DETERMINANTS OF CHANGE IN ANIMAL MANURE USE LEVEL IN BANANA PRODUCTION IN UGANDA

SARAH KAGOYA
BSc. Agric (Hons) MUK

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2011
DECLARATION

I, Kagoya Sarah, hereby declare that, to the best of my knowledge and understanding the originality of the findings in this thesis is my work, and has never been presented in Makerere University or any other University for the award of a degree.

Kagoya Sarah
Signature………………………………… Date……………………………
CANDIDATE

SUPERVISORS:
Dr.Dick Sserunkuuma
Signature………………………………… Date……………………………

Professor. Benard Bashaasha
Signature………………………………… Date……………………………

Department of Agricultural Economics and Agribusiness, Makerere University, Uganda
DEDICATION

To my Aunt Teddy, my grandmother Anna Maria Nansubuga, my mother Rebecca, my two daughters, Danielle and Darlene and my husband Daniel
### LIST OF ABBREVIATIONS/ACRONYMS

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
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<tbody>
<tr>
<td>PMA</td>
<td>Plan for Modernization of Agriculture</td>
</tr>
<tr>
<td>PEAP</td>
<td>Poverty Eradication Action Plan</td>
</tr>
<tr>
<td>IFPRI</td>
<td>International Food Policy Research Institute</td>
</tr>
<tr>
<td>REPEAT</td>
<td>Research on Poverty, Environment and Agricultural Technologies</td>
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<tr>
<td>FASID</td>
<td>Foundation for Advanced Studies in International Development</td>
</tr>
<tr>
<td>FA</td>
<td>Faculty of Agriculture</td>
</tr>
<tr>
<td>NGOs</td>
<td>Non Government Organizations</td>
</tr>
<tr>
<td>MFPED</td>
<td>Ministry of Finance, Planning and Economic Development</td>
</tr>
<tr>
<td>LDCs</td>
<td>Low Developed Countries</td>
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<tr>
<td>CEC</td>
<td>Cation Exchange Capacity</td>
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<tr>
<td>CWD</td>
<td>Coffee Wilt Disease</td>
</tr>
<tr>
<td>SWC</td>
<td>Soil Water Conservation</td>
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<tr>
<td>NAADS</td>
<td>National Agricultural Advisory Services</td>
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<tr>
<td>CIMMYT</td>
<td>International Maize and wheat Improvement Centre</td>
</tr>
<tr>
<td>FAPU</td>
<td>Food and Agricultural Policies, Uganda</td>
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Lastly but not least, my highest gratitude goes to the almighty God for the gift of life and good health he gave me throughout this study.
ABSTRACT

Banana yield in Uganda has declined during the past years 20 years due to declining soil fertility, reduced labor availability and increased pests and diseases. Despite the increase in the acreage, under banana production, there are no indications of improvement in the production of this staple food and major income earner. This decline in yield has affected household income and threatened people’s livelihood. To reverse this trend, the fertilizer option can be adopted, but inorganic fertilizers are expensive. Hence, organic fertilizers like animal manure, which is readily available on the farm, can be a good alternative. The level of use of animal manure on bananas and its determinants is not well known. This study aims to fill this knowledge gap to determine the factors that influence manure use and determine the effect of manure use on banana production. The study used household data gathered by the International Food Policy Research Institute (IFPRI) and the Faculty of Agriculture (FA), Makerere University between November 2000 – July 2001 and by the Foundation for Advanced Studies on International Development (FASID) and FA in August-December 2003. The data was gathered from households that grew bananas (N=177) in the study period (2000-2003). The results show that of the 177 farmers, 17% increased their manure use, 21% decreased while 62% did not change. Difference of mean tests were performed to determine differences among households in the three categories (increased, decreased and constant). The probit model was used to identify and quantify the relationship among factors underlying change in manure use. Increase in cattle holding, contact with extension agents and change in number of family members providing labour positively & significantly influence animal manure use level. Multiple Linear Regression Analysis was used to determine the effect of change in manure use on the value of bananas produced. The results show that the value of bananas produced significantly increases with age and education level of the household head, farm size and family labor endowment.
CHAPTER ONE
INTRODUCTION

1.1 Background

Uganda is one of the largest producer and consumers of bananas in the world (Sserunkuuma et al., 1992); contributing about 44% of the total amount of bananas produced in Eastern Africa. Banana production fell from contributing 18% of total food production and 7% of total cash production in the 1970s to only 4% and 2% respectively in 1990s (Bagamba et al., 2000). Per capita consumption of bananas in the Great Lakes region is between 220-460 kg annually which is the highest in the world. Ugandan banana farmers rank it as the most important source of food and third most important source of cash (Rubaihayo, 1991).

Bananas are the principle staple crop and also an income source in the Lake Victoria crescent region of Uganda. In Eastern Africa in general and Uganda in particular, four major types of bananas are grown; the cooking, dessert, beer and roasting bananas. The cooking type is the most grown type by Ugandan farmers, occupying about 75% of their banana plantations (Bagamba et al., 2000). There is need to enhance banana productivity so that it’s continuously harvested and soil fertility not depleted.

Productivity enhancing technologies developed, released or promoted by the national agricultural research system during the past century have not been fully adopted (Feder et al., 1985 and Nuhu 2002) and the yield for major crops like bananas stagnated or declined since the 1990s (MAAIF, 2008). The available productivity enhancing technologies include those for land management e.g Organic/Inorganic fertilizer
application, green manure usage, soil and water conservation techniques to prevent erosion/Leaching, and the crop related technologies like pests and disease control methods and usage improved seed. The Government of Uganda (GoU) has over the past decade committed to supporting the generation, dissemination and adoption of productivity-enhancing and poverty-reducing technologies under the Plan for Modernization of Agriculture, (PMA) (MAAIF, 2000). Of particular interest to this study are land management technologies for banana-based farming systems that use animal manure available on the farm to provide the required soil nutrients and replace those lost through crop harvesting and other means. This interest is rooted in two important facts:

1) Due to the continuing concern over the movement of inorganic fertilizer nutrients to ground and surface waters with possible eutrophication and public health consequences, there is a growing interest in technologies or systems of agriculture that are less vulnerable to energy price fluctuations and have smaller adverse environmental impact, (Klepper, 1977).

2) Due to the high cost and uncertain accessibility to mineral fertilizers in the Sub-Saharan region, there is a need to identify fertility management strategies based on available organic resources that provide much of the nutrients (Bekunda and Woomer 1996).

