ETHNOMEDICINAL PRODUCTS USED IN BANANA PRODUCTION, MANAGEMENT PRACTICES, FARMERS' PERCEPTION AND EFFICACY IN MASAKA AND MPIGI DISTRICTS, UGANDA

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Ethnomedicinal Products Used in Banana Production, Management Practices, Farmersô Perception and Efficacy in Masaka and Mpigi Districts, Uganda

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Declaration

I Bwogi Godfrey do here by declare that this dissertation *"Ethnomedicinal Products Used in Banana Production, Management Practices, Farmers' Perception and Efficacy in Masaka and Mpigi Districts, Uganda"* is entirely my personal work, except where acknowledged, and that it has never been presented for the award of a degree in any other University or Institution of higher learning.

Signed: é é é é é é é é é é é é é é é Date é é é é é é é é é é é é ....

Bwogi Godfrey Vianney Masembe

AG332-1976/2010

This dissertation has been submitted for examination with our approval as University supervisors.

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List of Abbreviations and Acronyms

AATF	African Advance for Technology Foundation
ANOVA	Analysis of variance
FAO	Food and Agricultural Organization
IFOAM	International Forum for Organic Agricultural Movement
IPM	Integrated Pest Management
NAADS	National Agricultural Advisory Services
MOPED	Ministry of Planning and Economic Development
PMA	Plan for Modernization of Agriculture
PEAP	Poverty Eradication Action Plan
PCI	Percentage Coefficient of Infestation
REML	Restricted Maximum Likelihood Estimator
SSA	Sub Saharan Africa
WHO	World Health Organization
UNHC	Uganda National Housing Census

Definition of important terms

Perception: Peoplesô experience / observation on use of ethnomedicinal products

Efficacy: The ability of ethnomedicinal applications to bring desired results

Ethnomedicine: Traditional medicine practiced by various ethnic groups

Abstract

Banana failure among smallholder farmers resulting from high incidence of banana weevils and other pests and diseases has resulted into a poverty trap for farmers, food insecurity and reduced economic growth among the banana producing communities. Use of ethnomedicinal products can offer alternative to farmers who cannot afford to buy the expensive synthetic agro-chemicals which are also known to be a health and environmental hazard. The study investigated the extent of farmersô use; the farmersô perceived effectiveness of ethnomedicinal product and weevilsô, percentage coefficient of infestation in plantations where ethnomedicinal products are used and where they are not. Quantitative and qualitative experimental and social economic approaches were used. Results indicated that most farmers (50.4%) still rely on cultural practices to control banana pests and diseases; 30.6% use ethnomedicinal products and 19% that use synthetic pesticides. It was also established that women were more likely to use cultural practices and ethnomedicinal products on a subsistence level of production and men were more likely to use chemicals on commercial scale. Use of ethnomedicinal products increased with the level of education, although people with tertiary education tended not to use the products. The finding that farmers who had never attended any schooling were more unlikely to use the products was an unusual result. It was also found out that most of the farmers (53%) especially women, intercropped banana with an annual crop or medicinal plants. The logistic model indicated that women were more likely to rate ethnomedicinal products effective than men in a ratio of 4:1 Being knowledgeable (aware) about the product was a significant factor in adoption of ethnomedicinal products and farmersô perception about them (P-value =0.05). Training was highly significant (P-value=0.008) for women who used ethnomedicinal products as compared to men (P-value=0.235) where training did not significantly result in usage of ethnomedicinal products. Most farmers who had livestock regarded ethnomedicinal products effective 5 times more than those who don't keep livestock (P-value= 0.041). Farmers who used ethnomedicinal products had a relatively lower PCI resulting from banana weevils. REML analysis indicated a significant difference (P-value = <0.001) between plantation where synthetic chemicals, clean planting materials (tissue culture), cultural practices and ethnomedicinal products were used. There was also significant variation resulting from different varieties grown (P-value=<0.001) as different varieties responded differently to banana weevils. However, there was no significant variation resulting from the response of different varieties to the different treatments (P-value= 0.262). Multiple comparison indicated that there was no significant difference between a farmer who applied ethnomedicinal product from those who applied synthetic chemicals on banana (P-value=0.678) although farmers who applied ethnomedicinal products had a lower average PCI. However, results indicated that when one uses ethnomedicinal products the percentage coefficient of infestation (PCI) with the mean of 3.88% was less than for those farmers who applied synthetic chemicals directly on mat with PCI of 5.02% or farmers who observed cultural practices with a mean PCI of 6.70%. Therefore based on the results, use of ethnomedicinal products should be investigated further as it can offer reduction in banana weevils in banana plantations to farmers who can't afford synthetic chemicals below economic injury level; nevertheless this still needs further investigation. Also there is need to find the mode of preparation and application that are not labour intensive and can be suited to women who were found to be the major users of ethnomedicinal products. The study also recommended use of alternative training methods like community radios which are suited to women since it was found that women could not attend trainings; due to maternal child rearing activities if seminars are conducted at the same time as they are preparing for the family.

CHAPTER ONE: INTRODUCTION

1.1 Background

Sub Saharan Africa, Uganda inclusive is still agro-based with 80% of the population still employed in the agricultural sector and majority are peasant farmers (Uganda Bureau of Statistics (UBOS), 2006). Such a set-up has over the years resulted into low incomes and to a large extent kept these farmers in abject poverty. Most farmers cannot afford agro-inputs and high production technologies. Therefore, they rely on traditional practices for crop and animal production. World Health Organisation (WHO, 2008) reported that the proportion of small scale farmers in rural areas who still use medicinal plants for the control of pests and diseases are estimated to 80%.

In Uganda, field crop pests are among the greatest threat to increased crop production (Kamatenesi *et al.,* 2008). A research conducted in the Lake Victoria basin revealed that many farmers still rely on botanicals for pest control (Mwine *et al*., 2011; Kamatenesi *et al.,* 2008). Elsewhere use of synthetic agro-chemicals to control weeds, pests and diseases of both crops and livestock has increased risks to the environment, animals and humans. This has called for rethinking towards a paradigm of sustainable development that relies mainly on natural products within an existing system (Bodeker, 2005).

Land use in agricultural and rural development is to a large extent, influenced by the rapidly increasing food demand of the expected 10 billion people of the world population by 2020 (Schillhorn van Veen, 1999). Achieving food sufficiency in a sustainable manner is therefore a major challenge for farmers, agro-industries, researchers and governments. Dixon *et al.,* (2001) identified failure to identify specific rural development needs and opportunities as the major challenges to focus investment in areas where they would impact on food insecurity and poverty among smallholder farmers in Sub Saharan Africa (SSA). Food and Agricultural Organisation (FAO, 2001) highlighted the weak and unproductive research and extension services, characterised by lack of systematic thinking about the nature of natural resources at farmersô disposal and how they can be managed sustainably to reduce poverty.

Overall, research has been focused principally upon intensifying crop and livestock production, usually by means of purchased inputs (Dixon *et al.,* 2001). There has been far less research on integrated technologies for diversifying the livelihoods of small farmers in developing countries and increasing the sustainability of land use (FAO, 2001). On the other hand, the intensification of agriculture coupled with increased use of synthetic agro-chemicals to meet the food needs has resulted into several catastrophes like increased numbers of insect pest species attacking different crops due to death of natural enemies, loss of original habitats, and development of resistant pests. This has resulted into increased annual crop production losses (Jeyasankar and Jesudasan, 2005). There is now a move to discover alternative pest control products of crop and livestock pests and diseases. There is need to understand the role of Integrated Pest Management (IPM) in weed and pest control (FAO, 2001).

Exploring ethnomedicinal applications is one way of strengthening IPM principles. Use of ethnomedicinal products is based on indigenous knowledge (IK) that has existed from time immemorial (Nkwachukwu *et al.,* 2010). Herbs have been used in the management of diseases of humans, livestock and crop pests. Ethnobotany in agricultural production focuses on the knowledge of medicinal plant products that people have developed over generations. The ever decreasing farm land, characterised by deforestation and other environmental degradation factors, is depriving the farmersô access from many of the useful medicinal plants used in agricultural production let alone for human medicine as has been observed in BIDCO oil palm project, Kalangala Ssese Island, in Uganda (Wambi, 2009).

The government of Uganda is supporting farmers with the supply of improved seeds and agro-chemicals through programmes like NAADS to increase productivity of crops and livestock (MOPED, 2012). Farmers are given start up funds which they use to purchase inputs like agro-chemicals and improved seeds. Access to these funds is still very low especially in rural areas (MOPED, 2012). Farmers therefore need alternative means of solving their problems. Use of internal farm resources like botanicals can bridge this gap. However, most botanical concoctions are used in their crude forms without due consideration of their effectiveness (Mwine *et al*., 2010). Therefore, farmers appear be undecided for application of herbal remedies. Field comparative studies assessing efficacy of ethnomedicinal applications should be carried out, to help farmers to make informed decision about the use of ethnomedicinal products that are effective, environmentally friendly, require little capital and are affordable to the majority of smallholder farmers.

1.1.1 Use of Synthetic Chemicals in Uganda

Over 70% of the synthetic agro-chemicals used in Uganda are imported by independent agribusiness companies and distributed to registered stockist in major towns in the country (Kizza and Hetz, 2010). Others are supplied through big plantation operators of sugar, oil palms and tea estates to out growers. Studies have shown that use of purchased inputs is low and that productivity is maintained by exploring the attributes of the ecosystem components (Nterenya and Woomer, 2009; United Nations, 2006).

1.1.2 Advocacy for Botanical Products in Uganda

Due to the high cost and the negative attributes that results from the use of synthetic agro-chemicals, smallholder farmers are turning to botanicals for crop pests and diseases management. Research is being undertaken into the use of botanical in various educational and research institutions across the country (Mwine *et al.,* 2010). The major objective is, to provide farmers with knowledge and skills that they can use, to improve productivity of crops and livestock in a sustainable way. Organic farmers mainly rely on botanicals to control crop pests and diseases. Uganda now has the highest number of smallholder organic farmers in Africa (IFOAM, 2009).

Use of ethnomedicinal products is one of the strategies that can help to improve on banana production. It has been established that there is no single strategy that can effectively control banana weevils (Gold, 2000). A broad based management strategy has been suggested by Gold (1998). Given that people who use ethnomedicinal products and cultural practices continue to have fair products, it is now important to further investigate the effectiveness of these products as they can provide an alternative to banana pest management. Some farmers said that use of ethnomedicinal products has helped them to increase soil fertility. Incorporation of *Tithonia diversifolia* increases levels of nitrogen, which also is highly utilized by banana. Kizza and Henk (2010) observe that use of ethnomedicinal products fosters farmers to acquire livestock, which in addition to providing a base for making biorationals also provides extra income from the products when they are sold.

1.1.3 Ethnobotanical Studies in Uganda

A number of studies on ethnobotanical use in human and agriculture have been carried out in Uganda. Mwine *et al*., (2010) cited Freiburghaus *et al*., 1996; Katuura *et al*., 2007; Ssegawa and Kasenene, 2007 who reported on traditional plants used in human medicine; Waako *et al.,* 2007;

Tabuti *et al*., 2003; Bukenya-Ziraba and Kamoga, 2007; Gradé *et al*., 2007; Katuura *et al*., 2007 explored ethnomedicinal plants of veterinary importance and Kakudi (2004) did studies regarding ethnomedicinal plants and cultural values. However limited amount of information concerning pesticidal/insecticidal plants used is available (Kamatenesi *et al.,* 2008). Therefore, detailed information and use of ethnomedicinal plants in indigenous communities for crops and livestock production is still inadequate and that is why further study was carried out in this area.

1.1.4 Ethnobotanical Products used in Banana Production

Banana form the main staple food in the Central, Western and Mt. Elgon regions of Uganda. They are also a cash crop to many smallholder farmers in these regions. FAO (2009) estimated per capita consumption of Matooke in Uganda at 207kg/year. The total consumption is estimated at 4,554,000 metric tons (Spilsbury *et al.,* 2002). Given the important position of bananas in the diet of Ugandans, efforts to ensure sustainability and improved its production methods is a priority especially managing soil fertility, pests and diseases (Spilsbury *et al*., 2002).

