (Saunders *et al.*, 2003). Sekaran (2003) explained that one method of collecting data is to interview respondents to obtain information on the issues of interest. This targeted twelve (12) key informants who were interviewed using interview guides and they were engaged in in-depth discussions on issues of adoption of cattle manure. Interviews were conducted with 12 key informants that allowed the researcher to obtain information/ data about level or rate of adoption, the effect of socio-economic characteristics of banana farmers namely age, education level, sex of the farmer, household size, and level of income, marital status, and source of income., which were associated with cattle manure adoption, banana yields and adoption, and on-farm factors namely ownership of land, desire to improve soil fertility, perceived benefits of cattle manure adoption, distance to the road for ferrying cattle manure and produce, credit

access, cheap labour access, access to technical advice and group membership. The response rate from key informants was 100%.

3.7.2 Questionnaire survey

Amin (2005) defined a questionnaire as a form consisting of interrelated questions prepared by the researcher about the research problem under investigation, based on the objectives of the study. Questionnaires were administered to the selected household heads regarded as banana farmers randomly selected from the sub counties. The researcher carried out the study with the help of 5 research assistants from Datamine Research Centre, Mbarara who were specialists in data collection and therefore had prior experience in questionnaire distribution and interviews. However, these were trained to orient them and closely monitored and the researcher went with them in the field. A questionnaire was used because it facilitated collection of relevant information from banana farmers as they were given time to think before giving their opinions and is a less costly method (Sekaran, 2003). The questionnaire was used to collect both qualitative and quantitative data on the level or rate of cattle manure adoption by banana farmers, socio-economic characteristics of the farmers which included age, level of education, sex of the farmer, household size, level of income, marital status, source of income namely age, education level, sex of the farmer, household size, and level of income, marital status, and source of income., which were associated with cattle manure adoption, banana yields and cattle manure adoption, and on-farm factors namely ownership of land, desire to improve soil fertility, perceived benefits of cattle manure adoption, distance to the road for ferrying cattle manure and produce, credit access, cheap labour access, access to technical

advice and group membership. The response from farmers to the questionnaire was 174 which was 100% response rate.

3.7.3 Focus group discussions

Four Focus Group Discussions were conducted from the four sub-counties of Rugando, Bugamba, Mwizi and Ndejja using a Focus Group Discussion guide. The researcher acted as a moderator where she could pick one by one to give out his/her views on the topic under study. Each group had 10 participants and at least four were females. The discussions were focused particularly on reasons of adoption and non-adoption (How, Why), support mechanisms and types of support from Government, Non-government and Civil Society among others. The participants in the FGDs were selected during the process of administering questionnaire surveys. The researcher chose only those who expressed more knowledge about the adoption of cattle manure. Probing was used to supplement the responses that were considered lacking. . This method helped to get data about level of cattle manure adoption, on-farm factors influencing cattle manure adoption namely ownership of land, desire to improve soil fertility, perceived benefits of cattle manure adoption, distance to the road for ferrying cattle manure and produce, credit access, cheap labour access, access to technical advice and group membership, extent of use of cattle manure and household characteristics such as age of the farmer, level of education, sex of the farmer, household size, level of income, marital status, source of income which influence adoption of cattle manure. Cattle manure adoption and banana yields were also discussed. Attendance in the FGDS was 100%. All members expected all turned up whenever and wherever they were required.

3.7.4 Observation

According to Katebire (2007), observation provides a researcher with an inside view of reality. In addition, a researcher seeking to establish the immediate impact of an event on a given community or social group finds field observation handy. Katebire (2007) acknowledged field observation as an ideal method of data collection because it avails a researcher with quality and deep information. The information generated is detailed, of high quality, and firsthand account of the phenomena being studied. Observation was used to assess the yield potential of the gardens/ plantations where manure was applied, the terrain of the area, colour of soil, and modes of transporting bananas to the market, the availability of cattle in the households and distance to the market.

3.8 Instrumentation

3.8.1 Interview Guide

An interview guide was used in the study to collect detailed data from 12 key informants. The interview guide was used to collect data on the level of adoption of cattle manure, influence of socio-economic characteristics of the farmers, on-farm factors and availability of advisory services on cattle manure adoption by the farmers as described in variables found in section 3.7.1. The instrument was used in data collection because it enabled researchers to get in-depth information about the study in question. In addition, an interview guide was flexible and therefore allowed the researcher to adjust the questions so as to tap the required information from the respondents (Odiya, 2009).

3.8.2 Questionnaire

A semi-structured questionnaire was administered to 174 banana farmers who use cattle manure. The questionnaire was selected as the main data collection tool because it is cheaper to administer and covers a wide geographical area; it provides a hard copy that was filed for reference purposes. The questionnaire was also used because the information was collected from a large sample in a short period of time (Sekaran, 2003). Questions on variables; adoption level by farmers, socio economic characteristics of farmers, yield of bananas, level of cattle manure adoption and influence of on-farm factors on adoption of cattle manure were asked as described in section 3.7.2.

Close-ended requiring the respondents to tick on any one option that explains their true bio-data. On the other hand, questions related to the specific objectives in this study were designed in form of opinion statements formulated by the researcher using a 5-point Likert Scale in front of each statement ranging from Strongly Agree (5), to Agree (4) to Not sure (3) to Disagree (2) and to Strongly disagree (1) where the scales had varying weights. On each opinion statement, respondents were supposed to tick on only one scale basing on their level of agreement or disagreement with the statement as shown in the Table 3.1. Results from these responses were used to compute mean values which were used as interval variables which were used to compute to give Pearson r values yielding .associations of variables with cattle manure adoption thus showing their effects or influence.

Table 3.1: A 5-point likert rating scale with their respective weights

Opinion statement	Rating Scale (weight)				
	Strongly Agree (5)	Agree (4)	Not Sure (3)	Disagree (2)	Strongly Disagree (1)
Opinion statement '1'					
Opinion statement '2'					
Opinion statement '3'					
Opinion statement 'n'					

3.8.3 Focus Group Discussion Guide

A focus group discussion guide was used to gather detailed information from 40 respondents who were thought to have more information and knowledge about the adoption of cattle manure by farmers, socio economic characteristic of banana farmers, and on-farm factors affecting cattle manure adoption in the selected sub counties. Discussion was held on variables of as described in section 3.7.3

3.8.4 Observation Guide

Observation guide was used to check and increase accuracy of other tools like questionnaire. Aspects like size of banana plantation, colour of soil, heads of cattle reared, nature of terrain, and distribution of road networks were observed as described in section 3.7.4

3.9 Data quality control

This entailed establishing the validity and reliability of the study instruments.

3.9.1 Validity

According to Katebire (2007), validity refers to the extent to which that data collection instrument collects data that have the characteristics or attributes the

researcher wants to measure. Odiya (2009) defined validity of an instrument as the ability of the instrument to collect justifiable and truthful data; that is, measuring what it is developed to measure (Odiya, 2009). The supervisor and one other expert in the field were consulted about the content of instruments and relevancy of question items. Scale level Content Validity (S-CVI) was computed. The S-CVI is defined as “the proportion of items given a rating of quite/very relevant by both raters involved” (Waltz *et al.*, 2005: 155) and “the proportion of items given a rating of 3 or 4 by both raters involved” (Waltz & Bausell, 1981:71). Lynn (1986), acknowledged that 3- or 5-point rating scales might be considered, but she advocated using a 4-point scale to avoid having a neutral and ambivalent midpoint. The closer to 1 the CVI, the more valid is the instrument (Odiya, 2009). From the expert judgment, a content validity index of 0.909 was determined on computing implying the instruments were valid.

3.9.2 Reliability

Reliability deals with the accuracy of the instrument and the consistency of the data collection by it (Katebire, 2007). Amin (2005) defined reliability as the consistency of the instrument in measuring whatever it is intended to measure. The questionnaire was piloted in Sheema District. The reliability of the questionnaire was assessed using Cronbach’s Alpha at 0.05 level of significance. According to Odiya (2009), Cronbach’s alpha is used if the instrument has more than two responses provided for each item. Cronbach’s alpha coefficient was used to test for internal consistency of the research variables so as to test for the reliability of the questionnaire. From the pilot, the researcher computed a Cronbach’s alpha value of 0.784 which was higher than the recommended 0.7 making the instruments internally consistent.

3.10 Data analysis

3.10.1 Qualitative data

Qualitative data collected from interviews and literature review was sorted and grouped into themes. The researcher analyzed the adequacy of information in answering the research questions through identifying categories and parameters that emerged in response to the study variables. While analyzing qualitative data, summaries were made on how different themes of variables were related. Narrative statements were used as well as verbatim quotations from the key informants and focused group discussions. The qualitative findings showed a holistic picture about the status of adoption of cattle manure and what results the judged level of adoption in its perceived relationship with the different variables declared by the four objectives and research questions. Results are ported in Chapter Four.

Qualitative data is reported as categorical data. Categorical data was analysed using themes of facts and figures presented by the data collected in order to organize it. The data was organized by open coding according to the main ideas which are referred to as themes. The themes were then put in categories according to pairing relevant independent and dependent variables which were compared so as to interpret the meanings of their association which gave the qualitative findings of the study. These findings are recorded in this report.

3.10.2 Quantitative data

All the questionnaires from the selected respondents were collected and cleaned by the researcher to ensure that the required information was captured so as to facilitate easy analysis. After editing, each variable in the questionnaire

was recorded in the variable view sheet of SPSS Version 21.0 by assigning specific dummy values in numeric form that were used while entering/recording data in the data view sheet. After recording the variables, the responses on each variable/research question were entered into the data sheet view of SPSS using the numeric values already specified in the variable view sheet. After data entry, data on the socioeconomic characteristics of the respondents was analyzed by extracting individual frequency distribution tables which were later combined into one single table for socio-economic characteristics to aid in easy interpretation. However, the responses on the opinion statements on each specific objective were analyzed by extract in gone combined table showing individual frequencies, percentages, means and standard deviation on each opinion statement Interpretation of the frequency tables was done by combining the 'Strongly agree' and 'Agree' responses on one hand and 'Strongly disagree' and 'disagree' responses on the other hand alongside the 'Not Sure' responses.

As shown in Table 3.2, the researcher highlighted all the four objectives, research questions and hypotheses for the study. Association for each pair of independent and dependent variables indicated in the table is given and analysed in the form also indicated.

In determining the association between quantitative independent and dependent pairs of variables, Pearson's r values were computed using Statistical Package for Social Scientists

(SPSS) Version 21.0. The values were accepted or rejected at 0.05 level of confidence. Pearson's r values were used because they measured parametric data interval variables using mean values of the data collected (Amin, 2005;

Kothari, 2004; Frankfort-Nachmias & Nachmias, 1996). The resulting values give association computation which is as good as when using chi-square on parametric data. The r values were used to show association between variables of interest carried in the data to get meaning of their relationship with adoption of cattle manure in Mbarara District. Those relationships are recorded in this report.

Therefore, Table 3. 2 shows the processes of linking the objectives research questions, hypotheses, and analysis forms for testing the strength of relationships between independent and dependent variables.

Table 3.1: Summary of Data Analysis

Objective	Research Question	Hypothesis	Independent Variable	Dependent Variable	Relationship IV& DV	Analysis form
1.To establish the levels of cattle manure use in banana production	What is the level of cattle manure use in banana production?	There is a high level of cattle manure use in banana production.	Level of adoption of cattle manure	Banana production/ yield	Thematic Association	Categorical analysis Pearson r value
2.To describe the socio-economic characteristics of banana farmers in Mbarara District	What are the socio-economic characteristics of banana farmers in Mbarara District?	Socio-economic characteristics of the banana farmers influence use of cattle manure.	Socio-economic characteristics For example age, gender	Cattle manure use	Thematic Association	Categorical analysis Pearson r value
3. To determine yields of banana resulting from use of cattle manure	To what extent does cattle manure use improve the Banana yields?	Use of cattle manure has greatly improved banana yields.	Cattle manure use	Banana yields	Thematic Association	Categorical analysis Pearson r value
4.Ascertain the influence of on farm factors on cattle adoption	What are the likely on farm factors affecting of cattle manure in banana production	Favorable on-farm factors enhance cattle manure use in banana production	On-farm factors	Cattle manure	Thematic Association	Categorical analysis

Interpretation of Pearson correlation was based on the scale given in the Table 3.2. This scale was adapted from Rumsey (2015) to facilitate interpretation.

Table 3.2: Interpretation of Pearson rank correlation coefficient

Pearson Coefficient (r) range	Interpretation		
	Positive significant relationship (+)	Negative significant relationship (-)	No relationship
$r=0$	-	-	-
$0 < r \leq 0.39$	✓ Low	✓ Low	-
$0.4 \leq r \leq 0.59$	✓ Substantial/ Moderate	✓ Substantial/ Moderate	-
$0.6 \leq r \leq 0.99$	✓ High/Strong	✓ High/Strong	-
$r = 1$	✓ Perfect relationship	✓ Perfect relationship	-

NB: The relationship is significant only when the value of Sig.(2-tailed) < 0.05
Source: Rumsey (2015)

The Pearson r values were interpreted as the strength of association between the interval variables in the data collected showing relationships between variables studied. The researcher interpreted correlations based on the ranges shown in Table 3.2. Where $r=0$, it implies no relationship between the independent and dependent variables. Sign (-) means that 'r' equals zero so the variables had no relationship between them. A low relationship is any relationship where r value is greater than zero but less than 0.39. This can either be positive or negative. Where r values are greater than 0.4 but less than 0.59, the relationship is substantial or moderate which can be either positive or negative. The relationship was considered high or strong when the r values are greater than 0.6 but less than 0.99 which can also be either positive or negative. Finally, the relationship was considered perfect when the r value is at 1 that is either positive or negative. All associations in the study were interpreted to give relationships to reach meanings that gave some quantitative findings.