Ideally, bananas require deep, well-drained loam soils with high content of humus (Zake et al., 1997). According to Bekunda et al 2003, bananas take up considerable amounts of nutrients, some of which are removed in the harvested fruit and must be replaced if production is to be maintained. Organic manures are the most common fertility amendments used by farmers, and
priority is given to bananas. Evidence shows that when organic matter management is separated into general categories of animal manure and compost, there are significant differences in impact measured by average bunch weights, with animal manure giving the largest bunch weights of approximately 20.3 kg per bunch.

In the past, cattle manure used to be the most important source of nutrients, but it has of late become scarce. As an immediate strategy, farmers have resorted to the utilization of small ruminants’ livestock manure and processing of composts from household wastes (Bekunda and Woomer, 1996). However, community and household surveys conducted by the International Food Policy Research Institute (IFPRI) and Faculty of Agriculture (FA) in 2000 indicate limited use of organic practices such as manuring and composting as well as other soil conservation methods in Uganda (Pender, 2001).

1.2 Problem Statement

The yield of bananas in Uganda has stagnated or declined over the past 20 years due to declining soil fertility, reduced labor availability and increasing pests and disease pressure while area and production have remained constant (Gold et al., 1999). The declining soil fertility is due to continuous cropping without appropriate soil management, leading to deterioration in soil physical, chemical and biological properties; lower crop yields and worsening poverty in rural agricultural areas (Mwajiuba and Akinsami, 2002).

Since 2000, government and non-government programs exemplified by the PMA have intervened into the agricultural sector to promote the use of yield-enhancing agricultural
technologies in order to increase agricultural productivity and reduce poverty and land degradation. The NAADS Secretariat established partnerships to enhance accessibility to technologies for improved productivity. The purpose is to create farmer awareness of the technologies in collaboration with the private sector to generate demand for and ensure sustained farmer access to the technologies (MAAIF, 2007). The effect of these interventions on the use of technologies that are readily available on the farm (for example, animal manure) and on crop yield is not well known, hence the need for this study to fill this knowledge gap and to provide a basis for informing policy makers on how to effectively increase the use of such technologies for enhancing agricultural productivity.

1.3 Objectives

1.3.1 General objective

The main objective of this study is to determine the adoption of animal manure in banana production in Uganda between 2000 and 2003 and the influencing factors, as well as the impact of this change on banana yield.

1.3.2 Specific objectives

1. To determine the level of use of animal manure in banana production and how this has changed between 2000 and 2003.

2. To identify and quantify the relationship among factors that caused the change in the level of animal manure use between 2000 and 2003.

3. To determine the effect of change in manure use on the value of bananas produced ceteris paribus.
1.4 Hypotheses

1. The level of use of animal manure in banana production increased significantly between 2000 and 2003.

2. Change in the level of use of animal manure is influenced by changes in household-level characteristics including number of household members who provide family labor, farm size, cost of hired labor, farmer contact with extension agents, agricultural training, cattle ownership, chicken ownership, off-farm income and access to credit.

3. Increased manure use significantly increases the value of bananas produced.

1.5 Justification of the Study

Increasing land degradation (soil erosion and nutrient mining) has been recognized as a major factor contributing to the low agricultural productivity and poverty in Uganda. The decline in banana yield in the past two decades needs to be reversed because bananas constitute a major staple and income source for farmers. This reversal can be achieved through the use of fertilizers, but because inorganic fertilizers are expensive and can be dangerous to the environment if not properly used, then animal manure is a key alternative. Manure use has been shown to have a positive impact on crop yield (Nkonya et al, 2005) and is one of the yield-enhancing technologies being promoted under the PMA to address the problem of land degradation, low agricultural productivity and poverty in Uganda. Since the PMA was launched around 2000, and because this study is designed to assess the level of use of organic manure on bananas and how it changed between 2000 and 2003, it offers an opportunity to measure the impact of interventions under PMA and other programs in promoting the use of improved agricultural technologies. The
findings will also serve as a basis for advising policy makers on how to effectively enhance the use of manure and other productivity – enhancing technologies as envisaged in the PMA.
CHAPTER TWO

LITERATURE REVIEW

2.1 Technology Adoption in Agriculture

Adoption of a new technology at the household level has been defined as the degree of use of a new technology in long-run equilibrium when the farmer has most of the information about the new technology and it’s potential. This definition implies that adoption has two separate components: a time component indicating length of time the technology has been used, and an intensity of use component indicating its appropriateness. Selection of appropriate technology should be on the basis that it is initially sustainable and can be expected to continue for several years. Most adopted technologies are those that provide short term benefits at little cost and create enthusiasm among the farmers. A new agricultural technology may reflect high yield, low cost, or other desirable traits ((Feder et al. 1985).

Two approaches are common in agricultural technology adoption literature. The first approach emphasizes the adoption of the whole package while the second one stresses step-wise or sequential adoption of components of a package. Technical scientists often recommend the former approach while field practitioners specifically farming system and participatory research groups advance the latter. There is a great tendency in agricultural extension programs of developing countries to promote technologies as a package and farmers are expected to adopt the whole package. Opponents of the whole package approach strongly argue that farmers do not adopt technologies as a package, but rather adopt a single component or a few suitable technologies (Byerlee and Hesse de Polanco, 1986). Several adoption studies reviewed by Nagy and Sanders (1990) and Leather and Smale (1991) concluded that farmers choose to adopt technology components sequentially. The reasons often given for sequential adoption of a
package of recommendations are profitability, riskiness, uncertainty, lumpiness of investment and institutional constraints. Their study concluded that sequential adoption of components of technological package is a rational choice for farmers with limited cash. As cash is accumulated from previous adoption of a component of a package, farmers will add another component based on the relative advantage and its compatibility under their condition. This process will continue until the whole package is fully adopted.

Adoption of technological innovation in agriculture has attracted considerable attention among development economists. This is because the majority of the population in less developed countries (LDCs) depends on agricultural production and new technologies seem to offer an opportunity to increase production, value and income substantially. Therefore, there is a need for concerted effort to be directed towards enhancing adoption of proven agricultural technologies that lead to improved production and income (Feder et al., 1985). Such efforts need to be backed up by comprehensive knowledge of factors that affect technology use by farmers.

2.2 Empirical studies on determinants of adoption of new agricultural technologies

Studies on utilization of composts and Farm Yard Manure (FYM) for crop production in East Africa have been reported since the 1930s (Beckley, 1934; Beckley, 1937; Mehlich, 1965). 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 (International Maize and wheat Improvement Centre, CIMMYT, 1988; Adesina and Zinnah 1992). It shows that various farm, farmer associated attributes, farming objective and technology specific attributes are important determinants of technology use. It is expected that changes in these attributes over time will cause changes in technology use.