Of recent, bananas are under threat of various pests and diseases. Most pests include banana weevils and nematodes and the major diseases are bacterial wilt and panama wilt diseases. Banana weevils are one of the major pests that threaten the industry (Bosch *et al*., 1995 cited by Spilsbury *et al*., 2002). Use of agro-chemicals like carbofuran (Furadan) to control banana pests, can only offer short term remedy to the problem of pests but has failed to provide long term solutions to the challenges (Gold *et al*., 2002). On the other hand, smallholder farmers cannot afford to pay for the high cost of imported agro-chemicals. In addition, prolonged use of agro-chemicals has resulted to resistant pests, health hazards to users and destruction of the non targeted natural enemies thus destabilising the ecosystem. Therefore, studies to elucidate efficacy of the ethnomedicinal products were important. Like other crops, productivity of banana is greatly affected by pests and diseases. It is heavily attacked by a variety of pests and diseases, which are active throughout the year, probably due to favourable tropical conditions. Therefore, farmers have to fight these pests in order to obtain tangible outputs. Over time, farmers have developed local knowledge and skills of controlling banana pests and diseases but have slowly been overshadowed with use of agro-chemicals. In the management of banana pests, farmers use remedial ethnomedicinal products composed of a number of plant species and targets several pest species in the field.

Inyang and Emossairue (2005) studied the repellence of 13 plant species while Musabimaana (1999) and Umeh, *et al.,* (2010) experimented on the use of neem leaves as mulch in banana weevil management with acceptable results. This reaffirmed the possibility of having active ingredients in plants that can act as an option in management of banana weevils.

1.1.5 Farmers Perception on Ethnomedicinal Products

Adopting a given technology is often influenced by perception. There is current contention among some farmers supported by scientist especially those dealing in agro-chemical production that it is only the synthetic agro-chemicals that can effectively control and manage various pests and diseases. On the other hand, some farmers, scientists and environmentalist argue that non synthetic remedies can effectively control and manage crop pests with minimal side effects to the environment (Bodeker *et al*., 2005). Mwine *et al.,* (2011) identified the need to elucidate chemical composition of particular medicinal plant species and their efficacy on specific pests. Even before such studies are carried out, comparing results of ethnomedicinal products as used by farmers with those who do not apply at all and/ or with those who use synthetic chemicals can help to have a bench mark to ascertain efficacy.

This research sought to evaluate which farmers consistently used the ethnomedicinal products. It also sought to identify the indicators that farmers use to assess effectiveness of ethnomedicinal products. This is a stage further to validate the farmersô claims and thus the first step to scientific investigation to evaluate efficacy of the selected plant species. This study sought to assess the management practices, used in preparation of the products in relation to the general banana management practices, observed by farmers in the project area. The study further assessed the factors in place that favour or hinder promotion of ethnomedicinal products in Uganda and the farmersô perceived effectiveness of ethnomedicinal products.

1.2 Statement of the Problem

Low productivity of banana, resulting from high cost of controlling pests and diseases, is creating fear and challenges among resource poor smallholder farmers in Uganda. There is banana failure among smallholder banana farmers resulting from high incidence of banana weevils and other pests and diseases. This has resulted into loses in yields especially among poor farmers, food insecurity and has reduced economic growth among the banana producing communities in Masaka and Mpigi. With the losses in yields, farmers cannot afford to buy synthetic chemical and other inputs to improve productivity of banana. On the other hand, use of conventional pest remedies especially the use of synthetic chemicals has resulted in pest resistance, environmental pollution and ecological destruction. Identifying alternative sources of pest control is now vital. Botanicals pesticides are user friendly and can be possible alternatives. Mwine *et al.,* (2010) and Kamatenesi *et al*., (2008) identified some plant species used by farmers to control banana pests but their effectiveness is not yet established. This research sought to assess the effectiveness of ethnomedicinal products on banana weevils using PCI. The study assessed the composition, source of ethnomedicinal products and knowledge of farmers about them. It also assessed the management practices of the products of ethnomedicinal products in Masaka and Mpigi. It is hoped that farmers will get safe environmental methods of managing agrosystems that are affordable.

1.3 Purpose of the Study

The purpose of this study was to find alternatives to synthetic chemicals of controlling banana weevils especially for the smallholder banana producers in Masaka and Mpigi Districts.

1.4 Objectives

1.4.1 General Objective

The general objective was to analyse the extent to which, ethnomedicinal applications are utilised by banana farmersô, focusing on their preparation and application; perceptions on effectiveness of products and percentage coefficient of infestation in plantation where they are used to control banana pests in Masaka and Mpigi Districts.

1.4.2 Specific Objectives

i. To establish the demographic and socio-economic characteristics of banana farmers, their relationship to banana farming and pest management systems in Masaka and Mpigi Districts.
ii. To establish what ethnomedicinal products are used and factors that are associated with use of ethnomedicinal products; their composition, source, preparation, management practices and source of knowledge.
iii. To assess the farmersô perceptions on efficacy of ethnomedicinal products used to control banana weevils.

iv. To assess the level of damage by weevils in plantations where ethnomedicinal products are used and where they are not.

1.5 Research Questions

- Who practice banana farming at house hold level and what are the banana cropping, farming and pest management practices in project area?
- Do farmers use ethnomedicinal products? If yes what are the ethnomedicinal products used by farmers, their source, composition, preparation, management practices and sources of knowledge?
- What are the farmersô perceived effectiveness of and the factors contributing to the perception of ethnomedicinal products used in control of banana weevils being effective?
- What is the weevilsô percentage coefficient of infestation in plantations where ethnomedicinal products are applied in comparison to non use of products?

1.6 Significance of the Study

Banana weevils are amongst the most important pests that affect the performance of banana in the field. Most small scale farmers cannot afford to buy pesticides to control the pests in banana plantations. The significance of this research was as follows:

The research sought to contribute to better policy formulation on sustainable agricultural production and provide alternatives to synthetic chemicals that can be used in control of crop pests. This can save on foreign exchange used to import agro-chemicals to country.

It was meant to be a basis for further research into the useful plants that are available for crop protection, which avails farmers with knowledge of useful plants, which they can use instead of synthetic agro-chemicals to control banana weevils.

The research sought to feed into the policy for sustainable environment conservation through promotion of ecological farming practices and mitigation of problems associated with climate change.

The research also was aimed at forming a basis for production, formulation and commercialisation of affordable bio-rational products.

Using resources from nature would also provide the general population with safe organic foods that are not dangerous to human health.

1.7 Justification

Banana pests and diseases and soil fertility continue to present a major challenge to banana production (Abodi and Wood, n.d.). Farmers are already poverty stricken from the cost of purchasing synthetic chemicals. Exploring the effectiveness of ethnomedicinal products sought not only to control banana pests, but also to provide deficient banana nutrients. Thus this could not only reduce the cost of pest chemicals but also supplement fertiliser inputs to banana.

Validating the knowledge of ethnomedicinal products that farmers are using, the management process for their formulation and the perception of farmers on efficacy can be used as source of knowledge in the control of banana pests.

The overall goal of bio-pesticide research was to make products available at farm level at affordable prices and to overcome the existing bottleneck of high costs of plant and animal protection. Thus researching into the useful plants that are available for banana protection would avail farmers with knowledge of useful plants that they can use for banana pests and other crop protection. The research also sought to form a basis for production, formulation and commercialisation of bio-products. It was aimed at exploring the ability of nature to regulate the production system with minimal external inputs for crop and animal production. It was also aimed at exploring and building confidence of local people to harness nature using locally available resources. To establish this, a comparative study was carried out to assess farmersô perception of efficacy on use of ethnomedicinal products as a means of banana weevil control system. This would help in evaluating the effectiveness of ethnomedicinal products used by farmers to control banana weevils. It aimed at providing the resource poor small scale farmers with alternative methods of controlling banana pests and concretises the importance of researching and developing traditional knowledge.

1.8 Conceptual Framework

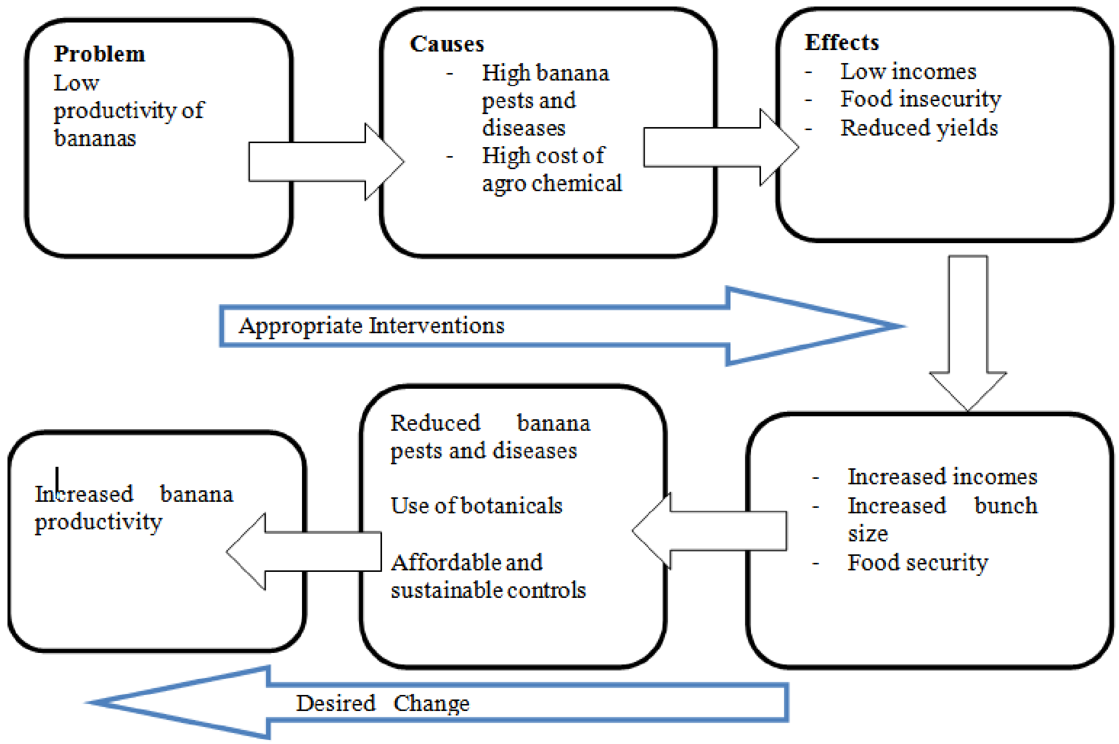

Figure 1: Conceptual Framework

1.9 Theoretical Concept

This research was aimed at addressing low productivity of banana caused by high incidence of banana pests and diseases. Prevalence of banana pests and diseases is escalated by the high cost of agro-chemicals, which are not affordable by smallholder farmers many of whom are subsistence farmers. High prevalence of banana pests especially weevils has resulted in low incomes to farmers, food insecurity and reduced yields. Banana weevils can cause banana loss to up to 90% (CTA, 2012). By addressing the challenges caused by banana weevils it was hoped that the size of bunch would be increased, farmerôs incomes would be increased and food security among smallholder farmers would be enhanced. This could be achieved if the percentage of banana weevils and other pests is reduced below economic injury level using affordable, environmentally friendly products. The overall goal was to increase productivity of banana in the project area at low cost.