Based on the understanding that correlation values can be used to show association between interval variables according to Amin (2005), Kothari (2004) and Frankfort-Nachmias & Nachmias (1996), Pearson r values were computed to test the hypotheses postulated in Chapter One on page 5. Variables namely number of household members, marital status, sex of the farmer, source of income, desire to improve soil fertility, access to advisory services, availability of cheap labour, membership to farmer groups, were variables that were used as dummy variables as they were not interval variables which lent themselves for computation of r values to show association. The means derived from the Likert scale ratings found in Tables 4.2, 4.9 and 4.13 were used as interval variables to compute the association through use of Pearson's r values between cattle manure adoption and the variables in Tables 4.6, 4.10 and 4.14. Therefore the r values shown in those tables give the association values at 0.05 alpha in all those cases.

CHAPTER FOUR

PRESENTATION AND INTERPRETATION OF FINDINGS

4.0 Introduction

This section illustrates the response rate from the field as well as presentation and interpretation of the analyzed data from close ended questionnaires as generated by SPSS Version 21.0. The data is presented in separate frequency tables for qualitative, descriptive statistics and quantitative findings. Each frequency table shows the number of respondents (frequency), percentages and descriptive statistics such as mean and standard deviations which were generated directly using SPSS version 20.0. On the other hand, the tables for qualitative findings present narrative statements/responses from the field as reported by majority of the respondents during interviews and focus group discussions.

4.1 Response Rate

The total target number was 226 respondents who comprised banana farmers and key informants who were NAADS Coordinators and sub county extension officers. One hundred seventy four questionnaires were administered to 174 household heads. Questionnaires were all appropriately completed and returned with 100% response rate. In addition, 12 key informants were participated in interviews while 40 farmers were engaged in focus group discussions organized into four groups of 10 each. This implies that all the target respondents participated in the study with 100% response rate.

4.2 Levels of cattle manure adoption

The level of cattle manure adoption in this study was determined by an assessment of the frequency of supervision, quantity of cattle manure, application of other inorganic fertilizers along with cattle manure, source of cattle manure, method of application, timing of cattle manure use and need for weeding during cattle manure application. The results regarding this objective are presented in the Tables 4.1, 4.2 and 4.3.4.2.1.

4.2.1 Qualitative results about cattle manure adoption

Table 4.1 presents qualitative responses from interviews and focus group discussions regarding whether, when and how banana farmers utilize cattle manure in their banana plantations. Respondents were asked seven questions in interviews and focus group discussions and relevant quotations were made based on majority views and responses reported in Table 4.1.

Findings from the interviews and focus group discussions revealed that majority of the banana farmers applied cattle manure in their banana plantations. Respondents highlighted that cattle manure makes banana plantations look good and therefore they are obliged to maintain constant banana yield by applying cattle manure because bananas are one of their most stable foods.

Responses in Table 4.1 shows that majority of the farmers applied cattle manure ranging from 3-6 tonnes, each tonne being bought at Ugx. Shs.80,000-120,000 depending on the relationship with the seller and the level of negotiation. However, most farmers reported that such amount of manure was not sufficient for their banana plantations as they would require over 10 tonnes

per 3 months for maximum results. This is due to the fact that cattle manure is expensive which makes it difficult for farmers to buy it in large quantities.

Table 4.1: Qualitative responses from focus group discussions regarding cattle manure adoption

Qualitative Responses
<p>Do you apply cattle manure in your plantation <i>"-----Yes, I apply cattle manure in my banana plantation. As you know us the Banyankole, bananas are one of our most staple foods...so we have to maintain constant yield by applying cattle manure. You can hardly find any good plantation without cattle manure in it-----"</i></p>
<p>What is the quantity of cattle manure applied in your banana plantations <i>"-----I normally apply cattle manure ranging from 3-6 tonnes, each tonne I buy at Ugx. Shs. 80,000-120,000 depending on the relationship with the seller and the level of negotiation.....Cattle manure is expensive and therefore I cannot afford to buy it in large quantities. If I had sufficient money and source, I would apply over 10 tonnes per 3 months.. Now you see, people who keep large herds of cattle in our village are few which put cattle manure at a high competition thus reducing the quantity bought-----."</i></p>
<p>Do you apply other inorganic fertilizers along with cattle manure? If yes, what are they? <i>"-----We normally use kitchen refuse and "kasasiro" along with cattle manure. Kitchen refuse is readily available and cheap as it is not bought but rather got from their day to day operations such as banana/cassava/potato peelings, sweeping and tree leaves and cuttings. I actually apply about 3-5 wheel barrows of "Kasasiro" per week-----."</i></p>
<p>Where do you get the cattle manure you use in your plantation <i>"-----I buy cattle manure from the nearby cattle keepers in my village who keep large herds of cattle. For example, I buy each trip of cattle manure at a price ranging from Ugx. Shs. 80000-120000 depending on the relationship with the sellers-----."</i></p>
<p>Explain the procedure you follow to before applying cattle manure <i>"----- We heap the cow dung in one place and spread it to the banana field only when the temperatures are stable. Fresh cow dung contains high acidic contents as the gas excreted from it is always warm. This warm gas has negative side effects on the banana plantation as it makes the banana stems to wilt/wither out...We normally advise banana farmers to first leave the cattle manure to decompose and let out all the acidic gas in it before spreading it into the banana plantation. This can take about at least 1-3 months to decompose-----."</i></p>
<p>In which season do you apply cattle manure <i>"-----During the dry season, cattle manure is dry and well drained and can easily be spread around the banana plantation with all its nutrients so that when rain comes, the cattle manure will become wet and release a black/dark liquid to the soil which is later absorbed by the roots of banana suckers thus enhancing their growth-----."</i></p>
<p>Is there any need for removing weeds before cattle manure? <i>"-----there is no reason why I should leave weeds in my banana plantation. It is always the first thing to think of, that is to remove weeds. This provides space for easy application of cattle manure...if these weeds dry up and later get into contact with rain, they also decompose and become manure on its own. This saves the cattle manure that would be spread all over but rather you put it only where it is lacking/required..... However, there is no defined order of application for cattle manure and weeds removal-----."</i></p>

Source: Primary data, 2017

Further responses in table 4.1 show that most of the farmers also used other inorganic fertilizers like kitchen refuse and decomposed rubbish locally called, 'Kasasiro' in their banana plantations along with cattle manure. This was

measured in wheel barrows ranging from 3-5 per week. Respondents reported that kitchen refuse is readily available and cheap as it is not bought but rather got from their day to day operations such as banana/cassava/potato peelings, sweeping and tree leaves/cuttings.

Regarding the sources of cattle manure used in banana plantations, most participants in the focus group discussions reported that they bought cattle manure from the nearby cattle keepers in their villages who kept large herds of cattle. Respondents also reported that they bought each trip of cattle manure at a price ranging from UgxShs. 80,000-120,000/= depending on the relationship with the sellers.

Findings from focus groups further revealed that most of the respondents heaped the cow dung in one place after which it would be spread to the banana field when the temperatures are stable. One respondent reported that fresh cow dung contains high acidic contents as the gas let out from it is always warm. This warm gas has negative side effects on the banana plantation as it makes the banana stems to wilt/wither out. Banana farmers therefore had to first leave the cattle manure to decompose and spread-out all the acidic gas in it before spreading it into the banana plantation. This took them about 1-3 months to decompose.

Majority of the farmers as shown in the Table 4.1 reported that they applied cattle manure during a dry season because during such a sunny season, cattle manure is dry and well drained and can easily be distributed/spread around the banana plantation with all its nutrients so that when rain comes, the cattle manure will become wet and release a black/dark liquid to the soil which is later absorbed by the roots of banana suckers thus enhancing their growth.

Lastly, responses in Table 4.1 revealed that it is not mandatory to remove weeds before cattle manure is applied but the importance lies in the need to make the plantation clean. However, most farmers lamented that there is no reason why they should leave weeds in their banana plantation as weeding provides space for easy application of cattle manure. It was reported that if these weeds dry up and later get into contact with rain, they also decompose and also become manure. Dry and rotten weeds save cattle manure that would be spread all over the banana plantation as it can instead be applied only where it is lacking/required.

4.2.2 Application of cattle manure in farmers' banana plantations

This section presents the responses from close ended questions regarding the application of cattle manure among banana farmers in Mbarara District. Seven statements were provided by the researcher which sought respondent's opinions regarding each statement. A five point Likert scale (1-5) ranging from strongly disagree (1) to strongly agree (5) was provided in front of each statement and this required the respondents to show their level of agreement with each statement. In the analysis, responses on strongly agree and agree were combined to come up with single frequency and percentage. Likewise, responses on strongly disagree and disagree were also combined to come up with one frequency and percentage. The combined frequencies and percentages for agree and disagree were then presented alongside those who were not sure about the statement. Mean and standard deviation were also generated in order to make interpretation easy. A higher mean indicates a higher extent of agreement by majority of the respondents and vice versa. Conversely, a lesser value of standard deviation indicates that responses are so close to each other,

an implication that all participants had almost similar responses and therefore shared similar characteristics and experiences as regards to cattle manure and banana production. The findings are presented in Table 4.2.

Responses in Table 4.2 indicate that majority (77%) of the respondents agreed that they regularly apply cattle manure in their banana plantation per year. This was further shown by mean of 3.75, SD=1.274 implying that cattle manure is very important in improving banana yield.

The study further revealed that the quantity of cattle manure applied was not enough for their banana plantation. In fact 66% of the respondents disagreed about the statement. This was further shown by a lower mean and higher value of standard deviation (Mean=2.32, SD=1.102). This implies that even if majority of them applied cattle manure, the quantity of cattle manure was not enough to cover all their plantations.

Results from observations show that cattle manure was concentrated near the banana stems/stools to enable easy absorption by banana roots and less concentrated in empty/free spaces in the plantations. Results in table 4.2 also indicate that 62.1% of the respondents agreed that they applied other fertilizers specifically kitchen refuse, DAP, NPK & CAN along with cattle manure. This was also indicated by a mean of 3.35 and standard deviation of 1.091. This is because cattle manure alone is not sufficient for their banana plantations due to reasons of scarcity and high cost.

The results further revealed that more than half (56.4%) of the respondents, do not get cattle manure used in their banana plantations from their own cattle. This was also proven by a lower mean and higher value of standard deviation (Mean=2.94, SD=1.342) showing greater variability in responses. This implies

that cattle manure used by most banana farmers is bought from outside the household normally from cattle farmers with large herds.

Table 4.2: Farmers' responses from questionnaires on the adoption of cattle manure in their banana plantations (N=174)

Opinion statements on cattle manure adoption	Not			Mean SD	
	Disagree	Sure	Agree	Mn	df
	%	%	%		
Regular application of cattle manure	23.0	0.0	77	3.75	1.274
Adequacy of cattle manure applied	66.7	16.1	17.2	2.32	1.102
Application of other inorganic fertilizers	38.0	0.0	62.1	3.35	1.091
Cattle manure got from own cattle	56.4	0.0	43.7	2.94	1.342
Heaping method of application	33.9	0.0	66.1	3.43	1.415
Application of cattle manure in dry season	17.8	1.7	80.4	3.78	1.071
Application of cattle manure after removal of weeds	5.2	0.0	94.8	4.30	.747
Total	34.4	2.5	63.0	3.41	1.12

Source: Primary data, 2017

The study also revealed that 66.1% of the respondents applied cattle manure by heaping it in one place for about 1-3 months after which it was applied within the banana plantation. This was also shown by a mean of 3.43 and SD of 1.42. The reasons for heaping were to allow manure to let out the excess gas/acid which could make the bananas to wilt if applied immediately.

Majority (80.4%) of the respondents also reported that cattle manure is applied in the banana plantation in a dry season than rainy season. Further it was also shown as so by a Mean of 3.78 and SD of 1.071. The results further revealed that majority of the respondents (94.8%) agreed that they applied cattle manure only after removing all the weeds from the banana plantation. This statement received the highest mean and lowest standard deviation (Mean=4.30, SD=.747) which indicates the higher importance of weeding before applying cattle manure.

Table 4.3 presents different ways cattle manure was used by banana farmers. Five variables; the amount of cattle manure used per hectare, frequency of cattle manure application, duration of manure disposal, type and percentage of any other fertilizer(s) applied along with cattle manure were presented. The researcher provided various categories and ranges to give the respondent chance to tick on the category which was relevant to him/her.

4.2.3 Quantitative results about cattle manure

Results in table 4.3 show that majority of the respondents totaling to 37.9% applied less than 10 tonnes of cattle manure per hectare which is approximately 300 wheel barrows each weighing about 33kgs. Only 30.5% of the farmers apply 10-20 tonnes (300-600 wheel barrows) per hectare, 18.4% apply 21-30 tonnes (601-900 wheel barrows) while 13.2% above 30 tonnes (>900 wheel barrows). This implies that cattle manure is insufficient for effective banana yield as few farmers can apply beyond 10 tonnes per hectare.