Recently, there has been increased interest in analyzing the determinants of farmers’ choice and level of use of agricultural technologies. Empirical research identifies household size, farm size, education, farming experience, access to markets, agricultural extension services, agricultural training, credit and input services, use of hired labor, age, gender, farming systems, household endowment of assets e.g cattle, off farm income and others as key factors affecting the adoption of new agricultural technologies (Bisanda et al. 1998; Shapiro and Brorsen 1988; Colman and Young 1989; CIMMYT 1993; Doss and Morris 2001; Huffman 1997, Sserunkuuma 2005, Kataike 2003, Mwanjuba 2002, Ogwal 2003 and Kongai 2005).

The adoption decision also involves the choice of how much resource (i.e. land) to be allocated to the new technology if technology is not divisible. However, if the technology is divisible, the decision process involves area allocations as well as level of use or rate of application (Feder et al., 1985).

A distinction has to be made between technologies that are divisible and that are not divisible with regard to the measurement of intensity of adoption. The intensity of adoption of divisible agricultural technologies can be measured at the individual level in a given period of time by the share of farm area under the new technology or quantity of input used per hectare in relation to research recommendations (Feder et al., 1985). On the other hand, the extent of adoption of non-
divisible agricultural technologies such as tractors and combined harvesters at the farm level at a
given period of time is dichotomous (use or not use) and the aggregate measure becomes
continuous.

Bisanda et al. (1998) observed that education level increased the probability of adoption of
recommended technologies because it increased farmers’ ability to obtain process and use
information of a given technology. Huffman (1997) concluded that farmers’ allocative
efficiencies in changing optimal fertilizer rates were significantly related to education. The rate
of adoption of reduced tillage production techniques rose with increased education. Goodwim
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 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). Proximity to
neighbors utilizing a new technology may increase use by other households by increasing the
non-user’s understanding of the technology, and therefore reducing the uncertainty of the
technology (Ghadim and Pannell 1999).

Different rates of fertilizer and other technology use are typically observed between male and
female heads of household (Doss and Morris 2001). The gender of the head of household may
influence the use of a new technology for various reasons. 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.
Often when included in econometric analyses, however, the coefficient estimates of gender of
the head of household variable indicate this variable to be insignificant. Results from studies in
Ethiopia by Croppenstedt and Demeke, 1996 indicate gender of the head of household not to be
significant. Doss and Morris 2001 also found no significant influence of gender upon use of
modern varieties of maize or fertilizer use among farming households in Ghana. Despite results
to the contrary, Doss and Morris 2001 do suggest that gender may play a role through other
institutional constraints such as access to extension visits and other resources.

Age of the head of household has been found to be a significant factor affecting the use of new
technologies, but of contradictory impact in some research; and even insignificant in others.
Kaliba et al. 2000 found that older heads of household were more likely to use fertilizer in
Tanzania. Khanna 2001 found similar results: higher levels of education and experience (both
only attainable through increased years of farming) led to higher rates of use of new technologies
in high-input agriculture. Several other studies of fertilizer use in Sub-Saharan Africa found age
of the head of household to be insignificant (Green and Ng'ong'o 1993, Croppenstedt and

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; larger families would
theoretically have more family members available to work on the household crops. Croppenstedt
and Demeke 1996 and Green and Ng'ong'o 1993 suggest this to be the case. Doss and Morris
2001 reported the number of adult males to 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 labor or those in areas with less access to hired labor. Kato (2000) report an increase in adoption of K131 bean variety in Uganda as a result of increased family and hired labor. However, family size was not found to be significant by Nkonya et al. 1997 and Kaliba et al. 2000. Interestingly, Sain and Martinez 1999 hypothesized that larger families would be less likely to use improved maize seeds because the increased financial strain of larger families led to budget constraints. Anikola and Young (1985), who studied the Nigerian farming system, found that labor scarcity increased the importance of family labor.

Farm size will generally have a positive impact on a household’s decision to adopt and use a new technology such as chemical fertilizer (Nkonya et al. 1997, Kherallah et al. 2001). Households with larger cultivated areas tend to have more productive assets and fewer credit constraints than smaller ones. Doss and Morris 2001 reported farm size to positively affect the use of both modern varieties of maize as well as chemical fertilizer in Ghana. Land area cropped positively affected the results observed by Sain and Martinez (1999), which entered the land size variable as the natural logarithm for their study of the use of improved maize seed in Guatemala. Large scale farmers were also found to be more likely to adopt new technologies than small holders and that farm size was highly correlated to the adoption of agricultural innovations (CIMMYT, 1993). However, farm size may be negatively associated with manure use because it is bulky and one requires a lot of labor to apply it on a large farm. Thus, the relationship between technology use and farm size is context-specific.
Nair (1993) observed that for ease of adoption of a given technology, it should not be labor intensive or exceed the available family labor. Also Adams (1987) observed that in most parts of Africa where labor is in short supply, farmers are reluctant to adopt new technologies which are labor intensive even if those technologies give rise to better performance. Kiresuv et al. (1999) on the other hand found a negative relationship between farm size and adoption of modern sorghum technology in India. They found that a large scale farmer was limited by labor resources per unit area of land and therefore, allocated more land to traditional sorghum technologies which are less labor demanding compared to modern sorghum technologies. It is therefore proper to conclude that the effect of farm size on technology adoption is ambiguous.

Extension visits or participation in extension education programs positively increased the efficiency of reduced tillage adoption and optimal fertilizer application (Huffman, 1977). Katinila et al. (1998) stated that less contact of farmers with extension workers reduced adoption. Bisanda et al., (1998) report an increase in adoption of improved maize technologies as a result of increase in extension visits to farmers. Also, Beyene et al. (1998) report an increase in the probability of adopting improved wheat varieties (from 36% to 80%) when the farmer received extension visit or lived near a research station. Ogwal (2003) and Kongai (2005) also report that extension visits significantly influenced adoption of improved agricultural technologies. Off-farm income is typically seen as significant in the decision of households to use new technologies. Households with lower levels of off-farm income or poor access to credit are less likely to be able to afford newer, potentially riskier technologies. Some technologies may be too labor intensive and a farmer with higher levels of off-farm income will be in position to hire labor to supplement the inadequate family labor required for the new agricultural technology
hence, positively affecting adoption of a given technology (Feder et al. 1985). However, Green and Ng'ong'ola (1993) found off-farm income to be insignificant, in the use of fertilizer in Malawi.