1.10 Dependent and Independent Variables

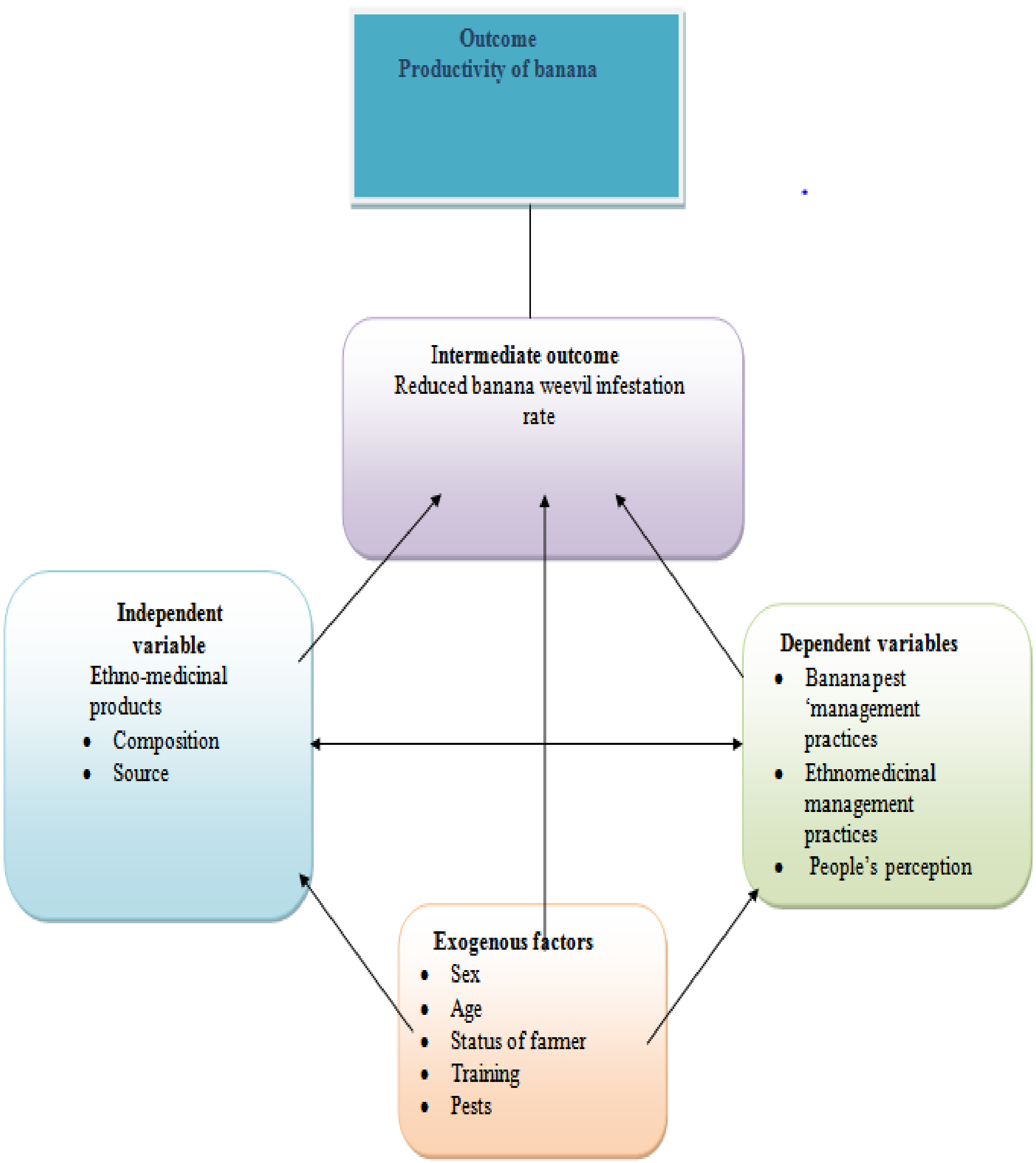

Figure 2: Dependent and Independent Variables

CHAPTER TWO

2 LITERATURE REVIEW

2.1 Use of Ethnomedicinal Products in Uganda's Agrosystems

Majority of peasant farmers in Sub Saharan Africa still depend on ethnomedicinal plants and traditional practices for both crop and livestock production (Amenu, 2001; Berger, 1994). Food systems especially for small scale farmers are increasingly being threatened by outbreak of pests and diseases. These pests and diseases are hard to control due to the high cost of agricultural inputs. This is compounded by the health hazards posed by these chemicals. Therefore, this necessitates for the urgent need to build up reliable food production systems in developing countries, not the least in Africa, where people are regularly faced with harsh environmental constraints of drought and pest outbreaks, a constant lack of agricultural inputs and limited financial means.

Berger (1994) further discuses need for smallholder farmers to embrace the theory of sustainable agriculture and self-reliance. It is envisaged that different aid organizations have tried to channel their help to small farmers in the tropics in order to facilitate their use of resources which are locally available and can be cheaply maintained (Berger 1994). With this view, it is hoped that natural crop protection could have an important role to play in the many situations where agricultural pests seriously hamper agricultural production. The possibility of making raw extracts from plants growing in the neighbourhood where the farmer lives assists in ensuring self sufficiency and gives him/her a cheap alternative to conventional synthetic pesticides which often are imported using foreign exchange. Large-scale production of natural pesticides based on crude or purified extracts could also provide an income for people in the countryside (Berger 1994).

The future of agriculture and rural development is largely influenced by the rapidly increasing food demand. Therefore, achieving food adequacy in a sustainable manner is a major question for various people in both private and public sectors (Schillhorn, 1999). Globally there has been a sharp increase in the use of agro-chemicals over the last decade. The growth of agriculture that relies on synthetic pesticides to fulfil food needs has increased the number of insect pest and diseases damaging different crops and livestock resulting in astounding annual production losses. Indiscriminate use of agro-chemicals has resulted in the development of resistant pests, resurgence and outbreak of new pests, toxicity to non-target organisms and hazardous effects on the environment, endangering the sustainability of ecosystems (Jeyasankar and Jesudasan, 2005).

In Sub Saharan Africa use of synthetics is still at its infancy. People have always been sceptical on using foreign chemicals on their farms. Smallholder farmers mostly rely on traditional knowledge to manage crop pests. Over thirty ethnomedicinal species have been identified by farmers and are used on various crops and livestock pests (Mwine *et al.,* 2010). However, there is a knowledge gap on the effectiveness and productivity of many extracts used in crop pest and disease management. Therefore, research in botanicals that are effective on crop pests is imperative. This is hoped to contribute to the objective of identifying, locating and documentation of those important plant products that can be used for pests and disease control in banana production.

Use of herbs is staging a comeback and herbal renaissance is happening all over the globe (Joy *et al.,* 1998). Use of plant derived botanicals in crops, livestock and human health symbolises safety in contrast to the synthetic chemicals that are unsafe to human and environment (Suman *et al,* 2011). Use of biopesticides is not only environmentally and ecologically friendly; it can also give good or even better products than the traditional synthetic chemicals. Biopesticides have an array of properties including toxicity, repellence, antifeedance and control of insect regulatory mechanisms (Prakash *et al.,* 2008). Therefore, smallholder farmersô relying on botanical products is not unfounded. However there is need to validate their knowledge. Some studies so far about traditional knowledge have been positive. On farm studies in biopesticides indicated that they increased yields in pigeon peas by 20-30% (Prakash *et al,* 2008). A vegetable research on the use of pencil tree was found effective in control of cabbage pests; an evidence that botanicals can effectively manage and reduce pest population pressure to below economic significance in crop (Mwine *et al*., 2011). Research is an expensive venture that takes time and resources. Screening the pool of traditional knowledge can help in reducing on the cost of planning for efficacy trials.

2.2 Banana Weevil

Banana weevils *Cosmopolites sordidus* belong to the *Coleoptera specie* super family *Curculionidae* and are the most important pests for bananas (Gold and Messien, 2000). They are nocturnal insects that are found mostly in banana plantations (Okolle *et al*, 2009). The damaging stage of the pest is its larvae that tunnels through the stem, rhizome and pseudo stem. Control of weevils varies from one farming system to another. Commercial farmers are more likely to use chemicals. Resource poor, small scale farmers are more likely to use cultural control methods (Gold and Messien, 2000). Botanicals have been tried and an extract of neem 20% proved successful on control of weevils in newly planted plantations (Gold *et al*., 2000; Musabyerimana, 1999). Similar studies were conducted at Kawanda near Kampala, Uganda and findings indicated that extracts of *M. azedarach, Targetes spp. and R. communis* could significantly reduce the population of weevils in banana (Tinzaara *et al*., 2006). However their efficacy, chemical composition, usage and productivity still remain to be investigated. On-farm research was conducted by Tinzaara *et al*., (2003) in Lwengo to evaluate neem powder efficacy on control of banana pests for one year, based on findings in Kenya by Musbyimana (1999) but results were not conclusive. Farmers still use ethnobotanical products in the study area. This research was aimed at finding out the status of banana weevil damage in plantations among farmers who still use ethnomedicinal products and those who donöt.

2.3 Farmers' Role in Ethnobotanical Research

Other than being constrained by lack of capital to invest in purchase of inputs, adoption of technologies by smallholder farmers in Uganda as elsewhere in Africa is often influenced by attitude and observation they have experienced over time. Farmers have developed own technologies (traditional knowledge) and used them to harness nature (Amenu, 2007). Their experience and participation in development of new technologies can facilitate development and adoption of new technologies (AAT F, 2005; Biggs and Clay, 1981). Farmers make their own research; integrate technologies from different sources and adapt it on their own farms (Oledale, 1994). According to Henrich and Mcelreath (2002) farmers are good decision makers and their view can contribute to understanding of many aspects of insect pest ecology. This knowledge combined with scientific expertise can contribute to the improvement of local practices in pest management (Fikret *et al*., 2000; Henrich and Mcelreath 2002). This can increase on the productivity of agricultural enterprises especially where capital is constrained. Farmeröss led research can therefore be used as a basis for development of appropriate technologies specifically suited to smallholder farmers. Adamo (2001) elaborated on the need of involving farmers to develop participatory perspective solution to problems. Non involvement of farmers in solving community problems, derail the initiatives meant to solve existing environmental and social challenges (Schoen, 1996 as cited by Kizza, 2010). Therefore, exploring farmersô perception and productivity of botanical products used in banana management is a prerequisite in solving the existing knowledge gap of overcoming the challenge of banana pests, especially by those farmers who canôt afford to buy synthetic pesticides.

2.4 Management Decisions at Farm level

The relative value of land, capital and labour that is at the farmers disposal often influence the type of decisions farmers take to invest in agriculture (Kizza and Henk, 2010). Farmers with external resources are more likely to invest in high input agro-chemicals than farmers who solely rely on their farm for subsistence. Also the size and type of operation a farmer does influence farmersô decisions. Farmers who produce high value horticultural crops are more likely to invest in agro-chemicals than small farmers who own perennial crops like banana and coffee. This research will try to find out why farmers use a given option of banana pest management and not the others.

2.5 Perceptions and Adoption of Technologies

According to Adehambi *et al*., (2010) farmerôs perceptions are important in determining whether farmers will adopt a given technology or not. A study on the use of botanical in control of vegetable pests found that farmers perceived the products a slow in action, labour intensive and needs repeated action. Alodale and Fawole (2002) found that people have subjective preference for characteristics of products and that the demand for a product is significantly affected by their perception of the productôs attributes. He also reaffirms the importance of farmersô perception in adoption of agricultural technology. Truong *et al.,* (2002) sum up the role of farmerôs perception by stating that farmers believe in technologies because they give good efficiency in terms of good yields, less pests and of more benefits.

2.6 Logistic Regression in Modelling of Farmers' Perception of Effectiveness

Logistic regression builds on the principal of the linear regression and ordinary least square (Guido *et al*., 2006; Field, 2000). It is used when the response variable is dichotomous with óYesô or óNoô, ñInfectedò or ñNot infectedô and in this case ñEffectiveò or ñNot effectiveò. In this study, binary logistic regression was assumed as the best model because the model involved the making of choice by farmer to whether the products were effective or not. Since the outcome is dichotomous, using unit change on a simple linear scale may predict outcomes that are less than zero or greater than one. Logistic regression instead focuses on probabilities of the farmers making choice through the odds ratio. Thus the probabilities and portions of choice are bound by the 0 and 1(Tranmer n.d).

Logistic regression links the dependent variable with the exploratory variable (Moshe *et al*, 1999) through a log transformation link turning binary data into a continuous scale of log odds: -

$$logit(p) = log[p/1 - p]$$

The logarithms of the odds allow one to use the linear model (Guido, 2006). Thus the results of logistic regression could allow expressing prediction as: -

Let p_i = Pr(Y=1|X=x_{i})

Therefore:-

$$\ln\left(\frac{p}{1-p}\right) = logit\, p_i = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + \beta_n x_n + \varepsilon$$

Where in this study (p) presents the probabilities of choice (=1 effective) if a farmer perceives ethnomedicinal products being effective and (=0 otherwise) for a farmer who consider them not effective.

β_0 = y intercept, x_1 to x_n being the independent variables associated with outcome (p) and each outcome (log odds) is indicated by β_1 to β_n .

Logistic regression is the best option when modelling perception and attitudes which are categorical in nature and involves decision making (Thiang, 2007). Use of linear regression was inefficient as categorical data cannot meet many assumptions of a normal linear equation (Guido *et al*., 2006). Also for ordinal data that has multiple responses use of multiway frequencies is hard to interpret (Barbra and Linda, 2002). Therefore, categories are collapsed into a dichotomous dependent variable in this study (=1 effective =0 otherwise). This therefore allows one to use proportions in (2x2 table) to predict outcomes of association of a dependent variable with several independent variable that may be categorical, interval or on continuous scale (Field, 2000).