Table 4.3: Ways used by banana farmers in Mbarara District in applying cattle manure (N=174)

Category	Percentage (%)
Amount of cattle manure used per hectare	
Less than 10 tonnes (300 wheel barrows)	37.9
10-20 tonnes(300-600 wheel barrows)	30.5
21-30 tonnes(601-900 wheel barrows)	18.4
Above 30 tonnes(>900 wheel barrows)	13.2
Frequency of cattle manure application	
Once a year	50.6
Twice a year	7.5
Once in two years	29.3
Once in 3 years	12.6
Less than 7 days	2.3
1-2 weeks	4.6
Duration of cattle manure heaping before disposal	
2-3 weeks	8.0
3-4 weeks	17.8
1-3 months	55.7
>3 months	11.5
Type of other fertilizers applied along with cattle manure	
None	37.9
DAP	2.3
NPK	14.9
CAN	3.4
Others (Kitchen refuge)	41.4
Percentage of other inorganic fertilizers applied along with cattle manure	
Less than 25%	35.1
25-50%	50.0
51-70%	11.5
71-100%	3.4

Source: Primary data, 2017

In addition, it was revealed that over half (50.6%) of the banana farmers apply cattle manure once a year, 29.3% apply cattle manure once in two(2) years, 12.6% apply cattle manure once in three years while the least 7.5% apply manure twice a year.

It was also revealed that before disposal of cattle manure, majority, 55.7% of the farmers heap it for 1-3 months, 17.8% heap it for 3-4 weeks, 11.5% heap it

for more than 3 months, and 8.0% heap it for 2-3 weeks while 2.3% heap it for less than a week. This implies that majority of the banana farmers cannot put cattle manure in their banana plantations before heaping it for some time to allow expulsion of the acidic gases.

Results further revealed that majority (41.4%) of the total participants applied other fertilizers especially kitchen refuse/husks, 14.9% applied NPK, 3.4% applied CAN, 2.3% applied DAP while 37.9% applied cattle manure alone. This implies that most banana farmers cannot apply cattle manure alone as it is scarce and expensive to buy. They, therefore, apply other inorganic fertilizers to support cattle manure. The findings also show that majority, 50% of the respondents applied between 25-50% of other inorganic fertilizers, 35.1% of the respondents applied less than 25% of other inorganic fertilizers, 11.5% of respondents applied 51-70% of inorganic fertilizers while 3.4% applied above 70% of other inorganic fertilizers.

4.2.4 Summary of the findings on the level of cattle manure adoption

The study findings revealed that most of the banana farmers in Mbarara District regularly apply cattle manure in their banana plantations especially in a dry season with almost half (50%) of the farmers applying it once a year after holding it for about 1-3 months before disposal to let it decompose and excrete out all the bio gas in it before spreading it into the banana plantation. However, findings revealed that the quantity of cattle manure applied was not enough to cover all their plantations where more than a third of the farmers applied less than 10 tonnes of cattle manure per hectare which is approximately 300 wheel barrows. This was due to limitations of high demand and low supply which

puts the prices of manure to as high as Ug. Shs. 80,000-120,000 per trip making most of the farmers unable to buy in large quantities.

4.3 Influence of socio-economic characteristics on level of cattle manure adoption

The section also presents the relationship that exists between the respondents socio-demographic characteristics and level of cattle manure since this was the second specific objective as shown in chapter one of this report.

4.3.1 Qualitative responses regarding the relationship between socio-economic characteristics and level of cattle manure adoption

This sub-section presents qualitative responses from interviews and focus group discussions regarding the relationship between farmer's socio-economic characteristics and level of cattle manure adoption in Mbarara District. These responses are presented in Table 4.4.

Qualitative responses in Table 4.4 reveal that children and young people do not have the ability to handle all the activities involved in cattle manure unlike the adults. This is because the adults (36-53 yrs) are the ones who possess money to buy cattle manure and have physical strength, commitment and hard work to apply cattle manure unlike old people (above 53 yrs) and children (below 18yrs) who are among the vulnerable groups or dependents. In conclusion there was a positive relationship between farmer's age and cattle manure adoption. This agrees with the result shown in Table 4.6 about association of age and adoption of cattle manure with r value of 0.914* at 0.05 alpha.

Responses from interviews shown in Table 4.4 revealed that most of the money earned from agriculture was again injected back into agriculture to perform

tasks such as cattle manure purchases and general maintenance of farm plantations. This implies that farmers with higher monthly incomes are more likely to inject more money in cattle manure than poor or low income farmers. Therefore there was a positive association between level of monthly income and cattle manure adoption with r values 0.781^* at 0.05 alpha.

In addition, responses in Table 4.4 indicate that most of the farmers who applied cattle manure in their banana plantations had studied at least to primary level. During interviews, the respondents generally agreed that highly educated people can effectively apply cattle manure as they understand its benefits, methods of application and appropriate measures of the quantity of cattle manure to apply compared to the less educated. Therefore there was a positive relationship which was confirmed by the association test between level of education and cattle manure adoption with r value 0.878^* at 0.05 alpha.

Responses in Table 4.4 further revealed that marital status also influences cattle manure adoption where most respondents reported that married people have the capacity and resources to manage all the activities involved in the of cattle manure adoption unlike the widows, singles and divorced families. This implies that there is a positive relationship between marital status and cattle manure adoption. The difference in abilities lies in the differences in family or household members who provide more cheap family labour for married people than other statuses.

It was also revealed in Table 4.4 that male headed households applied more cattle manure in their plantations than female headed households meaning that the sex of the farmer influenced cattle manure adoption. This is because males have the required physical strength to perform most of the activities involved in

cattle manure application like pushing wheel barrows, loading and offloading cattle manure, cattle manure heaping and disposal among others. In addition, males are less busy with family work unlike females and can therefore dedicate most of their spare time to maintenance of their banana plantations. In conclusion sex of the farmer showed a positive relationship with cattle manure adoption.

Regarding farmer's source of income as shown in Table 4.4, qualitative responses indicate that farmers whose major source of income is agriculture are more likely to add cattle manure in their banana plantations in the course of increasing food security and household income from banana sales compared to those who have formal employment and businesses. The former spend much of their time and efforts in the banana field compared to their counterparts who spend much of their time on their jobs and businesses. This implies that there was a positive relationship between source of income and cattle manure adoption.

Furthermore, the results in Table 4.4 show that only households which comprised of active youth have more chances of applying cattle manure in their banana plantations compared to those which comprised of children and old people. This was the greatest impediment to most farmers as they lacked reliable and cheap labour to help in applying cattle manure in their banana plantations. Most of them would employ 1-3 external workers to assist in looking after the banana plantations. Most of the households interviewed comprised children who were schooling and would wait for them to come home for the holidays in order to carry out most of the farm work in the banana

plantations like weeding, pruning and cattle manure application. In conclusion there was a positive relationship between the number of members in the household and cattle manure adoption.

In summary all seven of the variables studied showed positive relationships to cattle manure adoption. Four of them were qualitative variables which showed positive relationships and the other three were interval variables which showed significant associations with cattle manure adoption at 0.05 alpha. The r values of the latter are shown in Table 4.6.

Responses in Table 4.4 further revealed that marital status also influences cattle manure adoption where most respondents reported that married people have the capacity and resources to manage all the activities involved in the of cattle manure adoption unlike the widows, singles and divorced families. This implies that there is a positive relationship between marital status and cattle manure adoption. The difference in abilities lies in the differences in family or household members who provide more cheap family labour for married people than other statuses.

Table 4.4: Qualitative responses from interviews regarding socio-economic characteristics and level of cattle manure

Qualitative Responses
<p>age of the farmer and cattle manure adoption <i>---children and old people do not have the ability to handle all the activities involved in cattle manure unlike the youth and young adults. This is because the youth and young adults are the ones who possess money to buy cattle manure and have physical strength, commitment and hard work to apply cattle manure unlike old people and children---</i></p>
<p>Level of education and cattle manure <i>----highly educated people can effectively apply cattle manure as they understand its benefits, methods of application and appropriate measures of the quantity of cattle manure to apply compared to the less educated-----</i></p>
<p>Marital status and cattle manure <i>----Married people have the capacity and resources to manage all the activities involved in the of cattle manure unlike the widows, singles and divorced families. The difference in abilities lies in the differences in family members/household members who provide more cheap family labour for married people than other statuses----</i></p>
<p>Sources of income and cattle manure <i>----Farmers whose major source of income is agriculture most often add cattle manure in their banana plantations in the course of increasing food security and household income from banana sales compared to those who have formal employment and businesses. They spend much of their time and efforts in the banana field compared to their counterparts who spend much of their time on their employers and businesses-----</i></p>
<p>Sex of the farmer and cattle manure <i>----Male headed households apply more cattle manure in their plantations than female headed households. This is because males have the required physical strength to perform most of the activities involved in cattle manure application like pushing wheel barrows, loading and offloading cattle manure, cattle manure heaping and disposal among others. In addition, males are less busy with family work unlike females and can therefore dedicate most of their idle time to maintenance of their banana plantations---</i></p>
<p>Household members and cattle manure <i>----Only households which comprise active youth have more chances of applying cattle manure in their banana plantations compared to those who comprised children and old people. This is the greatest impediment to most of the farmers as they lack reliable and cheap labour to help in applying cattle manure in their banana plantations. Most of us employ 1-3 external workers to assist in looking after the banana plantations-----</i></p>
<p>Monthly income and cattle manure <i>----Most of the money we earn from agriculture is again injected back into agriculture to perform tasks such as cattle manure and general maintenance of farm plantations. Cattle manure is expensive to buy and involves high transport costs if it is got from far thus a poor farmer cannot afford using it. Even if household income is important in cattle manure, dedication and commitment of the farmer is the most important factor. Some of the farmers do not have enough money but they are just committed to dedicate all out time and little money to the improvement of our banana plantations----</i></p>

Source: Primary data, 2017

4.3.2 Socio-economic characteristics of banana farmers in Mbarara

District

This section presents further specific findings related to respondent's personal information/background characteristics such as Sex, marital status, age, highest level of education of household head, monthly income, Source of income and number of household members. The specific responses are presented in Table 4.5.

As presented in table 4.5 below, quantitative results indicate that majority (52.3%) of the banana farmers who applied cattle manure in their banana plantations were in the age bracket of 36-53 years, followed by 36.8% who were above 53 years while the least 10.9% were still youth below 35 years. This implies that most banana growers in Mbarara District are young adults and youth compared to the old people. This indicates that youth and young adults are always motivated to work towards improving banana production since it is their basic income generating mechanism and assists them to get money and adequate food to look after the dependents/vulnerable people in the family especially children and aged people.

In addition, statistics in table 4.5 regarding the level of education show that majority (53.4%) of the respondents were mostly primary school leavers while 30.5% were secondary school leavers, 12.1% had studied up to tertiary level/university and lastly 4.0% did not go to school. This implies that most banana farmers in Mbarara District had attained a significant level of education which implies that they understood how to read and write including numeracy.

Results in table 4.5 further indicate that majority (70.1%) of the respondents who applied cattle manure were married at the time of data collection, 16.1% who were single while 9.2% and 4.6% were widowed and divorced/separated families respectively. This implies that most banana farmers in Mbarara District have families which ease work when it comes to applying manure in banana plantations because they are being helped by their children, wives as well as husbands.

The results in table 4.5 also indicate that majority of banana farming households in Mbarara District have between 4-6 household members as shown by 58.6%, followed by those who have 7-9 members as shown by 29.9%, then 7.5% who had more than 10 household members while the least 4.0% have fewer than 3 members.

The results in table 4.5 also indicate that 46.6% of the banana farmers in Mbarara District depend on agriculture/farming as the main source of income, 36.8% depend on both agriculture & business, 11.5% depend on both agriculture & salary and 17% depend on both employment and business, while only 1.1% of farmers depend on business/selling produce. The least percentage 0.6% were those who depend on all the three activities; employment, business and agriculture. This implies that people need to adopt innovative strategies like cattle manure application in order to improve agricultural productivity as the main source of income.

Table 4.5: socio economic characteristics of farmers(N=174)

Category	Percentage (%)
Sex of the respondent	
Male	55.7
Female	44.3
Marital status of the respondent	
Currently single	16.1
Currently married	70.1
Divorced/ separated	4.6
Widowed	9.2
Age category of the respondent	
18-35 years	10.9
36-53 years	52.3
>53 years	36.8
Education level of the respondent	
None	4.0
Primary	53.4
Secondary	30.5
Tertiary/university	12.1
Source of income of the respondent	
Agriculture/farming	46.6
Business/selling produce	1.1
Salary/employment	1.7
Agriculture & business	36.8
Agriculture & salary	11.5
Salary & business	1.7
All the above	0.6
Monthly income of the respondent	
<100,000	9.2
100,001-200,000	16.7
200,001-300,000	28.2
>300,001	46.0
Household members of the respondent	
<3 members	4.0
4-6 members	58.6
7-9 members	29.9
>10 members	7.5

Source: Primary data, 2017

It is also observed from the results in table 4.5 above that most (55.7%)of the households who participated in the study were headed by while only 44.3% of the households were headed by females. This implies that male headed households are more involved in cattle manure application than female headed

households as males are physically strong to perform most of the activities involved in cattle manure application.

4.3.3 Pearson correlations between socio-economic characteristics and cattle manure adoption

Table 4.6 shows the results regarding the farmers' socio-demographic characteristics and their relationship with the level of cattle manure in Mbarara District. All correlations with (*) are significant at 0.05 level of significance as all the Sig. (2-tailed)/p-values are less than 0.05 which is at 95% confidence level (Rumsey, 2015).