Similarly, availability of external financing for Guatemalan households was not a significant determinant of the use of improved maize seed (Sain and Martinez 1999). In addition, time allocation to off-farm work may reduce time available for labour intensive technologies such as manure. Research on farmers’ perceptions and how they influence decisions by Adesina and Zinnah, (1993) and Adesina and Baidu-Forson (1995) found perceptions of yield, seed quality, tolerance to weeds, and adaptability to poor soil types, tillering capacity, threshing, and tolerance to drought to be significantly related to the use of modern seed varieties. Even perceptions of the ease of cooking of maize varieties were found to significantly impact the decision to use new maize varieties.
CHAPTER THREE

METHODOLOGY

3.1 Conceptual Framework

The conceptual framework for this study is adopted from the Research Triangle Institute (RTI) economic framework (Subhrendu et al 2002). It is believed that the key features relevant to agroforestry adoption are common to agriculture and forestry technology adoption. The RTI highlights five categories of factors that explain technology adoption: preferences, resource endowments, market incentives, biophysical factors, and risk and uncertainty. Preferences are placeholders for the broad category of farmer specific influences such as risk tolerance, conservation attitude and intra household homogeneity. Farmer preferences are difficult to measure explicitly, socio-demographic proxies such as age, gender, education level, and social status are used instead. Resource endowments measure the resources available to the technology adopter for implementing the new technology. Examples of resource endowments include asset holdings such as land, labor, livestock and savings as well as endowments of social and human capital. Generally, resource endowments are likely to be positively correlated with the probability of adoption. Market incentives include factors related explicitly to lower costs and/or higher benefits from technology adoption, including prices, availability of markets, transportation, and potential income losses or gains. Bio-physical factors relate to influences on the physical production process associated with farming, and these include soil quality, slope of farm land, and plot size. Risks and uncertainty reflect the unknowns in the market and institutional environment under which decisions are made. Some uncertainties of the new
technologies are mitigated by public inputs like extension, and training, household familiarity or related experience and tenure security. The underlying argument is that other factors remaining the same, we would expect change in any of the above factors to cause change in level of technology use including the use of animal manure in banana production.

3.2 The Theoretical model

Previous studies on adoption and use of new technologies have used a variety of econometric models with the majority incorporating maximum likelihood estimation techniques. Among the most commonly used estimation techniques are Tobit (Adesina and Zinnah 1993, Adesina and Baidu-Forson 1995, Nkonya et al. 1997), Logit (Green and Ng’ong’ola 1993, Sain and Martinez 1999), and Probit (Negatu and Parikh 1999, Kaliba et al. 2000). These models are more appropriate than Ordinary Least Square (OLS) for analyzing the decision to use a new technology (Feder et al. 1985). Because of the underlying specifications of these maximum likelihood models, they have a more discrete range of values. Production functions have also been used to examine adoption and levels of fertilizer use (Hiebert 1974).

In most adoption studies, the binary variable definition is normally used and is based on whether a household uses or does not use a technology. This approach has a major shortcoming treating households utilizing an inappropriate level of the technology the same way as those using an appropriate amount (Rauniyar and Goode 1992 and Feder et al. 1985).

All the above-mentioned techniques use multiple regression analysis to estimate relationships among several economic variables. According to Hedges and Olkins (1985) multiple regression is appropriate when the analyst hypothesizes that more than one factor plays a significant role in
explaining the study outcome. Changes in the dependent variable are explained by reference to changes in the explanatory variables. In this study, to get the determinants of animal manure use on banana production the probit model was used. OLS was also used for the second part of the analysis. OLS is one of the most popular estimators among researchers doing empirical work because it scores well in some estimation problems better than other estimators and also because of its computational ease. The fact that OLS estimator minimizes the sum of squared residuals, it automatically maximizes the Coefficient of determination ($R^2$). The OLS estimator has minimum variance among these alternative estimators; and is less sensitive than the alternative estimators to the presence of estimation problems like multicollinearity, misspecification or errors in variable, particularly in small samples.

3.3 The Empirical model

For the second objective of identifying and quantifying the relationship among factors underlying the change in the level of animal manure use on banana production between 2000 and 2003, the probit model was used. This is because the dependent variable considered in this study is dichotomous in nature. One would have difficulty in deciding whether to use a logit or probit model as they specify the functional relation between the probability of adoption and the explanatory variables (Feder et. Al., 1985). Despite the fact that probit and Logit models give similar results, the probit model was chosen because it was found to be convenient over the logit model.

The probit model was specified as follows:

$$I_i = \beta_0 + \beta_1 \Delta X_1 + \beta_2 \Delta X_2 + \ldots + \beta_8 \Delta X_8 + \mu$$

Where
Where $I_i$ = Farmers’ decision to increase or not increase manure use level ($I_i = 1$ when farmer increases manure use, 0 otherwise.)

$\beta_0 - \beta_8 =$ Vector of Parameters to be estimated

$\Delta X_1 =$ change in Number of members in household who provide family labor (-)

$\Delta X_2 =$ change in Farm size in acres (-)

$\Delta X_3 =$ change in Value of imported labour from outside the household in Ushs. (+)

$\Delta X_4 =$ change in contact with Extension Agents in days (+)

$\Delta X_5 =$ change in training obtained in days (+)

$\Delta X_6 =$ change in Cattle ownership in numbers (+)

$\Delta X_7 =$ change in Chicken ownership in numbers (-)

$\Delta X_8 =$ ownership of non-farm activity (Is a dummy, 1 if owns nonfarm activity, 0 otherwise) (-)

$\mu =$ Unobserved Error term assumed to be normally distributed.

For the third objective of determining the effect of change in manure on banana value, a system of equations is used. This is because change in quantity of manure used by the farmer is an endogenous variable, whose direct inclusion in the model measuring banana value would produce biased estimates, due to the correlation of the error term with the endogenous explanatory variable. To solve the endogeneity problem, a two-step approach that uses predicted values of the endogenous explanatory variables is used. The first step involves OLS estimation in which change in the level of use of animal manure on banana production is regressed against household level factors to produce predicted values of change in manure use that are used in step two.
In step two, the value of banana produced between 2000 and 2003 is regressed against predicted values of change in animal manure used and household level factors which are different from those used in step one regression.

For the Third objective,

Step 1

\[ \Delta Y^* = \beta_0 + \beta_1 \Delta X_1 + \beta_2 \Delta X_2 + \cdots + \beta_8 \Delta X_8 + \epsilon \]

Where

\( \Delta Y^* \) = change in quantity of animal manure used in banana production by the farmer (Kg)

\( \beta \)'s = Vector of Parameters to be estimated

\( \Delta X_1 \) = change in Number of members in household who provide family labor (-)

\( \Delta X_2 \) = change in Farm size in acres (-)

\( \Delta X_3 \) = change in Value of imported labour from outside the household in Ushs. (+)

\( \Delta X_4 \) = change in contact with Extension Agents in days (+)

\( \Delta X_5 \) = change in training obtained in days (+)

\( \Delta X_6 \) = change in Cattle ownership in numbers (+)

\( \Delta X_7 \) = change in Chicken ownership in numbers (-)

\( \Delta X_8 \) = ownership of non-farm activity (Is a dummy, 1 if owns nonfarm activity, 0 otherwise) (-)

\( \epsilon \) = Unobserved Error term assumed to be normally distributed.