2.7 Residual Maximum Likelihood Estimator (REML)

REML (Residual Maximum Likelihood Estimator) is used where ANOVA would have been used (Sue 2008) but when the data is unbalanced or correlated and have two or more sources of variation. The method was introduced by Patterson and Thompson (1971). REML is important in estimation of biased variance components produced by the ordinary Maximum likelihood estimators (MLEȏs). Since estimation of unbalanced designs is not possible, it therefore requires a robust maximum likelihood estimation model (Sue, 2008). Use of REML, which include an adjustment for the degrees of freedom, therefore is employed in estimation of the fixed effect (Patterson and Thompson, 1971; as cited by Sue, 2008).

The equation for model is thus:

□ = □’□ + □’□ + □ Where □ and □ are independent of each other.

According to Smith and Verbyla (1996) REML partition the likelihood into two independent parts:-

□□ = □□□ □□=fixed effects

2. □□ = □□□ □□= relating to residual

[illegible] = n x p matrix of full column rank

[illegible] =n x [n- p] matrix of full column rank

[illegible] = [illegible], [illegible] = 0

Thus

[illegible] ~ [illegible] ([[illegible] 0], [illegible] [[illegible]])

This can be solved using

[illegible] = [illegible] + [illegible]

The fixed effects are solved using the equation

[illegible] = [illegible] = [illegible]

And the random effects [illegible] = [illegible] / [illegible]

A detailed derivation of the REML can be viewed in Sue (2008) estimation of mixed and linear model since it is beyond the scope of this work.

CHAPTER THREE

3 RESEARCH METHODOLOGY

3.1 Introduction

This study was conducted using both qualitative and quantitative approaches. Qualitative data collection and analysis was used to assess respondentôs perception on ethnomedicinal products as used in management of banana weevils in the study area. Quantitative approaches were used in collection and analysis of data on the characteristics of banana farmers, important ethnomedicinal species and products used in pest management. It was also used to estimate damage in plantations where ethnomedicinal products are applied and where they are not. Data were analyzed using SPSS for social survey data and Genstat 14 for experimental data.

3.2 Area of Study

The area under study, Masaka and Mpigi Districts (Appendix 5) lies between N 000.0034, E 032^0.0080 and S 00^0 1891, E 031^0 .4447 elevation is 1229 Above Sea Level (ASL). The mean annual rainfall is 1000mm to 2200mm. The rains are spread in two seasons between March to May and August to November. The average annual temperatures range between 22.5 ^{0} C to 27^0 C. The relative humidity is 80% to 95%. The average rain days per year are 127 with an average 10.6 rain days/months. The climate is very favourable for the perennial crops especially banana and coffee; but it is also favourable for the multiplication of crop and animal pests and diseases.

This research was carried out in 3 sub-counties of Masaka and 1 sub-county of Mpigi Districts namely: - Nkozi, Kyannamukaka, Kabonera and Katwe-Butego, which are predominantly banana producing areas and therefore had the subjects of researcherðs interests.

3.3 Research Design

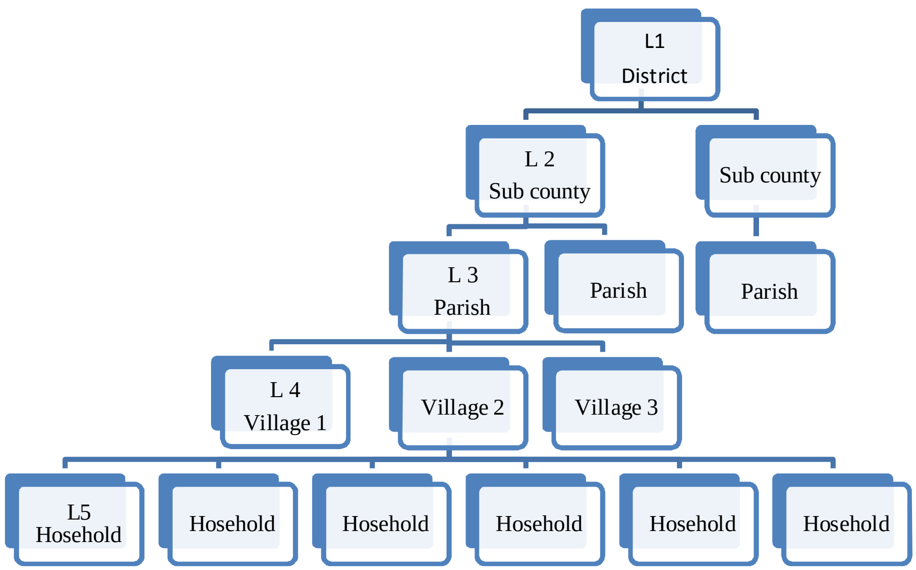

Figure 3: General Structure of the Study

Key:-

Primary sampling

Level 1: Purposive sampling

Level 2: Purposive sampling

Level 3: Random sampling

Level 4: Random sampling

Level 5: Random sampling

Secondary sampling

Stratified and snowball sampling (Figure 3)

3.4 Instruments Used

The survey was conducted using interview guides. During the farmersô interviews observations were done and where possible photos were taken on consent of farmers with a camera. Additional information was recorded in a note book. A tape measure was used to collect data of measurement of PCI in the secondary survey. A secondary survey to assess the weevil damage was conducted after the primary survey. The sample was derived at using Ross (2005) multistage sampling formula. Data was collected using stratified and snowball sampling procedure of Mugenda (1999) where one farmer in a group was used to identify fellow farmers using a given pest control practice. The percent coefficient of infestation (PCI) method was used as recommended by (Ogenga and Bakyalire, 1993; Tinzaara *et al*., 2003) to estimate the damage caused by weevils.

3.5 Subject of Study

The respondents used were all active banana farmers in the study area. They were adults of above 20 years who own a homestead.

3.6 Sample Size and Sample Selection

The sub-counties were purposively sampled in order to get banana farmers with the researcherôs criteria of interest. Participant in the survey were randomly selected in the primary sampling from the selected villages. From each village 6 farmers were selected to get a representative sample, and fit within available resources and manpower. Care was taken to pick farmers from all corners of the village in consultation with local area leaders. Expected total sample size from all the sub counties was 144 farmers (4 sub-counties x 2 parish x 3 villages x 6 farmers).

The primary sample was calculated using following formula suggested by Kothari (2004) for population of unknown population sizes.

Equation 1 : Sampling formula for unknown population size

$$N = \frac{Z^2 * (P) * (1 - P)}{C^2}$$

Where: N= sample size required

P = estimated percentage picking choice of farmers (0.5)

C =confidence interval (± 0.08)

Z= estimated confidence level (1.96 for 95%)

3.6.1Assessment of Ethnomedicinal Products using PCI

Farmers were characterized into those who use ethnomedicinal products and who do not apply them. Thereafter, the PCI for banana from different farms that used different treatments was assessed. Farmers were clustered into zones and data was collected from farmers who used ethnomedicinal products and those who use other pest control options. The damage was concentrated into the damage scored of 6.25% 12.5%, 25% 50% or 100% for total damage. Measurement of damage using percentage coefficient of infestation (damage score index) on bananas from the selected farms was done using the cross section method of concentrating damage (Gold *et al*., 1994, Rukazambaga *et al*., 2002) at the collar and below 5 cm of the collar of pseudostem in plantations where the different products are applied and where they are not from which the PCI in the cylinder and cortex were calculated (Rukazambaga *et al*., 2002).

Equation 2: Sampling formula for secondary sample with clustering

[illegible] = [illegible] * ([illegible] + [illegible] − [illegible])

Where: [illegible] = secondary sample

□ ∗ = primary sample (farmers who participated in first survey)

□=banana sample estimate to be picked from each plantation □□□= intra class correlation (0.1)

Obtaining from above a sample of 29 farmers out of 144 farmers was targeted. An estimate of 7 farmers per treatment and 9 plants per farm were used to determine the representative sample size. REML was used as recommended by Knight (2008) to carry analysis o find variation brought about by different treatments on percentage coefficient of infestation and from varieties picked from the different farms, where ethnomedicinal products are applied and where they are not; although (Tinzaara *et al.,* 2003) had done a similar experiment using ANOVA. Data was corrected from farms on the level of damage inflicted by the weevils on various species of banana picked at random.

3.7 Data Collection Procedures

Farmers were interviewed using interview guide with both open and closed questions. Closed questions were used where the researcher wanted to limit the responses of a given question and open ended were used where in depth view was required and to questions that may had divergent views. The interview guide were pretested with 10 farmers in Nyendo Ssenyange and reviewed by the Agricultural Officer and supervisor before it was administered to the respondents.

3.8 Data Analysis (Theoretical Models)

3.8.1 Objective one

Objective 1 was modelled using the descriptive statistics and likelihood estimator adopted from Barbara and Linda (2001) to test demographic, socio-economic characteristics and their association with pestsô management systems of banana production, where management system was meant to be the cropping system and farming systems. Expected Chi- square was used for 2*2 and 2*3 contingency model.

3.8.2 Objective Two

Descriptive statistics were used to find out the factor that influence ethnomedicinal products use, their preparation and management practices. A bivariate analysis using chi-square and p-values to find out different relationship between the socio economic and ethnomedicinal management practices was used. User Value adopted from Hudrib (2001) cited by Mwine *et al.,* (2010) was use to estimate the importance attached to ethnomedicinal plants used by respondents.

User value $UV=\frac{\sum M}{T}$ where:-

UV=User value

T = Total number of respondents

$\sum$ M = Total number of respondents who mentioned the plant

3.8.3 Objective Three

Before modelling the perception of farmers on effectiveness of ethnomedicinal products used in management of banana weevil, an overall opinion of farmers about banana pests and diseases was conducted using a non parametric binomial test. Confident level of significance was set at 0.05 and test of proportion at 50%.

Afterwards Indicators of effectiveness of ethnomedicinal products as perceived by farmers were assed using a pair wise matrix ranking. The study had targeted 10% of the respondents, which estimated the number of farmers to participate in this exercise to 14. Nineteen farmers (19) from 3 parishes of Kabonera participated in focus group discussion to rank the criteria used to access the symptoms of banana weevil in a plantation. Farmers were asked which of the two criteria in row and column they would choose to measure presence of weevils in a plantation. The criterion with highest number of appearance, in the matrix, was taken as the most important symptom used by farmers.

Before a logistic model was developed a bivariate analysis was carried out to show how the different variables were related with the dependent variable (perceived effectiveness) using cross tabulations and chi-square test.

Thereafter, assessment of how farmers perceive the efficacy of the products and the factors that determine the perceived effectiveness was done using logistic regression. Before the analysis was conducted the independent variables were tested for presence of multicollinearity and singularity. According to Jeeshim (2002), predictors with tolerance level of less 0.1 or Variance Inflation Factor (VIF) of above 9 signifies serious multicollinearity and thus the lesser variable should be excluded or similar variables can be combined.

A logistic regression was then carried out using the decoded dependent variable EFFECT2 with two variable 0= ñnot effectiveò and 1= ñeffectiveò. The model used, was adapted from Field (2005) and Hosmer and Lemeshow (2000). A Logistic regression was used because it is non parametric and the data in the analysis could not meet the assumptions of a normal regression.

Faced with the two options, farmers choose the alternative that brings the highest utility. The dependent variable was therefore in qualitative form with two choices, effective or not effective. In this research, farmersô perception of efficacy was hypothesized to be dependent on a number of factors namely: - gender of a farmer, knowledge a farmers has about ethnomedicinal products, size of land owned, method of preparation and application of products, presence of livestock on a farm, banana farming system practiced, training receive and educational level of a farmer.