X1=Sex, X2=Marital status, X3 = age, X4=education level, X5=monthly income, X6=source of income, X7=Household members, Y=Cattle manure

Table 4.6: Pearson correlations between socio-economic characteristics and cattle manure adoption (N=174)

	X1	X2	X3	X4	X5	X6	X7	Y
Sex of farmer (X1)	1.00							
Marital Status (X2)	.130	1.00						
Age of farmer (X3)	.101	.360*	1.00					
Education level (X4)	.110	.203	.410*	1.00				
Monthly income (X5)	.211	.460*	.314*	.578*	1.00			
Source of income (X6)	.110*	.160	.217	.451*	.200*	1.00		
Household members (X7)	.150	.201*	.181	.350*	.421*	.311*	1.00	
Cattle manure adoption (Y)	.737*	.860*	.914*	.878*	.333*	.781*	.663*	1.00

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

The figures in the table indicate the Pearson correlation coefficients (r) between variables

Based on the understanding that correlation values can be used to show association between interval variables according to Amin (2005) Kothari (2004) and Frankfort-Nachmias & Nachmias (1996), Pearson r values were

computed to test the hypotheses postulated in Chapter One on page 5. Variables namely number of household members, marital status, sex of the farmer and source of income were variables that were used as dummy variables as they were not interval variables which lent themselves for computation of r values to show association. The means derived from the Likert scale ratings found in Tables 4.2, 4.9 and 4.13 were used as interval variables to compute the association through use of Pearson's r values between cattle manure adoption and the variables in Tables 4.6, 4.10 and 4.14. Therefore the r values shown in those tables give the association values at 0.05 alpha in all those cases.

The results in Table 4.6 indicate that the r value for farmers' age was 0.914* at 0.05 level of significance which was positively associated to cattle manure adoption. Therefore the alternate hypothesis was accepted.

Results show that there was positive association between level of education ($r=0.878^*$) at 0.05 level of significance and level of cattle manure adoption among banana farmers in Mbarara District. This implies that level of cattle manure adoption was partly influenced by the level of education of the farmer, therefore the alternate hypothesis was accepted.

Furthermore, the results indicate that there was positive association between marital status and level of cattle manure adoption among banana farmers in Mbarara District ($r=0.860^*$). This implies that level of cattle manure adoption is partially explained by the marital status of the farmer. The results also indicate that there was positive association between respondents' source of income ($r=0.781^*$) at 0.05 level of significance and level of cattle manure

adoption among banana farmers in Mbarara District. This implies that level of cattle manure adoption is also related to the source of income of the farmer where those who solely depend on agriculture have high adoption levels. The results indicate that there was a positive significant association between farmers' sex ($r=0.737^*$) at 0.05 level of significance and level of cattle manure adoption among banana farmers in Mbarara District, therefore the alternate hypothesis was accepted.

Results in Table 4.6 indicate that there was positive association between the number of household members ($r=0.663^*$) and level of cattle manure adoption among banana farmers in Mbarara District. This implies that cattle manure adoption is likely to increase as the number of household members also increases. Conversely, the results indicate that there was a low positive association between monthly income ($r=0.333^*$) at 0.05 level of significance and level of cattle manure utilization among banana farmers in Mbarara District. This implies that monthly income has low influence on the level of cattle manure adoption.

4.3.4 Summary of findings associating socio-economic characteristics and cattle manure adoption.

The study findings revealed that there is a significant association between socio-economic characteristics such as age, level of education, sources of income, farmers' sex, household members and monthly income with the level of cattle manure adoption among banana farmers of Mbarara District. Among all the socio economic characteristics, age ($r=0.914^*$) and level of education ($r=0.878^*$) had the highest positive significant associations with the level of cattle manure adoption.

4.4 Yields of banana arising from cattle manure use

This is the third specific objective as shown in chapter one of this thesis. Responses on this objective were categorized into three; qualitative responses from interviews and focus group discussions; quantitative responses from the questionnaire, Likert type responses in questionnaires and Pearson correlation between banana yield and cattle manure use.

4.4.1 Qualitative Responses on banana yields arising from cattle manure use

Table 4.7 presents qualitative responses from FGDs with farmers and interviews with key informants from the field relating to the sustainability of the banana plantation, appropriateness of cattle manure with various types of bananas, quantity of bunches produced, consumed and sold per month, cattle manure influence on wilting, banana sales and size of the banana bunches.

Responses in table 4.7 from interviews and focus groups indicate that the banana plantations which contained cattle manure had been productive for over 30 years. Conversely, banana plantations where cattle manure was not applied had not been productive beyond 10 years. This implies that cattle manure adoption enables banana plantations to stay productive for a long time.

Regarding the appropriateness of cattle manure to different banana plant species, most banana farmers who participated in interviews reported that cattle manure was friendly to all types (varieties) of bananas including *Kibuzi*, *Entalagaze*, *Enjagaata*, *Embiire*, *Mbwazilume* and *Mujuba* among others. However, respondents in one focus group reported that there are some unknown varieties called (NAADS) whose leaves can easily dry up and become yellow when too much cattle manure is applied.

Table 4.7: The banana yields arising from cattle manure adoption

Qualitative Responses

How does cattle manure use influence the sustainability of the banana plantation?

“----The banana plantations which contained cattle manure have lived for over 30 years compared to the banana plantations which do not have cattle manure.....I planted this plantation when I had just given my first birth to a son... he is now married with 3 children. But you can also see it is still looking good for about 30 years....”

Is cattle manure appropriate with various types of bananas?

“----Cattle manure has been friendly to all types (varieties) of bananas which included Kibuzi, Entalagaze, Enjagaata, Embiire, Mbwazilume and Mujuba among others unlike other inorganic fertilizers such as NPK. ---However, there are some unknown varieties called (NAADS) whose leaves can easily dry up and become yellow when too much cattle manure is applied----”.

How cattle manure adoption influenced the quantity of banana bunches produced?

“----Cattle manure has greatly increased the number of banana bunches produced. ----Since 2008 when I started applying cattle manure in my banana plantation, the number of banana bunches produced has almost doubled compared to when I had not yet started using cattle manure By then I was producing about 50 bunches but now I produce over 100 bananas especially in July and August at the start of a dry season”

Do you think cattle manure adoption leads to reduction in wilting especially in a dry season?

“----wilting is caused by prolonged drought and unreliable rainfall regardless of whether it contains cattle manure or not.”.....cattle manure has little impact on preventing wilting... I imagine the prolonged drought that broke up in 2000 and that of September last year 2017 that killed people and cattle in Isingiro, I don't think cattle manure could do anything to help...the whole village suffered famine and all the bananas had wilted....”

How has cattle manure adoption influenced the banana sales?

“----cattle manure increases the sales of bananas. We sell many banana bunches especially during months of peak production that is in July-August and March-April. You can find one big bunch weighing 15 kgs costs about Ugx. Shs. 15000-20000 and feeding about 10-20 people to their satisfaction. However, we are disturbed by low prices and heavy losses during peak periods as most of the banana bunches ripen and get spoilt before being sold-----”.

How has cattle manure adoption influenced the size of the banana bunches?

“----cattle manure improves the size of the banana bunches and greatly contributes to the improvement of banana yield in terms of size. ---The numbers of clusters 10 each weighing 3kgs on each bunch when you use cattle manure....” Personal observations revealed that one big bunch produced with cattle manure had more than 10 clusters with about 12 fingers on each cluster.

What other factors influence banana yield rather than cattle manure?

Banana yield depends on the plant population i.e. the number of stools and average spacing among those stools, pests and diseases. *“.....banana stools which are more congested may not necessarily yield big bunches even if cattle manure is applied. It is important to leave some big spaces for the banana plantation to breathe....”*

Source: Primary data, 2017

Responses from table 4.7 also revealed that farmers who use cattle manure recorded more yield in terms of number of bunches produced and bunch size. However, most respondents also noted significant differences in production with seasonal variations where production was higher during dry season and less during a rainy season. Most of the farmers produced and sold many bananas during months of peak production that is in July-August and March-

April with one big bunch weighing about 30kg costing about Ugx. Shs.15,000-20,000 and feeding about 10-20 people to their satisfaction. This implies that cattle manure contributes greatly to improvement of banana yield in terms of size and quantity. Findings revealed that cattle manure improves the size of the banana bunches and has greatly contributed to the improvement of banana yield in terms of size with one bunch weighing more than 30kg with more than 10 clusters each weighing as heavy as 3kgs.

However, the findings revealed that much as cattle manure improves quantity of bananas produced, it has less impact on preventing wilting. Respondents reported that wilting is caused by a certain disease, prolonged drought and unreliable rainfall regardless of whether it contains cattle manure or not.

Qualitative responses from interviews and focus group show that banana yields can also be influenced by other factors which include plant population in relation to the portion of land occupied by bananas, number of stools and average spacing among those stools.

4.4.2 Quantitative responses regarding cattle manure adoption and banana yields

According to results in table 4.8, findings indicate that majority 69.0% of the farmers had 2-5 ha of land covered by banana plantation. This shows that banana crop is a very important food crop in Mbarara District as it is the one covering the biggest part of land. In addition, the findings indicate that majority 75.3% of the farmers used between 5-10 feet (150-300 cm) as average spacing between banana stools. Regarding the plant population (number of stools) per hectare, the results show that majority 85.6% of the farmers had 300-600 stools per hectare of land.

The findings further revealed that banana plantations for majority of the farmers have been in existence for over 30 years. This implies that cattle manure has helped banana plantations to live longer. Responses indicate that over half (50%) of the respondents after applying about 10 tonnes (300 wheel barrows) of cattle manure, yielded a range of 1001-1500 bunches per annum per hectare (approximately 83-125 bunches per months per hectare), consume between 31-90 bunches per month and sell 31-90 bunches reaping about Ugx310,000-2,000,000 per month when priced at an average of Ugx5,000-10,000 per bunch for small bunches, 10001-15000 for medium bunches and Ugx15001-20000 for large bunches (30kg, 3feet/90cm length). This implies that cattle manure improves banana yield in terms of quantity and size of banana bunches produced, consumed and sold, therefore the alternate hypothesis was accepted.

Table 4.8: Factors affecting banana yields in cattle manure adoption**(N=174)**

CATEGORY	RESPONSE (%)
Portion of land occupied by bananas:	
Less than 1 hectare	3.4
1 hectare	8.0
2-5 hectares	69.0
>5 hectares	19.5
Average spacing given between banana stools:	
Less than 5 feet(150 cm)	21.8
5-10 feet(150-300 cm)	75.3
11-16 feet(330-480 cm)	2.9
Plant population (number of stools) per hectare:	
Less than 300 stools	8.6
300-600 stools	85.6
601-900 stools	5.7
Sustainability/ logivity of banana plantation:	
Above 30 years	100.0
Quantity of banana yield per hectare per annum:	
Less than 500 bunches	15.5
500-1000 bunches	28.2
1001-1500 bunches	53.4
Above 1500 bunches	5.2
Quantity of banana bunches consumed per month:	
Less than 15 bunches	5.7
15-30 bunches	43.7
31-60 bunches	48.3
Above 60 bunches	2.3
Quantity of banana bunches sold per month:	
Less than 15 bunches	16.1
15-30 bunches	27.6
31-60 bunches	44.8
Above 60 bunches	11.5
Price of small bunch of banana:	
Less than 5,000	23.0
5,000-10,000	77.0
Price of medium bunch of banana:	
5000-10000	47.7
10001-15000	52.3
Price of large bunch of banana:	
Less than 5000	2.3
10000-15000	17.2
15001-20000	55.2
Above 20000	25.3

Source: Primary Data 201

4.4.3 Likert scale responses on cattle manure adoption and banana yields

This sub section presents responses on ten (10) opinion statements regarding the yields of bananas in cattle manure use. A five point likert scale ranging from strongly disagree (1) to strongly agree (5) was provided in front of each statement and this required the respondents to show their level of agreement with each statement. In the analysis, responses on strongly agree and agree were combined to come up with single frequency and percentage. Likewise, responses on strongly disagree and disagree were also combined to come up with one frequency and percentage. The combined frequencies and percentages for agree and disagree were then presented alongside those who were not sure about the statement. Mean and standard deviation were also generated to show the average responses and the closeness/similarity between responses. A larger mean value implies that majority of the respondents agreed on the statement where that mean is shown whereas a lower mean value implies that majority of the respondents disagreed about the statement. Likewise, a lower value of standard deviation implies that responses are close to one another (almost similar) which indicate that respondents share common characteristics or opinions or experiences. The findings are presented in Table 4.9.

The study findings in table 4.9 revealed that majority (93.6%) of the respondents agreed that their banana plantation had been in existence for quite a very long time due to cattle manure use. This was also shown by a Mean of 4.54 and SD of .697. A higher mean and lower standard deviation imply that cattle manure use in banana plantation improves the sustainability of the banana plantations among banana farmers in Mbarara municipality.

Table 4.9: Banana yields in cattle manure adoption

Yield of banana arising in cattle manure use	Disagree	Not Sure	Agree	Mean	SD
	%	%	%	μ	σ
Sustainability of the banana plantation	6.3	0.0	93.6	4.54	.697
Appropriate with various banana species	5.2	2.3	92.5	4.33	.784
Production of more bunches of banana	2.3	0.0	97.7	4.48	.733
Prevention of banana wilting	46.6	23.0	56.2	2.79	1.25
Increase in quantity of bananas sold	10.9	0.0	89.1	4.14	.976
Production of bigger size of banana bunches	8.0	21.8	70.1	3.85	.944
Constant production in different seasons	31.0	0.0	69.0	3.56	1.38
Adequacy of banana bunches for consumption	4.6	0.0	95.4 ^a	4.57	.623
Average response	12.5	4.7	77.4	4.12	0.91
					8

Source: Primary data, 2017

The study findings as agreed by 92.6% of the respondents, revealed that cattle manure used is appropriate with different varieties or types of bananas such as Kibuzi, Entalagaze, Enjagaata, Embiire, Mbwazilume, Mujuba and NAADs varieties. This was also represented by a higher mean of 4.33 and lower standard deviation of .784 which shows a higher agreement level with low variations in the responses. This implies that cattle manure is widely used by banana farmers because it is favorable to all banana plant varieties.