Step 2

\[ Z^* = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \cdots + \beta_7 X_7 + \epsilon \]

\( Z^* \) is the banana value in UShs

\( \beta \)'s = Vector of Parameters to be estimated
$X_1 =$ predicted values of change in level of use of animal manure in Kg

$X_2 =$ age of farmer in years.

$X_3 =$ education level of farmer in years of schooling

$X_4 =$ Farm size in acres

$X_5 =$ Hired labour in UShs

$X_6 =$ Family labor (persons)

$X_7 =$ Training in days

$e =$ Unobserved Error term assumed to be normally distributed.

For objective 2,

The model was developed using the utility approach as advanced by Gujarati (1995).

The decision of the $i^{th}$ farmer to increase manure use or not depends on an unobservable utility index $I_i$ (latent variable) that is determined by one or more explanatory variables in such a way that the larger the value of the index $I_i$, the greater the probability of a farmer increasing manure use. Index $I_i$ is expressed as,

$$I_i = \beta_0 + \beta_1 X_i . . . . . . . . . . . . . . . . . . . . . . . . . (1)$$

Where $X_i$ is an explanatory variable, $\beta_0$ and $\beta_1$ are parameters to be estimated.

For instance, Let D represents a dummy variable, which equals 1 if the farmer increased manure use and 0 if the farmer does not. It was also assumed that there is a threshold level of the index, such that if $I_i$ exceeds $I_i^*$ the farmer would increase manure use otherwise he would not. The threshold $I_i^*$ is not observable like $I_i$ but if we assume it to be normally distributed, the parameters of the index $I_i$ can be estimated and information about the unobservable index itself. To obtain information on $I_i$ as well as $\beta_1$ and $\beta_2$, the inverse of equation (1) is taken and we get:

$$I_i = F^{-1}(I_i) = \beta_0 + \beta_1 X_i + \beta_n X_n + \mu . . . . . . . . . . . . . . . . . . . . . . . . . (2)$$
Where \( I_i = \) Farmers’ decision to increase or not increase manure use level (\( I_i = 1 \) when farmer increases manure use, 0 otherwise.)

\[ \beta_0 - \beta_n = \text{Coefficients to be estimated} \]

\[ X_1 - X_n = \text{Explanatory variables} \]

\[ \mu = \text{Error term} \]

### 3.4 Data and Sources

#### 3.4.1 Study Area

The study uses primary data gathered through multiple surveys of plots, households and villages from in 32 districts of Uganda between November 2000 and July 2001, and between August and December 2003.

The first set of household and plot surveys (November 2000 and July 2001) were part of the activities of a collaborative research project between the International Food Policy Research Institute (IFPRI) and the Faculty of Agriculture (FA) on policy options for improved land management in Uganda. Building on the IFPRI–FA study, a second set of similar surveys (August to December 2003) was conducted in the same study area as part of the activities of collaborative Research on Poverty, Environment and Agricultural Technologies (REPEAT) between the Foundation for Advanced Studies on International Development (FASID) and the Faculty of Agriculture (FA).

Some of the variables covered in the questionnaire were the demographic characteristics of household head age, gender, education level, marital status, Asset ownership like land, labor, Livestock, savings, availability of infrastructure, income sources, and bio-physical factors of soil type, plot size and land quality.

The districts included are: Kabale, Kisoro, Rukungiri, Bushenyi, Ntungamo, Mbarara, Rakai, Masaka, Sembabule, Kasese, Kabarole, Kibale, Mubende, Kiboga, Luwero, Mpigi, Nakasongola, Mukono, Kamuli, Jinja, Iganga, Bugiri, Busia, Tororo, Pallisa, Kumi, Soroti, Katakwi, Lira, Apac, Mbale and Kapchorwa.
3.4.2 Sampling procedure and Data collection

Within the study region, communities (LC1s, the lowest administrative unit, usually a single village) were selected using a stratified random sample, with the stratification based on development domains defined by the different agro-ecological and market access zones and differences in population density (Pender et al., 2001). Agricultural potential was classified based upon the agro–climatic potential for perennial crop production, using the average length of growing period, rainfall pattern (bimodal vs. unimodal), maximum annual temperature, and altitude. Potential for annual crop production was also mapped and the maps were found to be very similar.

The study area was also classified according to the level of market access and population density. To classify market access, the measure of potential market integration was used, which is a measure of travel time from any location to the nearest five towns or cities, weighted by the population of the towns or cities. Population density was classified based upon rural population density of parishes in 1991 (greater or less than 100 persons per square kilometer, which is about the average rural population density in Uganda).

The stratification was based on the central hypothesis of the IFPRI-FA study, that agricultural potential, market access, and population density are key factors determining the comparative advantage of a location, which in turn affects the profitability of agricultural and land management practices in that location and, thus, their uptake. All together, 24 development domains were classified although only 16 are represented in Uganda to a significant extent. It is from these 16 development domains that the IFPRI–FA study selected a sample of 107 LC1s for surveying.
Due to worsened insecurity in the north and northeastern parts of the country, the FASID-FA surveys of August to December 2003 were conducted in 29 out of 32 districts, and in 94 LC1s out of 107 LC1s surveyed by IFPRI–FA study. However, ten households were selected per LC1 (instead of four in the IFPRI–FA study) making a total of 940 households. Of the ten households, four came from the IFPRI–FA study sample, making a total of 376. The analysis in this study is based on the households appearing in both the IFPRI–FA and FASID-FA studies that grew bananas (N=177) in 2000 and 2003 to determine the change in use of animal manure in banana production between 2000 and 2003 and the influencing factors. The gathered data were analyzed and compared across the three categories of farmers increased, decreased and constant manure users.

Both the IFPRI) and FASID data sets were collected from the same households, which offers an opportunity to capture change in level of use of manure between 2003 and 2000 and determine the factors driving these changes. Household heads as well as members of the household actively engaged in household decision-making were interviewed.

3.5 Data analysis

3.5.1 Regression Analysis

Data were entered in Statistical Package for Social Scientists, SPSS and analyzed using STATA. Exploratory data analysis was conducted on the data in order to check for outliers, normality (distribution) and symmetry (kurtosis and skewness). Outliers were removed, data were normally distributed and there was no problem of skewness and kurtosis.
Multi-collinearity was tested using the Variance Inflation Factors (VIFs) and the covariance matrix. The covariance matrix showed no multi-collinearity. All variables gave VIFs values of less than 10; therefore none of the variables was dropped.