3.8.4 Specification of Farmers' Perception Model

Suppose that the perception of effectiveness is denoted by óYô which has binary values. When Y=1, it shows farmersô choice in favour of the products being effective. If ópô is the probability that the household perceives the product as being effective, then 1-p will be the probability of the product not being effective. This means that $p/1 - p$ will be the odds ratio in favour of product effectiveness. As ópô is the probability that $Y = 1$ then, a simple form of farmersô perception of efficacy could be written as:

Equation 3: Logistic Probability Model

$P = (Y = 1) = F(\beta X + \varepsilon_{i})$ é (1)

Where: $F(\cdot)$ = a function of the independent variables

X= Vector of explanatory variables which affect farmersô perceptions

β = Vector of coefficients

ε_{i} = random disturbance terms (errors)

Therefore we can write:

Equation 4: Binary Logistic Formula

$Z = \ln[p/1 - p] = \beta X + \varepsilon_{i}$ é (2)

Since logistic regression considers the relationship between a binary dependent variable and a set of independent variables (Table 1); equation 2 is simplified and as a result, the empirical form of the model becomes:

Equation 5: Logistic Model

[illegible] = β_0 + β_1 [illegible] + β_2 [illegible] + β_3 [illegible] + β_4 [illegible] + β_5 [illegible] + β_6 [illegible] +

β_7 [illegible] + β_8 [illegible] + ε_{i} … … … … … … . . … … … … … … … … … … … … … … … … ..(3)

Table 1: Variables in the Logistic Model for Perceiving the Products as being Effective

Variable	Definition
[illegible] =	The probability of presence of the characteristic of interest (i.e. farmer perception =1 if effective, =0 if not effective)
[illegible] =	Constant
[illegible] =	Dummy variable, (=1 if male, =0 otherwise)
[illegible] =	Dummy variable, Knowledge of products (=1 if Yes, =0 otherwise)
[illegible] =	Level of education, illiterate, primary, secondary and tertiary Dumm variable
[illegible]	Presence of livestock, Dummy variable, (=1 if Yes, =0 otherwise)
[illegible]	Cropping system, agro.forest, pure.stand, inter.crop Dummy variables
[illegible]	Method of application, mix.water, band.apply, cover.und.soil meth.spo Dummy variables
[illegible]	Land holding, acre .0-2.5 acre.3-5, acre.-6, Dummy variables
[illegible]	Use of ethnomedicinal products, Dummy variable
[illegible]	High and low income dummy variables
[illegible]	Subsistence, Commercial and Semi-commercial dummy variables
Yields	Annual yields
[illegible]	random disturbance term (errors)

3.8.5 Comparing Percentage Coefficient of Infestation where Ethnomedicinal Products are used and where they are not (Objective 4)

The relative effectiveness of the products was assessed using the Percentage Coefficient of Infestation (PCI) using data from 29 farmers who use either chemicals, ethnomedicine or farmers who rely on cultural practices. Among the farmers who applied chemicals, 3 farmers applied chemicals on traps and a group of farmers who practiced cultural practices 7 farmers used tissues culture planting materials. These were decoded separately for analysis. Before a farmerôs plantation was assessed, history on management of banana for the last one year was asked since synthetic pesticides are assumed to be active for at least six month. Data was collected on the percent of damage on banana corms on at least 9 banana plants per plantation selected at random. Variety from which PCI was picked was also recorded. Percent coefficient of infestation (PCI) formula was based on (Latigo and Bakyallire, 1993; Gold *et al.,* 1994).

The suggested model used was interested in estimating the mean percentage coefficient of infestation, μ, from of the entire population of banana in the study area. The study also estimated the variation in percent coefficients of infestation expressed as $\sigma^{□}$.

Equation 6: REML Model 1

Assuming that the PCI, Y, is normally distributed (□~□ □□, σ□□) é é é é é é ..1

The model can be expressed as:

Equation 7: REML model 2

□ = □□ + □□ + □□□□□ é é é é é é é é é é é é é é é é ..é é é é é é é 2

Where: □ = Response variable with vector ($□_{□}$ to $□_{□}$)

□= fixed unknown treatment effects with design matrix(□□□) □

□= random effects with design matrix (□□□) □ and □ ~□ (□,$□^{□}_{□}$□); independent effects with equal variance

□= residual errors □~□ (0,$□^{□}$I) Also see (2.7)

3.9 Statistical Analysis

The descriptive statistics used were frequency distribution tables and graphs with varying percentages. Bivariate and multivariate analyses were carried out using chi-square tests and binary Logistic regression. Estimation of percentage coefficient of infestation in banana was done using REML although ANOVA had been suggested by (Blome *et al.,* 2006) after a square root transformation. REML was used because it was found that variables for ñTreatmentsò and ñVariety (CI)ò were unbalanced and spatially collected. After wards Tukeysô multiple comparisons to compare mean PCI for treatments was conducted.

3.10 Scope and Limitation

The study was limited to banana farmers in Masaka and Mpigi Districts. Data was collected on the practices as currently used by farmers. The study was only interested in the utility of choice not the economics of using a given pest control option.

The secondary sample was picked from farmers within a given cluster who use a given control option. They may not have participated in the primary sample. The entire sample for estimating the percentage coefficient of infestation was collected on newly harvested plants. Destructive sampling was not possible as proposed because farmers were not willing to give up their banana. On review of literature (Gold *et al.,* 1999) used newly harvested plants therefore the methodology was adopted.

CHAPTER FOUR

4 RESULTS

4.1 Results for Objective 1

4.1.1 Demographic and Socio-Economic Characteristics of Respondents in the Study Area

The total number of farmers to be interviewed was 144. The number of farmers who responded was 135. The response rate was 94%. Fourteen (14) respondents had critical information they did not disclose and were excluded from the analysis. The number of respondents that were used in the descriptive statistics was 121. In the logistic model, farmers 6 were undecided they were also excluded leaving 115 farmers for the logistic analysis.

Results indicated that they were 70.2% female to 29.8% male respondents (Table 2). The average age of respondents was 53 years for female and 49.3 for male. The number of farmers below 59 years of age engaged in banana farming was 67.7% and those above 59 years of age were 32.3% the number of youth below 39 years was 19.8% (Table 2).

About household size, most household on average had 5-9 people accounting to 55.4% with an average of 6.6 people per household. Families that had more than 10 people were 14.9%, the highest being 18 people in a household. Families that had less than five people were 29.8% (Table 2).

About education the percentage of farmers who had never gone to school was 16.5%. The percentage of farmers who had completed primary education was 50.4%; secondary education 24.8%; and tertiary education 8.3 % (Table 2).

About the average size of land holding, the research found that most of the banana farmers had less than 3 acres of land; 45.5% had 1-2.9 acres of land; 39.8% had 3-4.9acres of land and 14.9% had above 5 acres of land (Table 2).

Results on banana farming systems indicated that; 56.2% of all the respondents were subsistence farmers; 41.3% were semi-commercial and 2.5% were commercial banana farmers (Table 2).

Table 2: Demographic and Socio Economic Characteristics of Respondents (n=121)

	Attribute	Frequency	Percentage
Gender	Male	36	29.8
	Female	85	70.2
Age group	20-29 years	13	10.7
	30-39 years	11	9.1
	40-49 years	24	19.8
	50-59 years	34	28.1
	60-69 years	25	20.7
	70-90 years	14	11.6
Landholding	0-2.5 acres	55	45.5
	3-4.5 acres	48	39.7
	>5 acres	18	14.9
Education	None	20	16.5
	Primary	61	50.4
	Secondary	30	24.8
	Tertiary	10	8.3
Household size	Less than 5	36	29.8
	5-9 people	67	55.4
	10-14 people	14	11.6
	Above 14	4	3.3
Banana Farming systems	Subsistence	68	56.2
	Semi-commercial	50	41.8
	Commercial	3	2.5

On the source of funding for agricultural activities, results showed that the major source of income was farming mentioned by 99.2%. In addition to farming, 38.8% received remittance from children or relatives; 11.6% were salaried earners; 29.2% had business and 19.8% had off-farm employment (Figure 4).

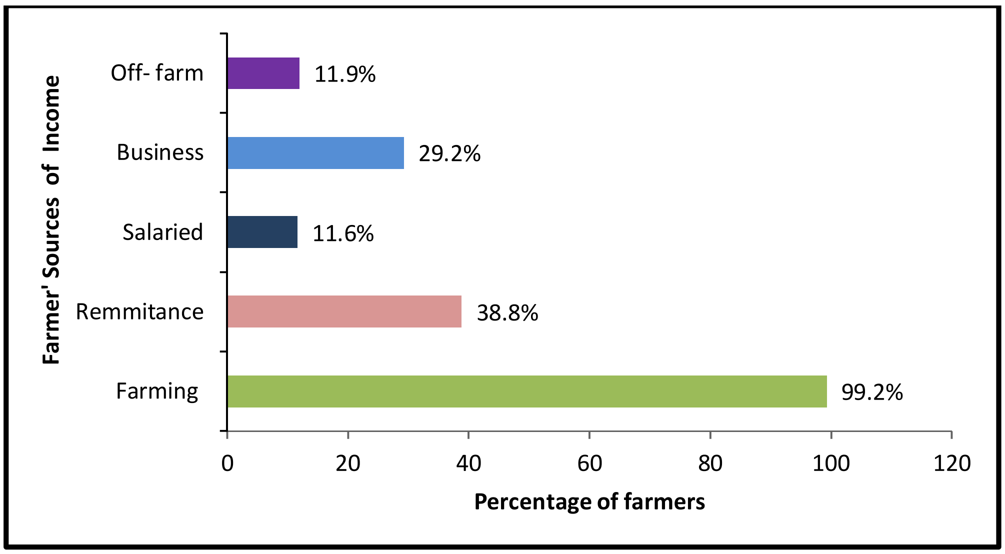

Figure 4: Farmers Income Sources

4.1.2 Relationships between Gender, Education, Landholding and Banana Farming systems

Further analysis showed that the percentage of farmers who had never gone to school was 20% female and only 8.3% male (Table 3). The percentage of farmers who had completed primary education was 52.9% female and 44.4% male; secondary education 41.7% male and 17.6% female; and tertiary education 5.6% male and 9.5% female. Overall Males had a literacy rate of 91.7% and females 80%. The relationship between gender and education was significant (p=0.032) (Table 3).

Table 3: Segregated Gender and Education of Respondents (n=121)

	Male		Female	
	Count	Percent	Count	Percent
None	3	8.3	17	20.0
Primary	16	44.4	45	52.9
Secondary	15	41.7	15	17.6
Tertiary	2	5.6	8	9.5
	Chi-sq 8.782		P. value 0.032	

Analysis between gender and farming system showed that female 79.4% farmers were subsistence farmers compared to 66.7% male who were commercial farmers with significant relationship of gender and farming systems (p=0.027) (Figure 5).

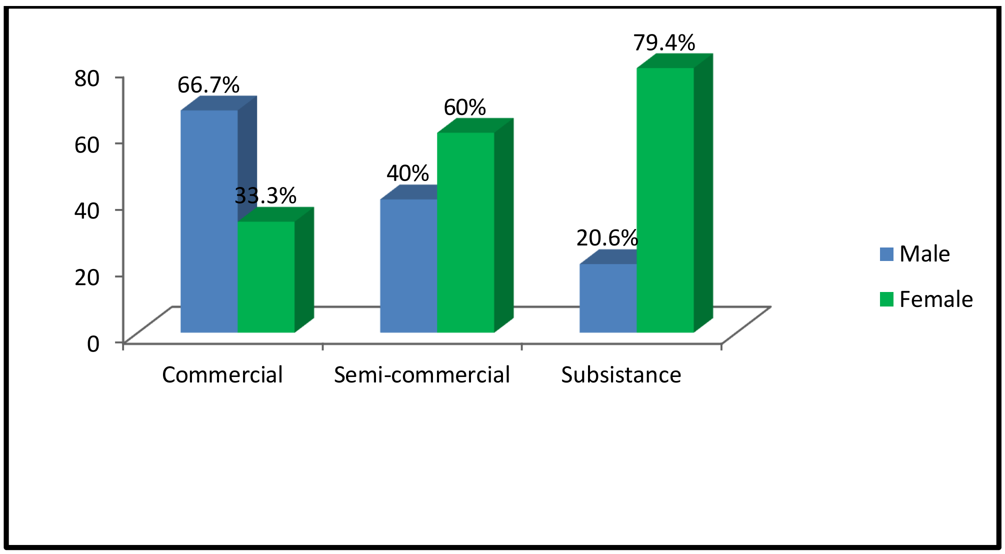

Figure 5: Relationship between Gender and Banana Farming Systems

4.1.3 Chi-square test between Education and Banana Farming systems

Results of this study revealed that 75% illiterate farmers; 60% primary school levers; 46.7% farmers with secondary education and 20% farmers with tertiary education practiced subsistence banana farming; as compared to 25% farmers who were illiterate; 37% with primary education; 46.7% farmers with secondary education and 80% with tertiary education who were semi-commercial banana farmers (Table 4). The relationship between education and banana farming systems was significant (p=0.049).