Majority of the respondents (92.6%) who used cattle manure in their banana plantations produced more bunches of banana every month compared to other farmers who did not use cattle manure. This was also shown by a higher mean of 4.48 and lower standard deviation of .733 which indicates that most

respondents had almost similar responses. This implies that cattle manure use in banana plantations is directly related to the improvement in quantity of bananas produced per month. This is in line with the quantitative results where it was revealed that most banana farmers who used cattle manure produced about 60-90 bunches each having more than 10 clusters of 12kgs each with more than 12 fingers of about 150g each.

The study findings in table 4.9 also revealed that majority (89.1%) of the respondents agreed that their banana sales have increased steadily as a result of cattle manure. This was shown by a higher mean of 4.14 and lower standard deviation of .976. This is because cattle manure leads to production of more bunches of bananas which are big in size thus increasing the price per bunch as well as overall volume of sales. Majority of the farmers have seen their banana sales increasing to as much as Ugx310,000-2,000,000 per month when priced at an average of Ugx5,000-10,000 per bunch for small bunches, 10001-15000 for medium bunches and Ugx15001-20000 for large bunches.

Responses in table 4.9 further show that majority (94.8%) of the farmers produced far more bunches of banana after applying cattle manure than when they had not yet started using cattle manure. This also received a higher mean of 4.49 and lower standard deviation of .773. This implies that cattle manure use can boost banana yield as majority of the farmers produced 60-90 bunches per months after applying cattle manure compared to 30-60 bunches before using cattle manure.

The study also revealed that majority (70.1%) of the farmers agreed that the bunch size of bananas produced after using cattle manure was much bigger

than when they had not yet started using cattle manure. This was reported with a higher mean of 3.85 and standard deviation of .944. Likewise, responses revealed that the more the cattle manure used, the greater the size of the banana bunches as reported by 94.8% of the respondents with mean of 4.40 and standard deviation of .789. It was further revealed that one bunch produced with cattle manure had more than 10 clusters of 12kgs each with more than 12 fingers of about 150g each.

In addition, responses in Table 4.9 revealed that the more the cattle manure used, the greater the number and size of the banana bunches produced as agreed upon by 94.8% of the respondents with a higher mean of 4.40 and lower standard deviation of .789. This implies that cattle manure use increases the number of banana bunches produced where most banana farmers who used cattle manure produced between 60-90 bunches per months and 1000-1500 bunches per annum per hectare.

Lastly, responses in table 4.9 also show that most of the households that participated in the study consume at least one bunch of banana every day as a result of cattle manure use. This was agreed upon by majority (95.4%) of the respondents with a higher mean of 4.57 and standard deviation of .623. This implies that banana farmers who use cattle manure in their banana plantations produced more than 30 banana bunches per month specifically for home consumption.

4.4.4 Correlation between level of cattle manure adoption and banana yield

Tables 4.10 shows the results regarding the relationship between the level of cattle manure and banana yield among banana farmers in Mbarara District. All correlations with (*) are significant at 0.05 level of significance as all the Sig. (2-tailed)/p-values are less than 0.05 at 95% confidence level.

Table 4.10: Correlations between level of cattle manure and banana yield (N=174)

	X	Y1	Y2	Y3	X4	Y5
Cattle manure (X)	1.00					
Sustainability of banana plantation (Y1)	.728*	1.00				
Adaptation to various types of bananas (Y2)	.516*	.081	1.00			
Quantity of bunches produced (Y3)	.740*	.091	1.00	1.00		
Reduction in wilting (Y4)	.140	.103	-.110	.450*	1.00	
Bunch size (Y5)		.175	.236	.132	.055	1.00

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

The figures in the table indicate the Pearson correlation coefficients (r) between variables

Based on the understanding that correlation values can be used to show association between interval variables according to Amin (2005) Kothari (2004) and Frankfort-Nachmias & Nachmias (1996), Pearson r values were computed to test the hypotheses postulated in Chapter One on page 4. Variables namely adaptation to various types of bananas, quantity of bunches produced and reduction to wilting were variables that were used as dummy variables as they were not interval variables which lent themselves for computation of r values to show association.

Results in Table 4.10 indicate that there is a positive association between bunch size, ($r=.632^*$), sustainability/ longevity of banana plantation ($r=.728^*$), quantity of bunches produced ($r=.740^*$) and adaptability to various banana species ($r=.516^*$) with cattle manure adoption at 0.05 level of significance. This implies that as cattle manure adoption increases, the banana plantation will remain productive for a long time, produce more bunches and in large sizes and improve the productivity of various types of bananas. The reverse is true for low levels of cattle manure. Generally, the results show that cattle manure improves banana yields. However, the results show that there is no significant association between cattle manure and reduction in wilting ($r=.140$) at 0.05 alpha.

4.4.5 Summary on yields of banana arising from cattle manure adoption

The study findings found out that there is a positive significant association between cattle manure and sustainability of banana plantation ($r=.728^*$), productivity of various types of bananas ($r=.516^*$), quantity of bunches produced ($r=.740^*$) and size of the bananas ($r=.632^*$) therefore accepting the alternate hypothesis

4.5 On-farm factors affecting cattle manure among banana farmers in Mbarara District

This is the last specific objective as shown in chapter one of this report. The Table 4.11 presents responses relating to the perceived benefits of cattle manure, credit access, membership in organizations, and access to extension services; desire to improve soil fertility, access to cheap labour, distance to the road and ownership of the land.

4.5.1 Qualitative responses regarding on-farm factors influencing cattle manure adoption by banana farmers.

Table 4.11 presents the qualitative responses from interviews and focus groups regarding selected factors affecting cattle manure adoption among banana farmers.

During focus group discussions, farmers reported that perceived advantages about the benefits of cattle manure was among the motivators of its adoption. The major advantage of using cattle manure as reported by most respondents is that it can easily decompose, is cheap and has less side effects to the soil compared to industrial manures/fertilizers and other organic manures. Another benefit as reported in two focus groups is that cattle manure provides long life soil fertility unlike other industrial artificial manures which can lead to soil infertility in the long run. Results from focus groups also reveals that majority of the households had access to credit from SACCOs but not necessarily meant to facilitate cattle manure. Some of the Responses however revealed that most women were involved in women associations for saving and borrowing, others were involved in associations for sharing rice in when it reaches Christmas period but no association was formed specifically for banana production. Like women, most men were also involved in save and borrow associations where in December, most of them would buy a big cow/bull for slaughtering to facilitate the Christmas period variations. However, no one reported in interviews and focus groups to have been involved in any organization for banana production farmers borrowed money to pay school fees settle their debts or start up small projects like piggery, poultry, tilling of land for cultivation and other farm operations especially weeding, planting and harvesting (Table 4.11)

Table 4.11: Responses from interviews and focus groups relating to the socio-economic factors influencing cattle manure

Responses
<p>Do you think cattle manure would benefit your plantation before you applied it? If yes, how.</p> <p><i>"...obviously I knew the benefits of cattle manure.....last 3 years back, our neighbor applied industrial fertilizers but the soil fertility was exhausted within few years. But when he changed to cattle manure last year, now his plantation is gaining fertility and is regaining its healthy... I observed from this man's plantation that cattle manure has more benefits than other fertilizers...."</i></p>
<p>Have you ever borrowed money from financial institutions to support cattle manure</p> <p><i>".....I have just acquired a loan to till my land for cultivation of G-nuts...." "...I cannot borrow for buying cattle manure. The bank can arrest you when you have not yet noticed the benefits. I only borrow when I am in a critical situation without money and may be my child has been sent home for school fees, or admitted in a hospital, or a family member arrested....."</i></p>
<p>How often have you hosted extension workers to teach you about manure/ fertilizer usage?</p> <p><i>"....Surely I do not remember hosting any extension worker to teach me how to apply cattle manure.... What I remember is when we hosted extension workers last year to teach us how to prevent the so called Banana Xanzomonas Wilt which was destroying most of our plantations at the time...". We have often seen them visiting big people like chairperson LC5, LC3, ...".</i></p>
<p>Have you formed any farmer groups to assist in banana production and farm improvement? Which ones?</p> <p><i>"..... we have groups where we save like 2000 every Sunday and borrow when there is need, and when all the borrowed money is returned..." "...Most of the associations we belong to are for saving money in a rotational cash round form where for one month all members give their subscriptions to a particular member, and the process continues to up to the last member for the following months.... But I do not even know any group in this village that was formed specifically to discuss on banana production or soil improvement only...."</i></p>
<p>Do you think soil quality of the banana plantation influenced you to apply cattle manure? Why?</p> <p><i>".....You know well that Bananas form the staple food in Ankole region. So we are forced to add cattle manure with the hope that the soil quality would improve and enhance banana production as in the past.....". "... however, the value of the land is determined by the state of soil quality in terms of humidity, soil pH, fertility and adoption to different crops.... ..."</i></p>
<p>Do you think access to cheap labour has an influence on cattle manure? How?</p> <p><i>".....collecting cattle manure is a big and tiresome task to me... it requires a lot of labour which I cannot afford... I only wait when my three children come back for the holiday, I join them and we carry the manure that suits our capabilities and spread it to some parts of the plantation....."</i></p>
<p>Do you think the distance to the banana influence on cattle manure? How?</p> <p><i>"....It was my plan to locate a banana plantation near the kraal because I wanted to have easy access to cattle manure. even if I am one person, I can easily spread this manure to the plantation"</i></p>
<p>Do you think ownership of land has an influence on cattle manure? How?</p> <p><i>".....nowadays land is scarce....no one can allow you to plant something that will grow for years on his/her land.... They can just hire you to plant other crops like maize, beans or g-nuts because these take short time but not bananas.....I cannot add manure to the land which is not mine...."</i></p>

In addition, qualitative results from table 4.11 also revealed that most farmers have rarely hosted extension services. In one focus group, respondents explained that they were once visited by extension workers only when there was a breakup of Banana Xanthomonas Wilt (BXW) in most banana plantations. They were teaching farmers how to avoid the disease through careful farm operations.

Qualitative results further indicate that most of the banana farmers depend on family labour to do most of the farm work which is still not enough. It was also revealed during the interview and focus group discussion most of respondents were forced to apply cattle manure only to the standard of their capacities and capabilities. Respondents reported that their banana plantations were near to the road as well as to their homes. Most farmers who kept their own cattle had plantations near the kraals. Results also revealed that majority of the banana farmers owned the land on which they planted their banana plantations. The researcher revealed through focus groups that most of the banana farmers were obliged to apply cattle manure to their plantations in order to make their own land more valuable in terms of soil quality and fertility. This also enhances them to apply other crops like coffee and beans along with bananas without hampering banana yield.

4.5.2 Quantitative results on-farm factors influencing cattle manure adoption

This subsection presents the quantitative responses regarding the factors influencing cattle manure adoption by banana farmers of Mbarara District. It describes the main sources of credit, frequency of extension contact,

membership and type of organization and distance of the banana plantations to the road. These responses are shown in table 4.12

The study findings in table 4.12 revealed that cooperative societies were the major sources of credit to about 81.0% of banana farmers. Results indicate that 65.5% of the respondents had never hosted extension workers and even 22.4% who had been visited by extension workers hosted them once in every 3 months. Statistics also show that 72.4% of the respondents did not belong to any association or farmer group. Results further revealed that 77% of the respondents had their banana plantations located less than 1km from the road.

Table 4.12: Quantitative results on factors influencing cattle manure

VARIABLE	RESPONSE (%)
Main sources of credit:	
SACCO	13.2
MFI	5.7
Cooperative societies	81.0
Frequency of extension contact:	
Never	65.5
Once every 3 months	22.4
Once per month	12.1
Organization(s)in which the farmer is a member:	
Cooperative society	10.9
Farmer groups	13.8
Both cooperatives and farmer groups	2.9
None	72.4
Distance of banana plantation to the road:	
<1 km	77.0
1-2 km	23.0
Total	100.0

Source: Primary data, 2017

4.5.3 Using Likert scale responses on the relationship between socio-economic factors and level of cattle manure adoption

This sub section presents responses on eight (8) opinion statements regarding other factors that influence cattle manure where a 5-point Likert scale ranging from strongly disagree (1) to strongly agree (5) was provided to show level of agreement of the respondent with each statement. In the analysis, responses on strongly agree and agree were combined to come up with single frequency and percentage. Likewise, responses on strongly disagree and disagree were also combined to come up with one frequency and percentage. The combined frequencies and percentages for agree and disagree were then presented alongside those who are not sure about the statement. Mean and standard deviation were also used to measure the mean score and how close the scores are centered on it (Posner, 2017). The findings are presented in Table 4.13.

Table 4.13: Responses on farm factors affecting cattle manure

Socio-economic factors affecting cattle manure	Not		Agree	Mean	SD
	Disagree	Sure			
	%	%	%	Mn	df
Perceived benefits of cattle manure	21.3	0.0	78.8	3.87	0.805
Access to credit for cattle manure use	81.6	0.0	18.3	2.16	1.130
Technical support from extension officers	59.7	0.0	40.2	2.57	1.555
Membership in farmer groups	72.4	0.0	27.6	2.31	1.446
Quality of soil fertility	28.7	9.2	62.1	3.53	1.337
Access to cheap labour	55.7	0.0	44.2	2.89	1.468
Distance to the market	30.5	0.0	69.5	3.62	1.041
Ownership of land	10.3	0.0	89.7	4.17	.988
Average response	40.4	1.2	53.8	3.14	9.77

Source: Primary data, 2017

The results in table 4.13 above show that cattle manure has more benefits than other types of manures such as NPK, DAP, CAN and kitchen refuse as agreed upon by 78.8% of the respondents. This was also indicated by a Mean=3.87 and SD=0.805 which indicates a higher level of agreement between respondents. This implies that most banana farmers used cattle manure because they perceived that it would be more beneficial to the soils and banana yields than other fertilizers.