Hypothesis one was tested by using the descriptive statistics and t-statistics. The t-statistics were used to establish whether there were significant differences in the different categories of manure users.

Hypotheses two was tested using the probit regressions and three was tested using the multiple regression model.

3.5.2 Apriori Expectations

Change in farm size

Change in farm size is the difference in total land area under cultivation in 2000 and 2003. Farm size is expected to positively associate with new technology use (Nkonya et al. 1997). For manure use, change in farm size is expected to be negatively associated with changes in manure use because manure is too bulky and it requires a lot of labor to apply it on large farm (Nair, 1993).

Change in family labor

Change in family labor is expected to positively associate with the changes in manure use, (Croppenstedt and Demeke, 1996).
Change in Contact with extension agents

Extension visits to farmers will generally have a positive influence on adoption of new technologies (CIMMYT 1993). Therefore, change in extension visits/contact with extension agents was hypothesized to positively associate with changes in manure use.

Change in Hired labor

Change in hired labor is expected to positively influence changes in manure use (Ogwal 2005). Labor constraints to a household may also affect the household’s ability and willingness to adopt and use a new technology (Feder et al. 1985).

Change in Cattle ownership

Resource endowments measure the resources available to the technology adopter for implementing the new technology. These include asset holdings like livestock (cattle holding). The number of cattle owned by a household head is expected to positively influence manure application (RTI 2002).

Change in training

Training is expected to positively influence technology adoption (RTI 2002) and so is the positive change in training.

Off-farm activity

Off farm activity is expected to positively influence adoption of a given technology. Households with lower levels of off-farm income or poor access to credit are less likely to be able to afford newer, potentially riskier technologies (Feder et al. 1985). This is because some
new agricultural technologies may be too labor intensive (like manure) and if a farmer is engaged in other off farm activities with higher levels of off-farm income, he will be in position to hire labor to supplement the inadequate family labor required for the new agricultural technology.

**Education**

Education is the literacy level of the household head (number of years spent in formal education). Education is hypothesized to positively influence technology (manure) use, an increase in education leads to an increase in manure use and vice versa.

**Age**

Age of the household head is expected to negatively affect technology (manure) use (Sain and Martinez 1999) and thus value of crop output.
CHAPTER FOUR
RESULTS AND DISCUSSION

4.1 Descriptive Statistics

The change in manure use between 2000 and 2003 was measured by the difference in the actual quantity of manure used in both years in Kilograms (Kg).

Table 1 Change in animal manure use level in banana production between 2000 and 2003

<table>
<thead>
<tr>
<th>Manure Use Change category</th>
<th>N</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Increased</td>
<td>30</td>
<td>17</td>
</tr>
<tr>
<td>Decreased</td>
<td>37</td>
<td>21</td>
</tr>
<tr>
<td>Constant</td>
<td>110</td>
<td>62</td>
</tr>
<tr>
<td>Entire Sample</td>
<td>177</td>
<td>100</td>
</tr>
</tbody>
</table>

Source: IFPRI-FA 2000 and FASID-FA 2003 survey data

Table 1 shows that 17% of the banana growing households increased manure use, 21% decreased it and 62% of the households did not change the quantity of manure applied on banana between 2000 and 2003. This suggests that the greatest percentage of farmers growing bananas is yet to appreciate the technology of manure use.
Figure 1 shows the average amount of manure used in the years 2000 and 2003. As seen in figure 1, more manure was used in banana production in 2000 (92.9 Kilograms) than in 2003 (66.7 Kilograms). This decline in manure technology use needs to be addressed and know what the responsible factors are for that and how this trend can be reversed.
Table 2: Descriptive statistics of Banana Farmers by manure use change category between 2000 and 2003

<table>
<thead>
<tr>
<th>Variable</th>
<th>Entire sample (N=177) Mean</th>
<th>I (Increased) (N=30) Mean</th>
<th>D (Decreased) (N=37) Mean</th>
<th>C (Constant) (N=110) Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Change in household members who provide labor (numbers)</td>
<td>1.0</td>
<td>4.3 a (4.8)</td>
<td>-0.14 b (5.3)</td>
<td>0.25 b (-0.54)</td>
</tr>
<tr>
<td>Change in farm size (acres)</td>
<td>-0.8</td>
<td>9.58 a (1.40)</td>
<td>-1.68 b (2.6)</td>
<td>-3.42 b (0.99)</td>
</tr>
<tr>
<td>Change in value of hired labor (Shs)</td>
<td>-20855.08</td>
<td>64795 a (2.9)</td>
<td>-55877.03 b (3.35)</td>
<td>-32434 b (-0.85)</td>
</tr>
<tr>
<td>Change in contact with extension agents (days)</td>
<td>1.58</td>
<td>5.6 a (3.37)</td>
<td>1.06 b (5.72)</td>
<td>0.66 b (0.51)</td>
</tr>
<tr>
<td>Change in training obtain</td>
<td>0.6</td>
<td>2.23 a (0.29)</td>
<td>3.32 a (1.3)</td>
<td>-1.63 b (1.64)</td>
</tr>
<tr>
<td>Change in cattle ownership (numbers)</td>
<td>0.77</td>
<td>3.93 a (4.04)</td>
<td>-1.16 b (2.86)</td>
<td>0.55 c (1.56)</td>
</tr>
<tr>
<td>Education level</td>
<td>4.9</td>
<td>6.3 a (-0.78)</td>
<td>5.5 a (3.1)</td>
<td>4.4 b (1.96)</td>
</tr>
<tr>
<td>Age</td>
<td>49.4</td>
<td>48.23 (0.63)</td>
<td>50.35 (0.42)</td>
<td>49.4 (0.36)</td>
</tr>
</tbody>
</table>

Source: IFPRI-FA 2000 and FASID-FA 2003 survey data

- Standard Errors omitted to avoid overcrowding the table
- Figures in Parentheses are t-values.
- I category = those who Increased manure use
- D category = those who Decreased manure use
- C category = those who didn’t change (Constant) manure use
- Within each row different superscripts (a, b, c) mean statistically significant differences in the means of the selected variables between the manure use change categories. Same superscripts indicate no significant differences in the means of the two compared categories.
- N = Number of observations
The education level of household heads of Constant manure users is significantly lower than for those of Increased and Decreased manure users, but the difference in education level for the latter categories is not statistically significant. This could be explained by the fact that education plays a big role in the adoption of new technologies because it puts the farmer in a better position to obtain information about new technologies, internalize and select the best option (Bisanda et al.1998). Similarly, Goodwim and Schroeder 1994 discovered that education of household head has a positive and significant impact on adoption of new technology. Also, Nabbumba (1994) found out that adopters of clonal coffee were more educated than non adopters.