Table 4: Relationship between Education and Banana Farming systems

Education	Farming system					
	Commercial		Semi commercial		Subsistence	
	Count	%	Count	%	Count	%
None	0	.0	5	25.0	15	75.0
Primary	1	1.6	23	37.7	37	60.7
Secondary	2	6.7	14	46.7	14	46.7
Tertiary	0	.0	8	80.0	2	20.0
	Chi Sq		12.6	P-value		0.049

As regards relationships between gender and landholding results showed that 90.6% had less than 5 acres of land compared to 72% men with a significant difference of (p=0.025) (Table 5).

Table 5: Gender and Land Ownership among Respondents (n=121)

Landholding	Gender			
	Male		Female	
	count	%	Count	%
0-2.5 acres	12	33.33	43	50.6
3-5 acres	14	38.89	34	40.0
>5 acres	10	27.78	8	9.41
Chi. sq 7.3399	P-Value 0.025			

4.1.4 Characteristics of Banana Cropping and Pest Control Products use

Results showed that 22.3% farmers planted banana in pure stand; 33.9% practiced agro-forestry and 43.8% farmers intercropped banana with annual crops or medicinal crops (Figure 6).

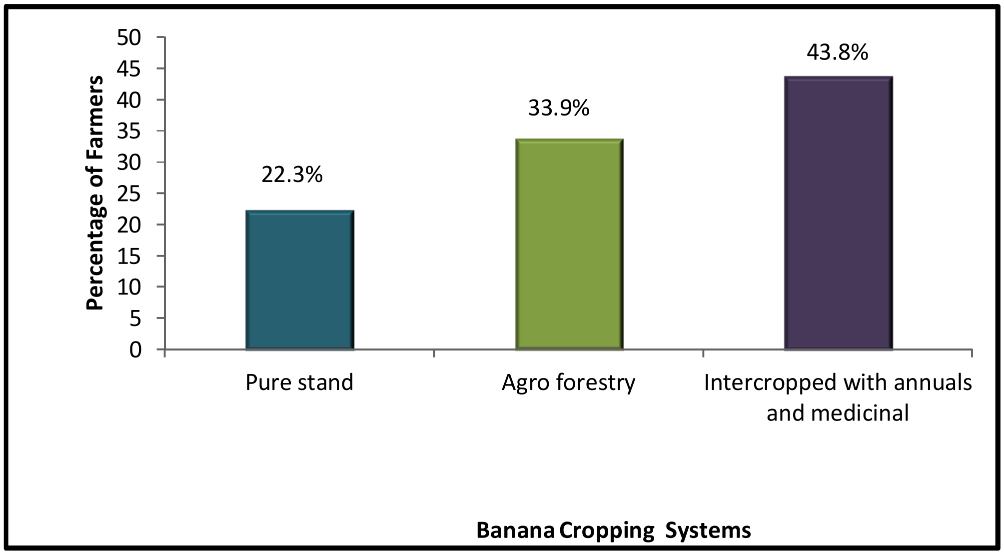

Figure 6: Banana Cropping Systems in Masaka and Mpigi

4.1.5 Pest control Products used in Banana Pest Management (Banana weevils)

Results from the survey showed that out of 121 farmers, 50.4% used cultural practices to control banana weevils and other pests; 30% used ethnomedicinal products and 19% used synthetic chemicals to control banana weevils and other pests (Figure 7).

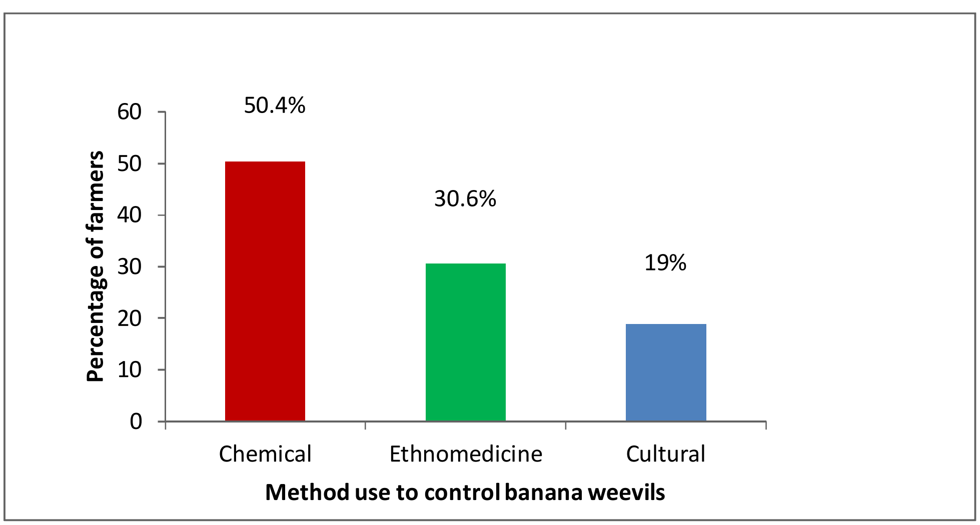

Figure 7: Banana Pest Control Methods in Study Area

4.1.6 Relationships between Gender, Education, Cropping Systems and Products used in Pest Management Systems

Result to compare gender and pest control product used showed that only 36.1% men used cultural practices to control banana pests; 30.6 % employed ethnomedicinal products; 33.3% applied synthetic chemicals. On the other hand, 56.5% women used cultural practices; 30.6% still applied ethnomedicinal products and 12.9% applied synthetic chemicals to control banana weevils with a (p=0.02) which indicated a significant relationship between gender and pest control products used to control banana weevils (Table 6).

Table 6 : Relationship between Gender and Pest control Product used

	Product use2					
	Cultural		Ethnomedicinal		Chemical	
Gender	count	%	count	%	count	%
Male	13	36.1	11	30.6	12	33.3
Female	48	56.5	26	30.6	11	12.9
	Chi Sq		7.61	P-value		0.022

The relationship between pest control product used and education showed that 85% uneducated used cultural practices, 15% used ethnomedicinal products, and no one used chemical control. Among the primary education leavers, 52% used cultural practices; 31.1% used ethnomedicinal products and 16.5% used synthetic chemicals. Among farmers with secondary education, 30% practiced cultural methods; 40% ethnomedicinal products and 30% synthetic chemicals. Whereas for farmers with tertiary 30% exercised cultural practices; 30% used ethnomedicinal products and 40% synthetic chemicals (Table 7) with a significant relationship of (P-value=0.004).

Table 7: Gender, Education and Product used to Control Banana Weevils

	Product used					
	Cultural		Ethnomedicine		Chemical	
Education	count	%	count	%	count	%
None	17	85	3	15	0	0
Primary	32	52.5	19	31.1	10	16.4
Secondary	9	30	12	40	19	30
Tertiary	3	30	3	30	4	40
	Ch. Sq		18.82	P-Value		0.004

Results of the cross tabulation to compare products used in pest control and the cropping systems indicated that farmers who practiced cultural methods , 21.3% planted banana in pure stand , 23% agro forestry ; 55.7% intercropped banana with annual crops. Farmers who used ethnomedicinal products, 16.2% planted banana in pure stand, 48.6% practiced agro forestry, 35.2% intercropped banana with annual crop. Farmers who used chemicals 34.8% grew banana in pure stand, 39.1% practiced agro-forestry and 26.1% intercropped banana with annual crops with a significant association of (P-value=0.024) (Table 8).

Table 8: Cropping System and Product Used in Pest Management n= (121)

Product	Pure stand		Agro forestry		Intercrop with annuals	
	Freq	%	Freq	%	Freq	%
Cultural	13	21.3	14	23.0	34	55.7
Ethnomedicine	6	16.2	18	48.6	13	35.2
Chemical	8	34.8	9	39.1	6	26.1
Ch-square	11.2			P-value	0.024	

4.2 Results for Objective 2

4.2.1 Ethnomedicinal Product used in Banana weevil Management

Farmers who had knowledge about ethnomedicinal products were 74.2% and 25.8% didnœt have any knowledge about ethnomedicinal products. Ethnomedicinal products used were mainly from three sources: - Kitchen wastes mainly ash used by 90. %; animal products (urine) mentioned by 27.3% and plant sources mentioned by 33.8% of the respondents (Figure 8).

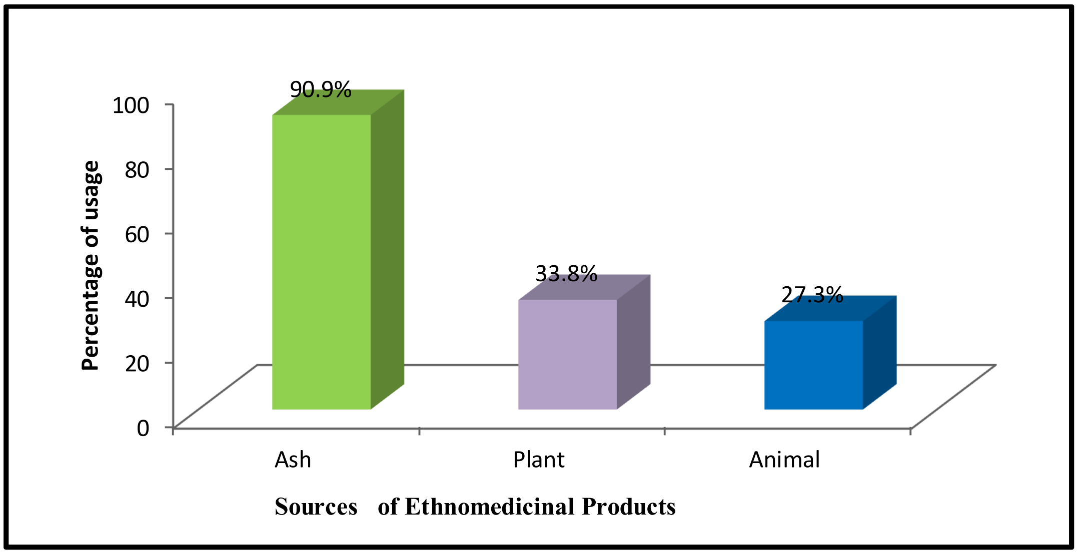

Figure 8: Sources of Ethnomedicinal Products

4.2.2 Ethnomedicinal Plants used in Preparation of the Products

The most common ethnomedicinal plants used to make ethnomedicinal products were: Pepper (*Capsicum frutencesis*) with user value of (0.554) reported by 40%; tobacco (*Nicotiana tabacum*) was mentioned by 20% with user value of (0.442) and Mexican marigold (*Tagetes minuta*) reported by 13% with a user value of 0.132 (Table 9). The plant with the least user value was Asplia Africana C.D Adams with user value of 0.017. Other plants mentioned were: - *Phyotolaca dodecandra, Tethonia diversifolia, Tephorosia vogelii,* and *Crassocephalum crepidioides*

Table 9: Plants used in Banana Pest Management

Common name	Scientific name	Part used	Freq of response	User Value (UV=× M/T)
Red Pepper	*Capsicum frutencesis*	Fruits	67	0.554
Tobacco	*Nicotiana tabacum*	Leaves	51	0.422
Tephorosia	*Tephoresia vogelli*	Leaves, seeds	16	0.132
Mexican marigold	*Tagetes minuta*	Leaves, intercrop	12	0.099
Phytolaca	*Phytolaca. dedocandra*	Leaves	18	0.149
ñSsekotekaò	*Crassocephalum crepidioides*	Leaves and intercrop	4	0.033
Lantana	*Lantana camara*	Leaves	1	0.008
Tethonia	*Tithonia diversifolia*	Leaves	2	0.017
Lemon grass(Citronella)	*Cymbopogan nardus*	Leave extracts	1	0.008
Vernonia(Quinone)	*Vernonia amygdalina*	Leaves	1	0.008
Garlic	*Allium sativa*	Bulbs	3	0.025
Makayi(Astraceae)	*Asplia Africana C L Adams*	Leaves	2	0.017

4.2.3 Preparation of Ethnomedicinal Products used in Control of Banana weevils

The methods of preparation of ethnomedicinal products in order preference were: fermentation reported by 62.8%; powdered applications by 31.5 % and both compositing and mulching, mentioned by 2.85% each (Figure 9).