Results also show that majority(81.6%) of the farmers in Mbarara District did not access credit facilities to support cattle manure in their banana plantation(Mean=2.16, SD=1.130).A low mean and higher standard deviation implies that majority of the respondents disagreed about the statement. This implies that access to credit facilities does not influence banana farmers to apply cattle manure in their banana plantations.

The results further revealed that majority (59.7%) of the respondents had rarely hosted extension workers going to teach them about manure/ fertilizer usage (Mean=2.57, SD=1.555). This implies that extension services did not influence cattle manure among banana farmers in Mbarara district. This is because extension workers could hardly visit them and therefore could not rely on their services.

It was also revealed from table 4.13 that majority (72.4%) of the respondents totaling to did not form farmer groups to assist in banana production and farm improvement (Mean=2.31, SD=1.446). A lower mean and higher standard deviation imply a higher level of disagreement among respondents. This also implies that farmer groups did not influence banana farmers to apply cattle manure in their banana plantations.

However, it was agreed by majority (62.1%) of the respondents that the soil quality of their land was very poor to the extent that it could not yield good bananas if manure was not applied (Mean=3.53, SD=1.337). This implies that most farmers applied cattle manure to increase the soil quality of their plantations.

Furthermore, results revealed that most (55.7%) of the respondents did not have access to cheap labour that could support them in carrying and disposing cattle manure in their banana plantation (Mean=2.89, SD=1.468). The lower mean and higher standard deviation imply lower level of agreement and wider gap/variations in the responses. This implies that low of cattle manure is attributed to lack of access to cheap labour.

The study also revealed that majority (69.5%) of the respondents agreed that their banana plots were near to the road which made transportation of the cattle manure to the farm easy (Mean=3.62, SD=1.041). A mean above 3.50 implies a higher level of agreement but with wide variations in responses. However, the findings imply that distance to road had a significant influence on cattle manure among banana farmers in Mbarara district.

Lastly, results in table 4.13 shows that majority (89.7%) of the respondents reported that they used cattle manure because the land is theirs and therefore they are obliged to improve its fertility (Mean=4.17, SD=.988). A higher mean and lower standard deviation indicate a higher level of agreement and closeness of responses which implies that ownership of land one of the major factors influencing cattle manure among banana farmers in Mbarara district.

4.5.4 Correlations between on-farm factors and cattle manure adoption

Table 17 presents the inferential statistics of Pearson product moment correlations between other factors that influence cattle manure adoption (Rumsey, 2015). The correlations with the sign (*) are all significant at 0.05 level of significance as all the

Based on the understanding that correlation values can be used to show association between interval variables according to Amin (2005) Kothari(2004) and Frankfort-Nachmias & Nachmias (1996), Pearson r values were computed to test the hypotheses postulated in Chapter One on page 5. Variables namely access to advisory services, membership to farmer groups, desire to improve soil fertility, availability of cheap labour, perceived benefits of cattle manure were variables that were used as dummy variables as they were not interval variables which lent themselves for computation of r values to show association.

Responses from correlations indicate that there is a positive significant association between on farm factors such as Ownership of the land(X8) ($r=.906^*$), perceived benefits of cattle manure (X1) ($r=.770^*$), desire to improve soil fertility (X5) ($r=.799^*$) and cattle manure adoption at 0.05 alpha. This implies that farmers were able to apply cattle manure in their plantations if they owned land where the banana plantation was located, if they wanted to improve soil fertility and if they expected significant benefits/returns from cattle manure adoption. Similar responses from the correlations also indicate that there was a negative association ($r=-.585^*$) at 0.05 alpha between distance to the market and cattle manure adoption implying that the more the distance to the market of cattle manure, the lesser the level of cattle manure adoption.

Table 4.14: Correlations between selected factors and cattle manure adoption (N=174)

	X1	X2	X3	X4	X5	X6	X7	X8	Y
Perceived Benefit (X1)	1.00								
Credit Availability (X2)	.210	1.00							
Extension workers (X3)	.222	.092	1.00						
Farmer Groups (X4)	-.134	.203*	.340*	1.00					
Desire to improve soil fertility (X5)	.022	-.022	.220	-.311	1.00				
Cheap labour (X6)	.143	.120	.217	.250*	.060	1.00			
Distance to market (X7)	.124	.142	.131	.181	.124	.134	1.00		
Ownership of the land(X8)	.322	.158	.092	.123	.128	-.176	.222	1.00	
Cattle Manure adoption(Y)	.770*	.213	0.29	.026	.799*	.262	-.585*	.906*	1.00

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

The figures in the table indicate the Pearson correlation coefficients (r) between variables

On the other hand, results indicate that there was no significant association between membership in farmer groups, credit availability, extension workers and cheap labour and cattle manure adoption. This implies that most banana farmers have not formed farmer associations to assist in banana production or cattle manure adoption implying that the above factors do not influence the decisions of farmers to apply cattle manure in their banana plantations.

4.5.5 Summary on on-farm factors that influence cattle manure adoption in Mbarara District

The study findings revealed that out that there is a positive significant relationship ($r=.770^*$) between perceived benefits, ownership of the land ($r=.585^*$) and desire to improve the soil fertility($r=.799^*$) and cattle manure adoption. The study also revealed a negative significant relationship ($r=.906^*$) between distance to the market and cattle manure adoption. No significant relationship between cattle manure adoption and access to credit, membership in farmer groups, access to extension services and access to cheap labour and cattle manure adoption.

CHAPTER FIVE

DISCUSSION OF THE STUDY FINDINGS

5.0 Introduction

This section presents a discussion of the main findings. The data is discussed according to the research objectives which includes; to establish the levels of cattle manure adoption in banana production, to establish the effect of the socio-economic characteristics of banana farmers on cattle manure adoption in Mbarara District, to determine yields of banana resulting from cattle manure adoption and to identify the likely on-farm factors influencing cattle manure adoption in banana production.

5.1 Discussion of findings

5.1.1 Levels of cattle manure adoption in banana production

The study findings revealed that most of the banana farmers in Mbarara District regularly apply cattle manure in their banana plantations with almost half (50%) of the farmers applying it once a year. Farmers hold the cattle manure for about 1-3 months before use to let it decompose and excrete out all the bio gas in it before applying it to the banana plantation. The findings are in agreement with the Yamano (2008) whose findings indicate that organic fertilizer application increased in the Western region of Uganda over the years where the improved cattle adoption increased significantly. This is because most people in Western Region keep cattle which and therefore have access to some cattle manure to use in their banana plantations.

The findings further revealed that even when most farmers applied cattle manure, the quantity of cattle manure applied was not enough to cover all their plantations. More than a third of the farmers applied less than 10 tonnes of cattle manure per hectare which is approximately 300 wheel barrows. The said quantity of manure was considered too little for approximately 70% of the farmers who had banana plantations ranging from 2-5 hectares with a plant population ranging from 300-600 stools per hectare and average spacing of 5-10 feet (150-300 cm) between banana stools. This was due to limitations of high demand and low supply which put the prices of manure to as high as Ug.Shs. 80,000-120,000 per trip making most of the farmers unable to buy in large quantities. According to Nuntagij (2009), banana is a crop that requires a high quantity of fertilizer for every growth stage. This implies that inadequate manure may not yield the required quantity unless if applied along with other fertilizers. Although it was difficult to quantify the banana yield levels arising from the use of cattle manure alone, the figures from Boonnap *et al.*, (1985) show that the application of 12,500 kg/ha of animal manure and 625.0 kg/ha of lime plus 312.5 kg/ha of inorganic fertilizer (15-15-15) was necessary to yield the highest banana production level which ranged from about 2.00 – 2.96 tonnes/ha while the plot that had no application of fertilizer and lime yielded only 0.39 tonnes/ha. This means that cattle manure alone was not able to give a yield higher than 0.39 tonnes/ha. Despite a good rate (77%) of cattle manure adoption in Mbarara, farmers need be encouraged to supplement cattle manure with other affordable fertilizers to considerably increase their banana production beyond 8.2 metric tonnes of East African cultivars used

The findings revealed that due to limited cattle manure applied, more than a half of the farmers also applied other inorganic fertilizers ranging from 25-50% along with cattle manure with approximately 40% of the total farmers applying kitchen refuse/husks. This is because kitchen refuse is readily available and cheap as it is not bought but rather got from their day to day operations such as banana/cassava/potato peelings, sweeping and collection of tree leaves and cuttings. The findings disagree with Nuntagij (2009) who revealed that generally, farmers apply a chemical fertilizer as the main fertilizer for its growth, or apply the chemical together with organic fertilizers. The findings also disagree with Nakviroj *et al.*, (2002) who found that the application of chemical fertilizer (complete compound fertilizer; 3 main elements (NPK) together with animal manure contributed to high yield of banana which increased by 50.1% compared with that had only chemical fertilizer.

The study findings also revealed that most of the banana farmers applied cattle manure in a dry season than rainy season. This is due to fact that during the dry season, the manure is light and easy to apply in the banana plantation with all its nutrients so that when rain comes, the cattle manure becomes wet and releases a black/dark liquid to the soil which is later absorbed by the roots of banana suckers thus enhancing their growth. According to Grant (1981), manure application overcomes or prevents deficiencies of micronutrients, including S, Mg, Zn and B, and enhances soil available N, P and K which improves soil tilth, aids in the retention of water and nutrients, lessens wind and water erosion and promotes environmental temperature. All of these factors affect the amounts of nitrogen (N), phosphorus (P) and potassium (K) in the soil (Pennington *et al.*, 2015). This agrees with the current findings as

most farmers applied cattle manure with the main intention of improving soil fertility.

5.1.2 Effect of socio-economic characteristics in adoption of cattle manure in Mbarara District

The study findings revealed that there is a positive relationship between socio-economic characteristics and level of cattle manure adoption among banana farmers of Mbarara District. Among all the socio-economic characteristics, age had the highest positive significant relationship with the level of cattle manure adoption ($r=.914^*$) where older people between 36-53 years and above have got an upper hand of handling all the activities involved in cattle manure adoption unlike the children and youth who do not own large pieces of land. This is because the adults are the ones who possess money to buy cattle manure and have physical strength, commitment and hard work to apply cattle manure unlike young people and children who are still dependents on their parents. Age of the household head has been found to be a significant factor affecting the use of cattle manure in various studies. Kaliba *et al.* (2000) also found that older household heads were more likely to use manure in Tanzania. Khanna (2001) also found similar results in Kenya. Several other studies of manure use in Sub-Saharan Africa found age of the head of household to be significant where older farmers are expected to command more resources hence have wider investment options including use of cattle manures. It is also expected that older household heads own relatively large farms while younger household heads own smaller holdings (Green and Ng'ong'ola 1993).

The results also indicate a high positive significant relationship between level of education and cattle manure adoption among banana farmers in Mbarara

District ($r=.878^*$) where farmers with significant level of education have more knowledge on cattle manure adoption and can therefore effectively apply cattle manure as they understand its benefits, methods of application and appropriate measures of the quantity of cattle manure to apply compared to the illiterate. According to Bisanda *et al.*, (1998), education level increases the probability of adoption of recommended technologies because it increases farmers' ability to obtain process and use information of a given technology. The results are also in line with Huffman (1997) who concluded that farmers' allocation efficiencies in changing optimal manure rates were significantly related to education. Similar results by Goodwin and Schroeder (1994) observed a 3.1% rise in adoption of a new or improved agricultural technology for each additional year of formal education. Education of the household head is assumed to have an important, positive impact upon the adoption and use of new technologies. The results of study by Nkonya *et al.*, (1997) also showed education to be an important factor in the household's decision to use improved seeds.

In addition, results indicate that there is a high positive significant relationship between marital status and level of cattle manure adoption among banana farmers in Mbarara District ($r=.860^*$) where married people have the capacity and resources to manage all the activities involved in the adoption of cattle manure unlike the widows, singles and divorced families. The difference in abilities lies in the differences in family members/household members who provide more cheap family labour for married people than other statuses. The results are in agreement with Croppenstedt and Demeke (1996) and Green and Ng'ong'ola (1993) who revealed that household size or family size (which

provides family labor) is typically hypothesized to have a positive effect upon a household's decision to use new technologies where larger families would theoretically have more family members available to work on the household crops.

The results also indicate that there is a very high positive significant relationship between respondents' sources of income and level of cattle manure adoption among banana farmers in Mbarara District ($r=.781^*$) where those who solely depend on agriculture have an advantage over others to add cattle manure in their banana plantations in the course of increasing food security and household income from banana sales. They spend much of their time and efforts in the banana field compared to their counterparts who spend much of their time on their employers and businesses. The results also agree with Nkonya *et al.*, (1997) and Kaliba *et al.*, (2000) who reported that households with many members dependent on farming are expected to rely more on organic manure. According to Omamo *et al.*, (2002), this is based on the assumption that such households are more concerned with meeting food security needs before pursuing income related objectives.

The results further indicate that there is a high positive significant relationship between farmers' sex and level of cattle manure adoption among banana farmers in Mbarara District ($r=.737^*$) where males have an advantage over females. It was revealed that males headed households applied more cattle manure in their plantations than female headed households because males have the required physical strength to perform most of the activities involved in cattle manure application like pushing wheel barrows, loading and offloading cattle manure, cattle manure disposal and heaping among others. In addition,

males are less busy with family work unlike females and can therefore dedicate most of their time to maintenance of their banana plantations. Similar studies by Doss and Morris (2001) show that male headed households are associated with being in command of productive resources. Even where women play key roles in farming decisions, they may lack access to inputs, cash incomes, credit and technical information. Male and female heads of households may have different levels of access to credit or to transportation assets. They may also differ in the types of crops they grow and as a result in their preferences for using certain technologies (Doss and Morris 2001). The results however disagree with the findings by Croppenstedt and Demeke (1996) in Ethiopia which indicate that Sex of the head of household was not significant. The results also disagree with Doss and Morris (2001) who also found no significant influence of Sex upon use of modern varieties of maize or manure use among farming households in Ghana.