The results also indicate that the change in number of household members was significantly higher for households of Increased than those of Decreased and Constant manure users, but the change in the latter two categories is not significantly different. Households with more family members have enough labor for the adoption of agricultural innovations technology which may be labour intensive. This is in line with the findings of Ntege-Nanyenya et al (1997) that adopters of improved maize technologies had households comprising of more members than those of non adopters.

The average change in farm size was 0.8acres which suggests an overall reduction in farm size. Change in farm size was significantly higher for households Increased than of Decreased and Constant manure users, but the change in the latter two categories not significantly different.

The average change in value of hired labor was Shs -20,855 suggesting an overall reduction in value of hired labor used. Change in value of hired labor was significantly higher for Increased
than for Decreased and Constant manure users, but the change in the latter two categories is not significantly different. This suggests that change in manure use and use of hired labor is positively related i.e. those who increased manure use also increased the value of hired labor.

The average change in days spent with extension workers was 2 days suggesting an overall increase in contact hours with extension agents. Change in contact with extension agents was significantly higher for households Increased than those of Decreased and Constant manure users. This suggests that an increase in contact with extension agents leads to increased manure use because extension workers encourage farmers to take up the improved technologies.

The average change in days spent in training (attending farmer training programs) was 1 day which suggests an overall increase in training. The change in training received was significantly lower for households of Constant than for those of Increased and Decreased manure users. This could be due to the fact that both categories are manure users and it is the level of use which differs.

The change in number of cattle owned was 1 which suggests an increase in cattle ownership by one head of cattle on average. Change in number of cattle owned was significantly higher for households in category Increased than for Decreased and Constant manure users. Cattle holding plays a great role in farmers’ adoption of animal manure use because it puts the farmer in a better position to utilize own manure from own cattle at no explicit cost.
### 4.2 Econometric Results of determinants of animal manure use in banana production

**Table 3.** Probit model results on determinants of animal manure use (dependent variable) in banana production between 2000 and 2003

<table>
<thead>
<tr>
<th>Variable</th>
<th>Estimated coefficient</th>
<th>Standard Error</th>
<th>P Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Change in members who provide labor(numbers)</td>
<td>.177</td>
<td>0.056</td>
<td>0.002</td>
</tr>
<tr>
<td>Change in farm size</td>
<td>0.013</td>
<td>0.016</td>
<td>0.446</td>
</tr>
<tr>
<td>Change in value of hired labor (Ushs)</td>
<td>0.000</td>
<td>0.000</td>
<td>0.166</td>
</tr>
<tr>
<td>Change in contact with extension (days)</td>
<td>0.077</td>
<td>0.030</td>
<td>0.010</td>
</tr>
<tr>
<td>Change in cattle ownership (numbers)</td>
<td>0.037</td>
<td>0.020</td>
<td>0.064</td>
</tr>
<tr>
<td>Change in training</td>
<td>0.021</td>
<td>0.019</td>
<td>0.283</td>
</tr>
<tr>
<td>Change in chicken ownership</td>
<td>-0.013</td>
<td>0.010</td>
<td>0.195</td>
</tr>
<tr>
<td>Off farm activity ownership</td>
<td>0.053</td>
<td>0.122</td>
<td>0.660</td>
</tr>
<tr>
<td>Constant</td>
<td>-1.397</td>
<td>0.258</td>
<td>0.000</td>
</tr>
<tr>
<td>Pseudo R²</td>
<td>0.32</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prob &gt;chi²</td>
<td>0.000</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Dependent variable is farmers’ decision to increase or not increase manure use level (where increase in manure use = 1, 0 otherwise.)

N=173
From the probit model results in table 3, changes in family labor, contact with extension agents and cattle ownership are positively and significantly associated with an increase in manure use. The positive and significant (p<0.01) relationship between change in family labor and manure use suggests that for any increase in family labor by one individual, manure use increases by 0.177Kg. This is consistent with Knepper (2002) who observed that higher rural labor requirements explained non-adoption of labor intensive rice varieties in Taiwan and that shortage of family labor explains non-adoption of high yielding rice varieties in India because of their high labor demand. This is also in line with the a priori expectations of the variable that change in family labor is expected to positively associate with the changes in manure use (Croppenstedt and Demeke 1996).

Change in value of hired labor had a positive and statistically significant effect on the level of use of animal manure. Other studies established a similar relationship for example, Nabbumba (1994) established a positive relationship between hired labor and adoption of clonal coffee in Uganda. Also, Ogwal (2004) noted hired labor to be positively related to integrated Pest Management adoption.

Change in contact with extension agents had a positive and significant (p<0.05) effect on level of use of animal manure meaning that a unit increase in contact with extension agents increased manure use by 0.077Kg. Nkonya et al. 1997 and Demeke et al. 1998 established that visits by agricultural extension workers to farmers are significant in farmers’ use of a new technology. Also, Bisanda (1998), Beyene et al (1998) note that it is through extension that agricultural information on new technologies gets to the farmers.
Increase in cattle holding had a positive and significant (p<0.1) influence on the level of animal manure use. This means that a unit increase in cattle ownership increased manure use by 0.37Kg. This corroborates the findings of Leslie (2004) that the ability to apply manure is closely linked to ownership of animals. Croppenstedt and Demeke (1996) used Oxen ownership as a proxy for wealth and found it to be positively related to use of fertilizer in Ethiopia.
Table 4. Factors affecting the effect of change in manure use on value of banana output

(Dependent variable is value of banana output)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Estimated coefficient</th>
<th>Standard Error</th>
<th>T Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Predicted values of change in level of animal manure use</td>
<td>-566.12</td>
<td>349.78</td>
<td>-1.62</td>
</tr>
<tr>
<td>Age of household head in years</td>
<td>-9380.8</td>
<td>2934.89</td>
<td>3.20*</td>
</tr>
<tr>
<td>Education level of farmer in years of schooling</td>
<td>49149.32</td>
<td>15907.95</td>
<td>3.09*</td>
</tr>
<tr>
<td>Farm size</td>
<td>5345.0</td>
<td>1336.64</td>
<td>4.00*</td>
</tr>
<tr>
<td>Training obtained in days</td>
<td>-373.97</td>
<td>2850.75</td>
<td>0.13</td>
</tr>
<tr>
<td>Family Labor</td>
<td>23888.9</td>
<td>11462.01</td>
<td>2.08**</td>
</tr>
<tr>
<td>Constant</td>
<td>360485.1</td>
<td>207011.1</td>
<td>1.74***</td>
</tr>
</tbody>
</table>

R² 0.2707

N=147

*, **, *** Refers to 1%, 5% and 10% level of significance.