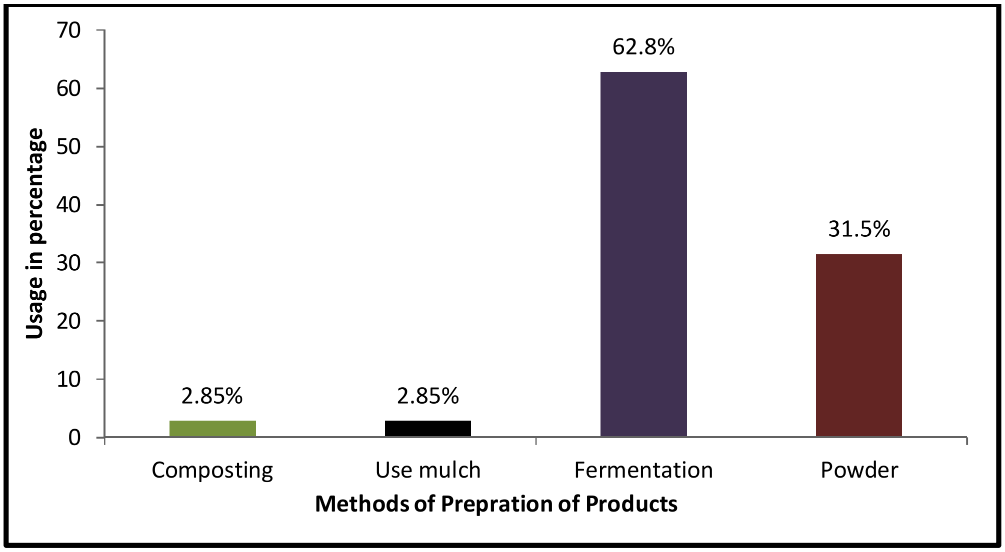

Figure 9: Mode of Preparation of Ethnomedicinal Products

4.2.4 Methods of Application of Ethnomedicinal Products

Results showed that 46.3% of the farmers apply products on spot; 40.5%; band application and the least was covering ethnomedicinal products under soil mentioned by 5.8 % of the respondents (Figure 10).

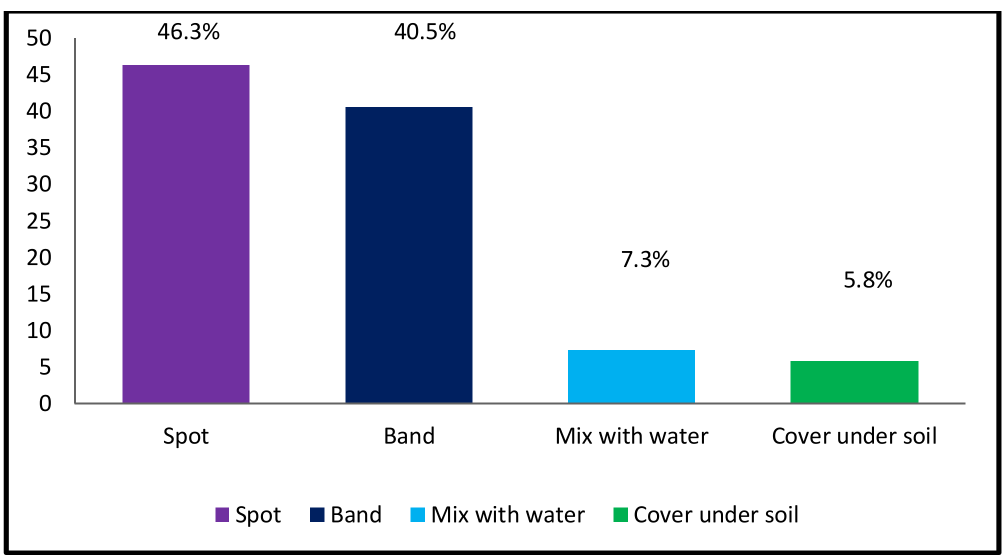

Figure 10: Methods of Application of Ethnomedicinal Products

4.2.5 Relationship between Preparation and Application of Ethnomedicinal Products

Results showed that 100% farmers, who composted, applied ethnomedicinal products under soil; 100 % who mulched applied ethnomedicinal products in bands. Of the farmers who prepared ethnomedicinal products by fermentation, 47% applied them on spot (basal application); 40% in band; 9.1% mixed them in water and sprayed and 6.1% covered them under soil. For the farmers who prepared ethnomedicinal products into powder before application 63.2% applied them on spot; 21.2% in band; 9.1% mixed them in water and sprayed and 6.7% covered them under soil. The chi-square test was significant (P-value=<0.001) indicating a significant relationship between method of application and method of preparation (Table 10).

Table 10: Relationship between Method of Preparation and Application of Ethnomedicinal Products (n=121)

	Common method of application									
Method of	Spot		Band application		Mix with H2O and spray		Cover under soil		Statistical values	
Preparation	Freq	%	Freq	%	Freq	%	Freq	%	X^2	P-value
Composting	0	0	0	0	0	0	3	100		
Use Mulch	0	0	3	100	0	0	0	0		
Fermentation	31	47.0	27	40.9	6	9.1	2	3.0		
Powder	21	63.6	7	21.2	3	9.1	2	6.1	52.73	<0.001

4.2.6 Sources of Knowledge for Ethnomedicinal Products

The major source of knowledge about ethnomedicinal products was from NGO reported by 34%.: government extension services and research 20%; fellow farmers were 18%. ; From the radio 8% and the least by intuition 2% (Figure11).

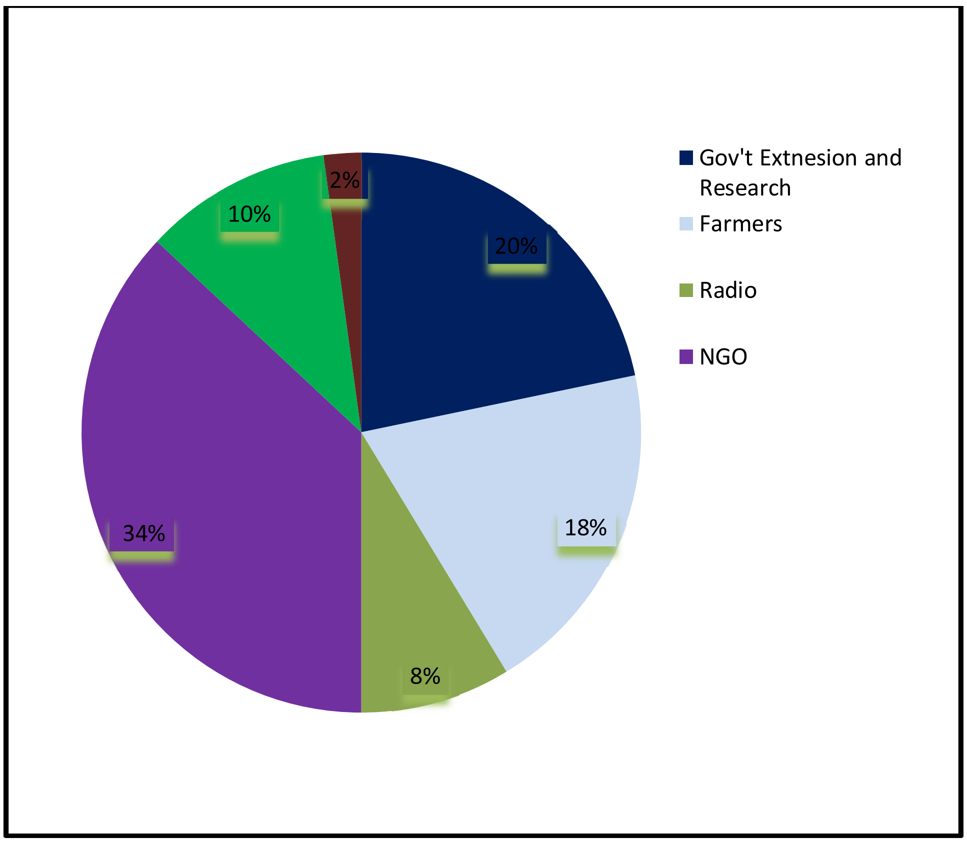

Figure 11: Sources of Information for Farmers on Ethnomedicinal Products (n=121)

4.2.7 Bivariate Relationship between Demographic, Socio economic and Use of Ethnomedicinal Products

Respondents who used the ethnomedicinal products were 30.9% men and 69.4% women. Respondents that did not use ethnomedicinal products to control banana pests were 29.9% men and 70.2% women (Table 11). The chi-test with a P-value=0.93 indicated no significant relationship between gender and use of ethnomedicinal products. This was supported by descriptive statistics that 30.6% men and women used ethnomedicinal products.

On education, of all the farmers that used ethnomedicinal products, only 5% who were illiterate applied the products. The remaining 95% did not use the ethnomedicinal products (Table 11). Of the literate, 35% used the products and 65% did not use ethnomedicinal products. The relationship between education and use of ethnomedicinal products with (P-value= 0.008) was significant.

On farmersô knowledge (awareness) of ethnomedicinal products, 74.2% of the respondents who used ethnomedicinal products were quite knowledgeable (aware) about them. Only 25.8% said that they were not quite knowledgeable about the products. The Chi-test to assess relationship (P-value= 0.001) was highly significant.

As for the relationship between training and use of ethnomedicinal products, the farmers who applied ethnomedicinal products, 44% had received training and used the products; 56% had received training but did not use ethnomedicinal products. Among the farmers that did not receive training only 20% used the products and the rest of 80% did not use the products indicating a significant relationship between being use of ethnomedicinal products and training (P-value=<0.001).

Results indicated that low income farmers who used of ethnomedicinal products were 21.3%; 78.2% low income farmers didnøt use the products. Of the high income farmers, 39% used the products and 61% did not use ethnomedicinal products. There was significant relationship (p=0.035) between economic status of farmers and use of ethnomedicinal products (Table 11). Livestock (P-value=0.623) and method of preparation (P-value=0.118) were not significant determinants for use of ethnomedicinal products.

Table 11: Bivariate Analyses of Respective Variables and use Ethnomedicinal Products (n=121)

Use of Ethnomedicinal Products							
Variable	Attribute	Used		Not used		Statistical values	
		Freq	Percent	Freq	Percent	X^2	P-value
Gender	Male	11	30.6	25	69.4	0.08	0.931
	Female	25	29.8	59	70.2		
Education	Illiterate	1	5.0	19	95.0	7.14	0.008
	Literate	35	35.0	65	65.0		
Knowledge of products	Have knowledge	33	37.5	55	62.5	10.64	0.001
	No knowledge	2	6.5	29	93.5		
Training	Trained	22	44.0	28	56.0	8.00	0.005
	Not trained	14	20.0	56	80.0		
Economic status	Low	13	21.3	48	78.7	4.46	0.035
	High	23	39.0	36	61.0		
Preparation method	Composting	1	33.3	2	66.7	12.60	0.118
	Mulch	2	66.7	1	33.3		
	Fermentation	26	40.0	39	60.0		
	Powder	7	21.2	26	78.8		
Product used	Chemical	10	43.5	13	56.5	32.80	<0.001
	Cultural	4	6.7	56	93.3		
	Ethnomedicine	22	40.5	15	59.5.		
Livestock	Have	32	33.1	71	68.9	0.242	0.623
	Donât have	4	25	12	75		

4.3 Results for Objective 3

4.3.1 Factors the Influence Perception Farmers' Perceptions on Efficacy of Ethnomedicinal Products on Banana Pest Management

Overall, 98.3% of the farmers had problems of pests and diseases in their farm holdings, only 1.7% didnꞌt. A binomial test to calculate the perceived risks of the pests and diseases listed by farmers during the study, when the level of significance was set at (P= 0.05) and the test proportion set at 50% indicated that:

Farmers, perceived risk of banana weevils was 0.97 with (P= <0.001).

The perceived risk of banana nematodes was 0.46 with (P=0.467).

The perceived risk of panama wilt disease was 0.37 with (P= 0.04).

The perceived risk of Banana bacterial wilt was 0.69 with (P= < 0.001) (Table 12).

Table 12: Binomial test of People's Perceived Risk of Pests and Diseases (n=121)

Binomial Test

		Category	N	Observed Prop.	Test Prop.	Asymp. Sig. (2-tailed)
Banana weevils	Group 1	Present	117	.97	.50	.000a
	Group 2	Absent	4	.03		
Nematodes	Group 1	Absent	56	.46	.50	.467a
	Group 2	Present	65	.54		
Banana Bacterial wilt	Group 1	Absent	37	.31	.50	.000a
	Group 2	Present	83	.69		
Panama wilt disease	Group 1	Present	44	.37	.50	.004a
	Group 2	Absent	76	.63		
Pests and Diseases	Group 1	Yes	119	.98	.50	.000a
	Group 2	No	2	.02		

a. Based on Z Approximation.