The results indicate that there is a moderate positive significant relationship between household members and level of cattle manure adoption among banana farmers in Mbarara District ($r=.663^*$). Findings show that households which comprise of many active youth have more chances of applying cattle manure in their banana plantations compared to those who comprise children and old people. During the period when children were at school, farmers would be forced to hire some casual workers to undertake activities related to cattle manure adoption. The results are in agreement with Feder *et al.*, (1985) who revealed that adoption of cattle manure was less attractive for those with limited family labor or those in areas with less access to hired labor.

Findings also revealed that there is a low positive association between monthly income and level of cattle manure ado among banana farmers in Mbarara District($r=.333^*$).Majority of the farmers (46%) earned a low monthly income just greater than UShs300, 001 from agriculture which was again injected into agriculture to perform tasks such as cattle manure adoption and general maintenance of the farm plantations. In addition, cattle manure is expensive to buy and involves high transport costs if it is got from far thus a poor farmer cannot afford it.

5.1.3 Perceptions of farmers about the yields of bananas resultinø from cattle manure adoption

The study findings revealed that there is a positive significant relationship ($r=.728^*$) between cattle manure adoption and the number of years a banana plantation stays productive.. In this study, majority of the farmers reported that their banana plantations where cattle manure had been applied remain productive for over 30 years compared to less than 5 years for banana plantations which did not have cattle manure. This has ensured sustainable income generation, food security and poverty eradication for banana farmers who apply cattle manure in their banana plantations. This is in agreement with Nkonya *et al.*, (2005) who revealed that cattle manure use has a positive impact on banana crop and is one of the banana yield-enhancing technologies which were promoted under the Plan for Modernization of Agriculture (PMA) to address the problem of land degradation, low agricultural productivity and poverty in Uganda.

The study also revealed a positive association between cattle manure adoption and quantity of bunches produced ($r=.740^*$). It was reported that most farmers who applied cattle manure produced more bunches (1,001-1,500 bunches) of banana every year compared to other farmers who did not use cattle manure (less than 500 bunches). In addition, findings show that most of the households that apply cattle manure consume at least one bunch of bananas every day and 31-90 bunches per month as a result of cattle manure use compared to less than 15 bunches for those who did not apply cattle manure. This implies that cattle manure adoption increases quantity of bunches produced per annum. However, most farmers noted significant differences in production with variations in season where production is higher during dry season and less during a rainy season. The findings are in agreement with Gangwar and Niranjana (1990) who reported increased banana yield from the use of inorganic fertilizers and farm yard manure in the banana plantations. The findings are also in line with Yamano (2008) who revealed that adoption of cattle manure has a positive impact for increased banana yield. The high average yield is a result of bigger sizes of bunches and more numbers of bunches produced among the households with some improved cattle. Pennington *et al.* (2015) also asserted that cattle manure use contributes to increased crop yields when properly applied to soils.

The study revealed that application of cattle manure resulted in production of bigger banana bunches. Most of the farmers produced large bunches of bananas after cattle manure application with one banana bunch weighing over 30 kgs with length of about 3 feet (90 cm). The size of the banana was also reflected from the size of the banana fingers and number of clusters on each bunch

where one big bunch produced with cattle manure has more than about 10 clusters with about 12 fingers on each cluster which can feed about 10-20 people to their satisfaction. This has also resulted to an increase in banana sales as bigger bunch cost an average of Ugx15, 001-20,000 per bunch. This implies that cattle manure contributes greatly to improvement of banana yield in terms of size. This is in agreement with Intisar *et al.* (2015) who indicated that there were significant differences in weights of bunches, number of hands, number of fingers and earlier times of flowering in gardens where cattle manure was applied.

5.1.4 On-farm factors influencing cattle manure adoption in banana production

The study findings revealed that cattle manure has more benefits than other types of manures and that there is a strong positive significant relationship ($r=.770^*$) between perceived benefits and cattle manure. Farmers are able to apply cattle manure in their plantations if they expect significant benefits/returns from the activity. Banana farmers noted that cattle manure can easily decompose, it is cheaper to buy and act as food and home for soil microorganisms and that it would provide long life soil fertility unlike other industrial /artificial fertilizers which can lead to soil infertility in the long run. This is in agreement with Pennington *et al.* (2015) who noted that manure can benefit a farm fertilization program by supplying organic matter that provides valuable nutrients to the soil including many micronutrients.

Although most of the banana farmers in Mbarara District accessed credit from SACCOs, this has not necessarily meant to facilitate cattle manure. The study

revealed no significant relationship between credit access and cattle manure. Some of the farmers borrowed money to pay school fees settle their debts or start up small projects like piggery, poultry, tilling of land for cultivation and other farm operations especially weeding, planting and harvesting but few of them borrowed funds to apply cattle manure. This is in agreement with the findings by Matiya *et al.*, (2005) in Malawi who revealed that of the total farmers, about 68% did not use credit in their operations although the physical distance between farms and credit centers such as bank, finance company and cooperatives are not more than 5-7 kilometers. According to them, this is due to the reasons that credit provided by financial institutions as well as credit cooperative groups was not so encouraging due to unfavorable policies, delay in timely transactions, higher interest rate which caused high cultivation cost and longer period of repayment.

The study also revealed that over 70% of the farmers in Mbarara District do not belong to any associations to assist in banana production or cattle manure. In addition, the study found no significant relationship between membership in organizations and cattle manure. Farmers were involved in associations for saving and borrowing, others were involved in associations for sharing rice and meat in the Christmas period while others were involved in rotational collective cash funding to members but no association was formed specifically for banana production. The findings are in agreement with Katungi (2007) who used a probit model to estimate the probability of using improved banana management practice and participation in an association. It was identified that some factors associated with levels of knowledge of innovation included

innovation proneness and of mass media influences rather than membership in associations.

The findings also revealed that there is no significant correlation between access to extension services and cattle manure. Results indicate that most of the farmers have rarely been hosted extension services with about 65.5% of the farmers having never been visited by any extension workers to teach about manure/ fertilizer usage. This implies that most of the farmers lack adequate knowledge on the methods and procedure of cattle manure. This is in agreement with Nowak (1991) who states that one reason for farmers being unable to adopt is their inadequate managerial skills which require constant learning and advisory services. This was also reported in Brazil where farmers found lack of knowledge as a barrier to adopt organic farming (Souza, 1997).

The study findings also revealed that there is a significant relationship between desire to improve the soil fertility and cattle manure as shown by a correlation coefficient of $r=.799^*$. Farmers reported that the soil quality of their land was very poor to the extent that it cannot yield good bananas if manure was not applied. This is one of the reasons why most of the banana farmers decided to apply cattle manure. This is in agreement with Wang *et al.*, (2016) who asserted that livestock manure (cattle manure) contains organic nutrients such as amino acids, nucleic acids, sugars, and vitamins, but it is also a valuable source of organic matter, nitrogen, phosphorus, potassium, and some micronutrients. According to them, there cycling of livestock manure in cropping systems is considered to enhance soil fertility and crop productivity by ameliorating soil properties. This increases the capacity for nutrient

Bekunda (1999) also revealed that livestock is herded on pastures or fed with forage from the outfields. For much of the time they are kept in kraals close to the home, which also favours the easy allocation of manure to the banana plantation (Bekunda, 1999).

The study findings also revealed that majority of the banana farmers owned the land on which they planted their banana plantations. This was also shown by a positive association ($r=.585^*$) at 0.05 alpha between ownership of the land and cattle manure adoption where farmers had a desire to improve the soil fertility of the plantations on their own land than those on hired land.

CHAPTER SIX

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

6.0 Introduction

This chapter presents summary of findings, conclusions and recommendations to the study. The study findings are arranged according to the study specific objectives which includes; to establish the levels of cattle manure adoption in banana production, To establish the effect of the socio-economic characteristics of banana farmers on cattle manure adoption in Mbarara District, to determine yields of banana resulting from adoption of cattle manure and to identify the likely factors influencing cattle manure adoption in banana production.

6.1 Summary of findings

6.1.1 Levels of cattle manure adoption in banana production

The study findings revealed that 77% of the banana farmers in Mbarara District regularly apply cattle manure in their banana plantations with almost half (50%) of the farmers applying it once a year after holding it in heaps for about 1-3 months in heaps before disposal. The findings further revealed that even when most farmers applied cattle manure, the quantity of cattle manure applied was not enough to cover all their plantations. As a result, more than a half of the farmers also applied other inorganic fertilizers ranging from 25-50% along with cattle manure with approximately 40% of the total farmers applying kitchen refuse/husks. In addition, the study findings also revealed that most of the banana farmers applied cattle manure in a dry season than rainy season in

order to ensure that cattle manure is dry and well drained to make it easy to be distributed/ spread around the banana plantation without affecting its nutrients.

6.1.2 Effect of farmers' socio-economic characteristics on cattle manure adoption in Mbarara District

The study findings revealed that there is a positive significant relationship between farmers' socio-economic characteristics and level of cattle manure adoption. Among all the socio economic characteristics, age was the most significant association ($r=.914^*$) followed by level of education ($r=.878^*$) and marital status also showed a positive relationship to cattle manure adoption. Older people between 36-53 years and above have high chances of handling all the activities involved in cattle manure unlike the children and youth who do not own large pieces of land. In addition, married people have the capacity and resources to manage all the activities involved in the of cattle manure adoption unlike the widows, singles and divorced families. Similarly, farmers with significant level of education have more knowledge on cattle manure and can therefore effectively apply cattle manure as they understand its benefits, methods of application and appropriate measures of the quantity of cattle manure to apply compared to the illiterate.

6.1.3 Yields of banana resulting from cattle manure adoption

The study findings indicate a positive significant association ($r=.728^*$) between cattle manure adoption and ability of the banana plantation to remain productive for a long time. Banana plantations where cattle manure has been applied had been productive for over 30 years compared to less than 5 years for banana plantations which did not have cattle manure. In addition, the study

revealed a positive association between cattle manure and yield in kg per ha⁻¹ produced ($r=.740^*$) and bunch size in kg ($r=.632^*$) and with yield in kg ha⁻¹ ($r=.740^*$). Farmers who applied cattle manure produced 1,001-1,500 bunches (8.5 metric tonnes ha⁻¹ per annum of bananas every year compared to less than 500 bunches for those who did not adopt cattle manure.

Results further showed that most of the households who applied cattle manure produced bigger banana bunches weighing over 30 kgs with length of about 3 feet (90 cm) per bunch than those who did not use cattle manure.

6.1.4 On-farm factors that influenced cattle manure adoption in banana production

The study findings that there is a positive significant association ($r=.770^*$) between perceived benefits of cattle manure and its adoption. Farmers applied cattle manure in their plantations when they expected significant benefits/returns from the activity. The study findings also revealed that although most of the banana farmers in Mbarara District accessed credit from SACCOs, this has not necessarily meant to facilitate cattle manure adoption. The study revealed no significant relationship between credit access and cattle manure adoption. In addition, the study revealed no significant relationship between membership in organizations and cattle manure as over 70% of the farmers in Mbarara District did not belong to any associations to assist in banana production or cattle manure adoption

The findings further revealed no significant relationship between access to extension services and access to cheap labour with cattle manure adoption. The study findings also revealed that there is a positive significant relationship

between desire to improve the soil fertility and cattle manure. The study findings also revealed a negative significant relationship ($r=.906^*$) between distance to the road and cattle manure adoption. Findings show that majority of the farmers had their banana plots near to the road which implies about 77% of the farmers had their banana plantations located less than 1km from the road which made transportation of the cattle manure to the farm easy. Lastly findings also revealed that there is a positive significant association ($r=.585^*$, $P=0.05$) between ownership of the land and cattle manure adoption where farmers have a desire to improve the soil fertility of the plantations on their own land than those on hired land.

6.2 Conclusions of the study

Based on the findings, the study came up with the following conclusions;

- i. The study revealed that 77% of the banana farmers adopted cattle manure in Mbarara District and regularly applied it in their banana plantations especially in dry seasons with more than a third of them applying less than 10 tonnes of cattle manure per hectare (about 300 wheel barrows) at least once a year after holding it in heaps for about 1-3 months before use. This manure was bought at high prices ranging from US\$ 80000-120000 per trip making most of the farmers unable to buy in large quantities. As a result, more than half (50%) of the farmers also applied other inorganic fertilizers ranging from 25-50% along with cattle manure with approximately 40% of the total farmers applying kitchen refuse/husks as this was readily available from their day to day operations such as banana/cassava/potato peelings, sweeping and collection of tree leaves and cuttings.

- ii. Farmers' socioeconomic characteristics such as age of the farmer, level of education, marital status, sex of the farmer, income level and household number of members (labour) have a positive significant relationship with the level of cattle manure adoption among banana farmers in Mbarara District. The researcher therefore rejects the null hypothesis (H_{02}) which states that there is no significant relationship or association between the socio-economic characteristics of the banana farmers and their adoption of cattle manure and accepts the alternative.

- iii. Cattle manure has a positive association thus impact on improvement of banana yield in terms of sustainability, quantity and size of the banana bunches which also increase the sales of bananas. The researcher therefore rejects the null hypothesis (H_{01}) which states that there is no significant effect of cattle manure on banana production and accepts the alternative. Likewise, the researcher rejects the null hypothesis (H_{03}) which states that there is no significant relationship between cattle manure and banana productivity. However, the researcher recognizes the influence of on-farm factors that improve banana yield along with cattle manure adoption. Such factors include portion of land occupied by bananas, recommended practices such as number of stools in the plantation and average spacing between the bananas.