Table 4. Which is about factors affecting value of banana output shows that education level; age, farm size and family labor had significant effect on the value of bananas produced by the sampled households.

Age of the household head had negative and significant (p<0.01) influence on banana value. This means that one year increase in age of the household head decreased the value of banana produced by Shs 9,380. Also, Dimara and Skuras (1998) report a negative and significant
relationship between age and technology adoption thus value of crop output. This could be attributed to the fact that older farmers are more risk averse than young farmers and have a lesser likelihood of adopting new technologies (Kebede et al, 1990, Polson and Spencer, 1991), which leads to lower value of crop output. Similar findings were reported by Jacques et al, 2002 that older farmers are less likely than young farmers to adopt compost manure because it requires a high input of labor.

Education level of the household head had a positive and significant (p<0.01) influence on banana value. This means that an increase of 1 year in school increases banana value by Shs 49,149. Educated farmers can easily grasp the information related to use of a new technology for enhancing crop yield and value. Nzuma et al (2001) found education to be positively associated with adoption of new farming techniques in maize production.

Farm size had a positive and significant (p<0.01) influence on banana value. This means that a unit increase in farm size increases banana value by Sh 5,345. With a bigger available cultivable land, a farmer can allocate more land to a given enterprise and thus realize higher output than their smaller counterparts.

Family labor had a positive and significant (p<0.05) influence on the value of banana. Croppenstedt and Demeke (1996), Green and Ng’ong’ola 1993 suggest that larger families have more family members to work the farm thereby leading to high production and thus value.
It is not clear why change in manure is negatively associated with banana output in value terms. Decrease in manure use would be expected to be associated with lower yields while increase in manure use should have been associated with higher yields. But this is not the case with the observed negative relationship. This is likely because those who increased the quantity of manure applied did so after recognizing that their yields were low to begin with. However because the impact of manure use manifests slowly; the increase in its application had not yet achieved the expected positive impact on banana yield by the time of the study.

Secondly, if manure is not handled properly its application can have a yield-depressing instead of yield enhancing effect on the bananas. This suggests a need for proper handling of manure before its application, if the expected benefits are to be realized.
CHAPTER FIVE
SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 Summary

This study draws upon primary data gathered through multiple surveys of plots, households and villages from about two thirds of Uganda between November 2000 and July 2001, and between August and December 2003. A random sample of LC1s was selected from over 30 districts of Uganda. Household surveys were then conducted on four randomly selected households from within each LC1. The household heads as well as members of the household actively engaged in household decision-making were interviewed.

Out of the 376 households in both 2000 and 2003 datasets, data for only those growing bananas (177 households) were analyzed in this study to determine the change in use of animal manure in banana production between 2000 and 2003 and the influencing factors. Out of the 177 households that produced bananas, 17% increased manure use while 21% decreased its use and 62% did not change the quantity of manure applied on bananas between 2000 and 2003. The gathered data were analysed and compared across the three categories of farmers (Increase, Decrease and No change).

From the descriptive statistics, Education level of household heads Constant manure users is significantly lower than for those of Increased manure users and Decreased manure users, but the difference in education level for the latter two categories is not statistically significant. Change in number of household members was significantly higher for households of Increased than for Decreased and Constant, but the change in the latter two categories is not significantly different. A reduction in farm size was significantly higher for households in category Increased than for Decreased and Constant, but the change in the latter two categories is not significantly different.
The average change in value of hired labor was an overall reduction and it was significantly higher for category Increased than for Decreased and Constant, but the change in the latter two categories is not significantly different. An increase in contact with extension agents was significantly higher for households in category Increased than those of Decreased and Constant. This suggests that an increase in contact with extension agents leads to increased manure use because extension workers encourage farmers to take up the improved technologies. The average change in days spent in training (attending farmer training programs) was 1 day which suggests an overall increase in training. The change in training received was significantly lower for households of Constant than for those of Increased and Decreased. The change in number of cattle owned was 1 which suggests an increase in cattle ownership by one head of cattle on average. Change in number of cattle owned was significantly higher for households of Increased than for Decreased and Constant manure users.

The regression results show that changes in family labor, contact with extension agents and cattle holding are the three most important drivers of change in manure use among the sampled banana producing households. Other factors include change in value of hired labor and chicken ownership. However, the value of bananas produced by the sampled households is significantly affected by education level, age, farm size and family labor. Surprisingly, the change in manure use is negatively associated with value of banana produced, implying that those who increased manure use between 2000 and 2003 had a lower value of banana output than those who didn’t. This is likely because those who increased manure application levels did so after recognizing lower yields, but the expected impact of manure use on yields was yet to be observed because of the time lag between application of manure and
realization of impact. It is also possible that poor handling of manure could have resulted in its negative influence on production value.

5.2 Conclusions

The study shows that changes in family labor and hours of contact of farmers with extension workers are the main determinants of sustained animal manure use while age, education level of household head, farm size and family labor significantly affected the value of produced bananas. These factors should be the areas of focus for improved land management in terms manure application. The percentage of farmers using animal manure in banana production in Uganda is still very low, and the average level of use is decreasing instead of increasing and yet, banana is a principle staple food crop and a major source of income. This is of great importance because currently, in southwestern Uganda, the importance of cooking banana as a cash crop has quadrupled since 1970 due to its ease in production and stability of yield. High yields attracted traders and urban market demand drove further crop expansion. However, concern remains about lack of replenishment of nutrients through improved land management technologies. This suggests that little has been achieved by efforts to promote the use of manure to replenish soil fertility, hence the need intensify these efforts. These efforts need to include a training component on manure handling before its application in order to realize the expected effect on banana production and value.

5.3 Recommendations

Mixed farming should be encouraged to farmers since increase in cattle holding has been shown to significantly enhance manure use in banana production.
Increase in contact with extension agents significantly influenced manure application on bananas and enhanced the value of bananas produced. Increasing extension service delivery will provide farmers with adequate knowledge of manure handling and processing prior to application for it to have a significant impact on yield and value of bananas. Also, the extension workers need to be highly motivated in terms of benefits so that they can effectively and efficiently deliver their services to the farmers.

Finally, an increase in family labor supply enhances manure use since its application requires a lot of labor. Thus, besides providing technical knowledge, assisting farmers with simple tools to reduce the drudgery associated with manure processing and application could be a further incentive for them to increase manure use. Nair (1993) and Adams (1987) recommended that for ease of adoption of a given technology, it should not be labor intensive or exceed the available family labor; otherwise, it will be hardly adopted. Finally, considerable work has been done to develop technologies for land management but with low adoption. It is recommended that ways of accelerating the already available technologies are developed than developing new ones. Further research is also needed to examine the negative relationship between manure application and the value of bananas produced.
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