- iv. There are on-farm factors that influence cattle manure adoption which included; perceived benefits of using cattle manure, desire to improve the soil fertility of the banana plantation, ownership of the land on which the

banana plantation is located and distance of the banana plantation to the road. The study revealed a positive significant relationship with the first three factors and a negative significant relationship with the 4th factor distance to the road of the plantation. However, the study revealed no significant relationship between access to credit, membership in organizations, access to extension services and access to cheap labour with cattle manure adoption. The researcher therefore accepts the null hypothesis (H_{04}) which states favourable on-farm factors and availability of advisory services have no significant influence on cattle manure adoption in banana production and rejects the alternative.

6.3 Recommendations to the study

The study came up with the following recommendations;

- i. There is need for collective efforts with banana farmers, to come from NGOs, community leaders and government in general in order to increase the quantity of the cattle manure adopted for increased banana production in Mbarara District and spread to the rest of Uganda where cattle manure can be found usable.
- ii. Government of Uganda in collaboration with public and private sector organizations such as Ministry of Agriculture, Animal, Industry and Fisheries (MAAIF), National Agricultural Research Systems (NARS), The National Agricultural Advisory Services (NAADS), National Agricultural Research Organization (NARO), Uganda National Farmers Federation (UNFFE) among others need to prioritize cattle manure adoption through policy and technical support in appropriate use of manure and affordable fertilizers for reinforcement. This can be done in collaboration

with community leaders, religious leaders and agricultural extension officers who interact directly with banana farmers.

- iii. There is need for government to promote banana production through agricultural awareness programs with some technical services which are advisory and scientific about cattle manure adoption to improve soil fertility which can be disseminated to farmers through provision of home to home extension services, seminars and workshops as well on social media and mass media platforms that are commonly used by local/rural people like radios, televisions, church services and posters/billboards translated into a commonly understood local languages.
- iv. There is need for provision of affordable agro inputs, tools and equipment that are approved by the quality enforcing agencies to enhance farm work operations in banana plantations and provision of cheap financial support to farmers to facilitate their operational costs and agricultural related capital expenditure under minimum supervision. This is because most banana farmers do not have ready access to financial serves to support them in buying the required amount of cattle manure to apply in their plantations.
- v. There is need for banana farmers to form and strengthen farmer groups in order to discuss factors affecting their banana production and to assist in raising funds in form of savings and loans to finance operations in banana production especially buying cattle manure and improved inputs and equipment. Groups can help them in putting their case to government and other stakeholders whenever they need help on agricultural knowledge.

- vi. There is need for banana farmers to keep livestock so as to enable them get cheap and reliable supply of cattle manure to apply in their banana plantations. This can be got from cattle kraals, pens, grazing places and other places where livestock animals dispose their dung. However, banana farmers are also recommended to apply in absence of adequate cattle manure, other affordable fertilisers appropriate for banana production including use of kitchen refuse and other biodegradable materials such as mulch that can improve humus or soil fertility. This will also save on the amount of money that can be used to buy cattle manure from external sources.
- vii. There is need for banana farmers to apply cattle manure in a dry season and hold cattle manure in heaps for about 1-3 months before use. This gives cattle manure time to cool and excrete bio gas emissions which scorch banana plant root causing wilting.
- viii. There is need for more experimental studies to establish the yields that accrue from cattle manure use alone/or in combination with industrial fertilizers.
- ix. There is need for further research on the influence of industrial fertilizers such as NPK fertilizers on banana production and other factors that influence banana productivity in Uganda additional to cattle manure use. Factors such as perceived benefits of using cattle manure, desire to improve the soil fertility of the banana plantation, ownership of the land on which the banana plantation is located and distance of the banana plantation to the road should also be researched about.

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APPENDICES

Appendix I: Questionnaire

Enumerator: Before starting the interview, inform the respondent the essence of this study. Read the consent form and ask them to sign on the TWO consent forms after accepting to participate. Leave one with the respondent and keep one with you.

Name _____ of _____ the
enumerator _____

Name _____ of _____ Household _____ head

Date of interview _____

A: FARMER SOCIAL-ECONOMIC CHARACTERISTICS

1. Sex

i) Male ii) Female

2. Marital status

i) Currently Single ii) Currently married
iii) Divorced/Separated iv) Widowed (My husband/wife died)

3. Age in years of household head

i) <18 years ii) 18-35 years
iii) 36-53 years iv) ≥53 years

4. Highest level of education of household head

i) None ii) Primary
iii) Secondary iv) Tertiary/University

5. Monthly Income

i) ≤100,000 ii) 100,001-200,000
iii) 200,001-300,000 iv) ≥300,001

6. Your sources of income

i) Agriculture/Farming ii) Business/selling produce

- iii) Salary/Employment iv) Agriculture and business
 v) Agriculture and salary vi) Salary and business
 vii) All the above

7. Household members (you inclusive)

- i) ≤3 members ii) 4-6 members
 iii) 7-9 members iv) ≥10 members

C: LEVEL OF USE OF CATTLE MANURE

8. Indicate your level of agreement with the following statements regarding cattle manure in your banana plantation using a 5-point scale as follows:

5=Strongly agree, 4=Agree, 3=Not sure, 2=Disagree, 1=Strongly disagree

Statement	SA(5)	A(4)	NS(3)	D(2)	SD(1)
I regularly apply cattle manure in my banana plantation per year					
The quantity of cattle manure applied is enough for my plantation					
I also apply other inorganic fertilizers in my banana plantation along with cattle manure					
The cattle manure I use in my banana plantation is got from my own cattle					
I apply cattle manure by heaping it in one place after which it is dispersed of allover the banana plantation					
Cattle manure is very beneficial to my banana plantation					
Cattle manure is applied in the banana plantation in a dry season than rainy season					
I apply cattle manure only after removing all the weeds					

9. Amount of cattle manure used per hectare

- i) Less than 10 ton (<300 wheel barrows)
- ii) 10-20 tonnes (300-600 wheel barrows)
- iii) 21-30tonnes (601-900 wheel barrows)
- iv) Above 30 tonnes (>900 wheel barrows)

10. Frequency of cattle manure application

- i) Once a year
- ii) Twice a year
- iii) 3 times a year
- iv) Once in two years
- v) Once in 5 years
- vi) Once in 3 years

11. Duration of cattle manure heaping before disposal

- i) Less than 7 days
- ii) 1-2 weeks
- iii) 2-3 weeks
- iv) 3-4 weeks
- v) 1-3 months
- vi) > 3 months

12. Type of other inorganic fertilizers applied along with cattle manure

- i) None
- ii) DAP
- iii) NPK
- iv) CAN
- v) Any other (specify) _____

13. Percentage of other inorganic fertilizers applied along with cattle manure

- i) Less than 25%
- ii) 25-50%
- iii) 51-70%
- iv) 71-100%

C: YIELDS OF BANANA RESULTING FROM CATTLE MANURE USE

14. Portion of land occupied by bananas

- i) Less than 1 hectare
- ii) 1 hectare
- iii) 2-5 hectares
- iv) > 5 hectares

- 15. Average spacing given between banana stools**
- i) Less than 5 feet ii) 5-10 feet
- iii) 11-16 feet iv) Above 16 feet

- 16. Plant population (Number of stools) per hectare**
- i) Less than 300 stools ii) 300-600 stools
- iii) 601-900 stools iv) Above 900 stools

- 17. Sustainability of Banana plantation**
- i) Less than 2 years ii) 2-4 years
- iii) 5-7 years iv) Above 7 years

- 17. Quantity of Banana bunches consumed per month**
- i) Less than 15 bunches ii) 15-30 bunches
- iii) 31-60 bunches iv) Above 60 bunches

- 18. Quantity of Banana bunches sold per month**
- i) Less than 15 bunches ii) 15-30 bunches
- iii) 31-60 bunches iv) Above 60 bunches

19. Price and size of banana bunches

Price	Small	Medium	Large
Less than 5000	<input type="text"/>	<input type="text"/>	<input type="text"/>
5000-10000	<input type="text"/>	<input type="text"/>	<input type="text"/>
10001-15000	<input type="text"/>	<input type="text"/>	<input type="text"/>
15001-20,000	<input type="text"/>	<input type="text"/>	<input type="text"/>
Above 20,000	<input type="text"/>	<input type="text"/>	<input type="text"/>

20. Indicate your level of agreement with the following statements regarding the yields of banana plantation arising from cattle manure use basing on the scale below;

5=Strongly agree, 4=Agree, 3=Not sure, 2=Disagree, 1=Strongly disagree

Statement	SA(5)	A(4)	NS(3)	D(2)	SD(1)
My banana production has been in existence for quite/very long time due to cattle manure use					
The cattle manure used is appropriate with every type of bananas in my banana plantation					
I produce more bunches of banana every months compared to other farmers who do not use cattle manure					
Cattle manure use makes bananas less prone to wilting even in the dry season					
My banana sales have increased steadily as a result of cattle manure					
I produce far more bunches of banana currently than when I had not yet started using cattle manure					
The bunch size of bananas produced after using cattle manure is much bigger than when using inorganic manures					
I produce more bunches of banana in a dry season than in a rainy season					
The more the cattle manure dispersed, the greater the number and size of the banana bunches					
My household eats at least one bunch of banana every day as a result of cattle manure use					

D: FACTORS AFFECTING CATTLE MANURE IN BANANA PRODUCTION

21. Indicate your level of agreement with the following statements regarding the yields of banana plantation arising from cattle manure use basing on the scale below;

5=Strongly agree, 4=Agree, 3=Not sure, 2=Disagree, 1=Strongly disagree

Statement	SA(5)	A(4)	NS(3)	D(2)	SD(1)
Cattle manure has more benefits than other types of manures					
I sometimes borrow money from financial institutions to support cattle manure in my banana plantation					
We have often hosted extension workers coming to teach us about manure/fertilizer usage					
We have formed farmer groups to assist in banana production and farm improvement					
The soil quality of my land is very poor to the extent that it cannot yield good bananas if manure is not applied					
I have access to cheap labour that can support me in carrying and disposing cattle manure in my banana plantation					
My banana plots are near to the road which makes transportation of cattle manure to the farm easy					
I use cattle manure because the land is mine and therefore I am obliged to improve its fertility.					

22. Main sources of Credit? (Multiple responses allowed)

- i). Commercial Bank ii) SACCO
iii) MFI iv) Money Lender
v) Others (Please specify) _____

23. Frequency of extension contact

- i) Never ii) Once every 3 months
iii) Once per month iv) 2 times per month
v) 3 times per month vi) 5 times per month

24. Type of organization (s) in which the farmer is a member

- i) Cooperative Society ii) Farmer Group
iii) Both cooperative society and farmer group

25. Distance of banana plantation to the road

- i) < 1 km ii) 1-2 km
iii) 3-4km iv) > 4km

Thank you for your participation

Appendix II: Interview Guide

Enumerator: Before starting the interview, inform the respondent the essence of this study. Read the consent form and ask them to sign on the TWO consent forms after accepting to participate. Leave one with the respondent and keep one with you.

1. Do you apply cattle manure in your plantation
2. What is the quantity of cattle manure applied in your banana plantations
3. Do you apply other inorganic fertilizers along with cattle manure? If yes, what are they?
4. Where do you get the cattle manure you use in your plantation
5. Explain the procedure you follow to before applying cattle manure
6. In which season do you apply cattle manure
7. Is there any need for removing weeds before cattle manure?
8. Do you think social economic characteristics influence cattle manure? How?
9. How has cattle manure influenced the sustainability of the banana plantation?
10. Is cattle manure appropriate with various types of bananas?
11. How cattle manure influenced the quantity of has bunches produced?
12. Do you think cattle manure leads to reduction in wilting especially in a dry season?
13. How has cattle manure influenced the banana sales?
14. How has cattle manure influenced the size of the banana bunches?
15. What other factors influence banana yield rather than cattle manure?
16. Did you think cattle manure would benefit your plantation before you applied it? If yes, how
17. Have you ever borrowed money from financial institutions to support cattle manure in your banana plantation? From where?
18. Have you often hosted extension workers coming to teach you about manure/ fertilizer usage? How often?
19. Have you formed any farmer groups to assist in banana production and farm improvement? Which ones?
20. Do you think soil quality of your banana plantation influenced you to apply cattle manure? Why?
21. Do you think access to cheap labour has an influence on cattle manure? How?
22. Do you think ownership of land has an influence on cattle manure? How?
23. Do you think ownership of land has an influence on cattle manure? How?
24. What are the banana yields per hectare of your banana plantation?

Appendix III: Focus Group Discussion Guide

1. Extent of use of cattle manure for banana production.
2. Household characteristics that influence adoption and use of cattle manure for banana production.
3. Economic factors influencing adoption and use of cattle manure for banana production.
4. Influence of advisory services on the adoption and use of cattle manure for banana production.
5. Contribution of cattle manure use on banana production.
6. Strategies for improved adoption and use of cattle manure for banana production.
7. What are the banana yields per hectare from your banana plantation

Appendix IV: Observation Guide

1. Size of the banana plantation
2. Distance of the plantation from the nearby homestead
3. Number of cows reared by the farmers
4. Processes of collecting and managing droppings from cows for manure
5. Distribution of road networks in the area
6. Terrain of the area
7. Signs or remnants of a farmer having used cattle manure
8. Heaps of manure ready for distribution to the whole garden
9. Colour of the soil
10. Size of the bunches, clusters, number of fingers per cluster in the areas where manure has been applied
11. Banana yields per hectare