4.3.2 Indicators of Effectiveness of Ethnomedicinal Products as Perceived by Farmers

Results of a pair wise matrix ranking indicated that split banana pseudostem, to count presence of weevils in the stool ranked the highest sign of banana weevilsô with (6) appearances in the matrix. This was followed by banana stools with water suckers (5); followed by logging of plants and the least used sign to assess presence of banana weevils was the appearance of leaves (Table 13).

Table 13: Criteria of Assessing Effectiveness of Ethnomedicinal Products

		1	3	4	5	6	7
		Appearance of leaves	Logging of plants	Water suckers	Split Pseudostem	Small finger	Hard food
1	Appearance of leaves		3	4	5	6	7
2	Holes in the corm		3	4	5	2	2
3	Logging of plants			4	5	3	3
4	Water suckers				5	4	4
5	Split Pseudostem					5	5
6	Small fingers						6
7	Hard food						
	Number of appearance in Matrix	0	4	5	6	2	1

Ranked indicator			
Split Pseudo stem	6	Small fingers	2
Water sucker	5	Hard food	1
Small leaves	4	Appearance of leaves	0
Holes in corm	3		

4.3.3 Farmers' Perceived Efficacy of the Ethnomedicinal Products Used in Control of Banana weevils

Results of descriptive statistics indicated that sixteen and half (16.5%) of the respondents perceived ethnomedicinal products as very effective; 39.7% effective; 16.5 % fairly effective; 27.3 % not effective (Figure 12).

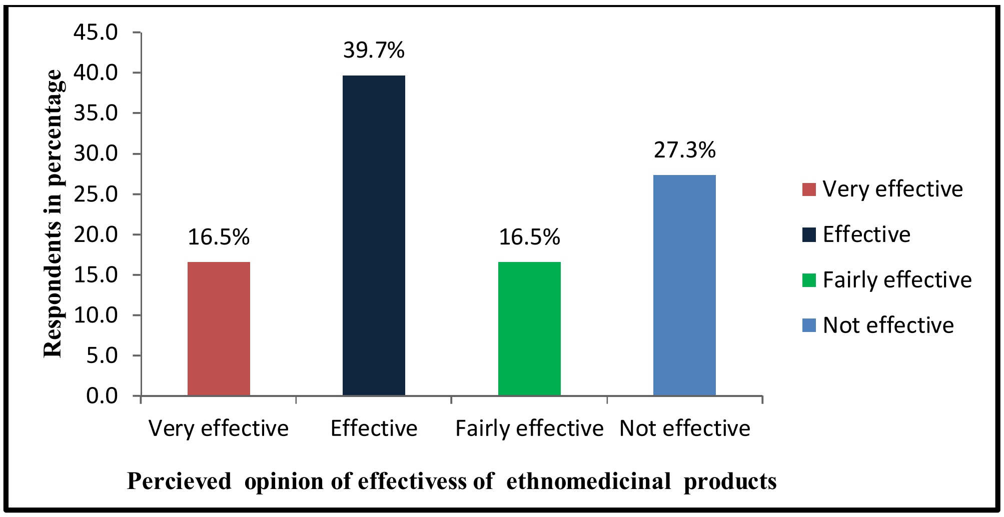

Figure 12: Graph showing Farmers' Perception on Effectiveness of Products (n=115)

4.3.4 Determinants of Farmers' Perceived Effectiveness of Ethnomedicinal Products

According to results of the bivariate analysis, it was noted that out of the ten independent variables entered into the model, it was only knowledge (awareness) of the products that was statistically significant (P=0.005) on how farmers perceived the efficacy of ethnomedicinal products used in banana production.

Although the bivariate analysis shows no significant relationship between gender and perception of the products, female farmers perceive the products more favourably than their male counterparts as shown by the percentages where the former had 68.2 percent whereas the latter had 61.1 percent. Similarly, farmers whose landholding was above five acres had a percentage of 83.3 which was higher than those with 0-2.5 and 3-5 acres (Table 14).

Table 14: Bivariate Relationships of Perceived Effectiveness of Ethnomedicinal Products (n=115)

Variable	Attributes	**Perceived Effectiveness of Ethnomedicinal products**				Statistical values	
		Not effective		Effective			
		Freq		Freq	Percent	ɢ2	p-value
Gender	Male	14	38.9	22	61.1		
	Female	27	31.8	58	68.2	0.573	0.449
Knowledge of products	No	17	54.8	14	45.2	7.941	0.005
	Yes	24	27.0	65	73.0		
Cropping system	Pure stand	9	33.3	18	66.7		
	Agro forestry	14	34:1	27	65.9	0.005	0.997
	Annuals Intercrop	18	34.0	35	66.0		
Landholding	0-2.5	21	38.2	34	61.8	2.886	0.236
	3-4.5	17	35.4	31	64.6		
	>5	3	16.7	15	83.3		
Education	None	8	40.0	12	60.0	4.204	0.24
	Primary	22	36.1	39	63.9		
	Secondary	6	20.0	24	80.0		
	Tertiary	5	50.0	5	50.0		

Perceived Effectiveness of Ethnomedicinal Products (cont.)

Variable	Attributes	Not effective		Effective		Statistical values	
		Freq	Percent	Freq	Percent	ɢ2	p-value
Livestock	Yes	33	31.7	71	68.3		
	No	7	43.8	9	56.3	0.901	0.342
Method of application	Spot	21	37.5	35	62.5		
	Band application	16	32.7	33	67.3		
	Mix with H2O and spray	4	44.4	5	55.6	4.395	0.222
	Cover under soil			7	100		
Income status	Low income	25	53.2	34	50.7	0.66	0.474
	High income	22	46.8	33	49.3		
Training	Trained	18	38.5	32	47.8	0216	0.343
	Not trained	29	61.7	35	52.2		
Pest control products	Cultural	25	53.5	31	46.3	0.406	0.406
	Ethnomedicinal	12	25.5	25	37.3		
	Synthetic Chemical	10	21.3	11	16.4		

4.3.5 Multivariate Logistic Regression of Factors Influencing Farmers' Perceptions of the Effectiveness of Ethnomedicinal products

In the previous section, a bivariate analysis was conducted to examine the relationship between the independent variables and farmersô perception of product effectiveness. It was found in the bivariate analysis that there is a significant relationship between the variable (knowledge/awareness of products) and the dependent variable perceived effectiveness. However, a bivariate association between two variables does not necessarily imply a significant causal relationship between them, because in real life more than one independent variable operates to influence the dependent variable. It was therefore important to carry out a statistical analysis which would incorporate more than one independent variable at a time. The most suitable analytical technique was a multivariate analysis, which allows the exploration of the effect of different independent variables on a dependent variable (Babra and Linda, 2000, Cohen *et al*., 2003).

Preliminary tests for muticollinearity and singularity were negative (Appendix 3). The proportion accounted for in the dependent variables (perceived effectiveness) based on the predictive power of the ten independent variables was 26.2% (Cox and Snell) and 35.3% (Nagelkerke) Mutiple -R -Square (Cohen *et al*., 2003). The goodness of fit between the predicted and observed probabilities using Hosmer and Lemeshow test suggested that that the P-value of 0.323 at 0.05 was statistically insignificant indicating that model was good.

Results from multivariate logistic regression model are given in (Table 15). This table provides the coefficients and odds ratios for those ten variables which were particularly of the researcherøs major interest; were found to contribute to the stability of the model during the backward forward selection and had been tested in a bivariate analysis and tested for multicollinearity.

Table 15: A Multivariate Logistic Regression Model for Farmers' Perception on Effectiveness of Ethnomedicinal Products (n=115)

Variables in the Equation

		B	S.E.	Wald	df	Sig.	Exp(B)
Step 1a	Constant	-4.501	1.364	10.895	1	.001	.011
	illiterate	.192	.676	.081	1	.776	1.212
	secondary	1.548	.694	4.974	1	.026	4.702
	tertiary	-.152	.854	.032	1	.859	.859
	female	1.291	.632	4.178	1	.041	3.638
	acre.3-5	-.238	.528	.203	1	.653	.788
	acre. above 6	1.999	.895	4.982	1	.026	7.379
	semi.com	-.231	.574	.162	1	.687	.794
	com.farm	-1.085	2.042	.282	1	.595	.338
	has.liv.stock	1.611	.789	4.167	1	.041	5.009
	pure.stand	.500	.644	.603	1	.438	1.649
	agro.forest	-.152	.551	.076	1	.782	.859
	use.ethn.pdts	.269	.592	.206	1	.650	1.309
	know	1.151	.589	3.826		.050	3.163
	band.apply	.391	.507	.596	1	.440	1.479
	cover.und.soil	3.044	1.305	5.442	1	.020	20.981
	mix.water	-.402	.856	.221	1	.638	.669
	Hi.income	-1.152	.816	1.997	1	.158	.316
	Use.chemical	.492	.676	.529	1	.467	1.636
	ANYEILDS	.004	.002	2.523	1	.112	1.004

Dependent Variable: farmersô perception on effectiveness of products =1 Not effective =0
Reference category: not effective = 0

The model to find the relationship between the dependent variable farmersô perception on effectiveness of ethnomedicinal products using a logistic regression, indicated that if all other factors are set to zero (B_0) the farmers perceived ethnomedicinal products not effective. This was evidenced by the negative constant coefficient of -4.501 and p-value of (0.001<0.05) which was significant (Table 15). However, this does not disregards the descriptive statistics which indicated that the farmers who said that they were effective (56.2%) were more than (43.7%) farmers who said they were not.

Results from the full model indicated that there was a pattern of relationship between gender and perceived effectiveness of ethnomedicinal products. Female farmers were more likely to perceive ethnomedicinal products being effective by 3.638 times than their male counterparts. This was indicated by the positive coefficient for the dummy variable of gender with a value of 1.291 and (P-value=0.041). This suggests that being a female significantly increases the probability of a farmer perceiving ethnomedicinal products being effective.

About knowledge, results of the logistic regression indicated that farmers who had knowledge of ethnomedicinal products were 3.164 more times likely to predict ethnomedicinal products effective, with a positive coefficient of (1.159) which was statistically significant (P-value= 0.05) (Table 15).

The third factor, which was positively significant in the model, was presence of livestock. It was found that possession of livestock increases the likelihood of farmers rating ethnomedicinal products effective as indicated by positive coefficient of 1.612. The odds of having a positive rating were five more times than farmers who donĝt own livestock and was statistically significant (P-value=0.041).

To find out the contribution of the cropping system to model, in this study, farmers were divided into three groups in relation to cropping systems they practiced namely: Pure stand, agro forestry and intercropping with annual crops. According to the results, farmers who practiced pure stand banana production were more likely to rate the products positively as shown by the positive coefficient (0.5) than those who practiced intercropping. The negative coefficient for the dummy of agro forestry (-0.152) implies that the farmers in this group were less likely to rate ethnomedicinal products positive than those in the reference category. Although cropping system was not statistically significant, the results of the odds ratio imply that farmers who used pure stand are 1.649 more times likely to have a positive perception whereas those who use agro forestry are 0.859 less likely to have a positive rating than those who use intercropping (Table 15).

As regards landholding, results of the analysis showed that having 3-5 acres decreased the likelihood of having a positive perception by 0.796 times whereas having 6 acres increased the perception by 7.379 times more than those with less than three acres.(0- 2.5acres). As land size increases to more than five acres, the odds increased by seven times compared to that of farmers in the reference category (0-2.5 acres). Despite the above findings, the p-values for the two coefficients of farmers with 3-5 acres and above 5 acres (-0.238 and 1.929) show that it is only farmers with more than five acres who had a significant likelihood of perceiving the products as being effective (P-value= 0.026) (Table 15).

About the relationship between education and perceived effectiveness of ethnomedicinal products, the coefficients for the different categories of level of education showed that, farmers with no education had almost 1.212 more times for rating ethnomedicinal products more effective than their counterparts with primary education as indicated by a positive coefficient (0.192). Farmers whose highest level of education was secondary were 4.702 times likely to perceive ethnomedicinal products being effective than those with primary education. On the other hand farmers whose education was tertiary were 0.859 less likely to rate ethnomedicinal products more effective than farmers who are primary school leavers This is shown by the negative coefficient of (-0.152). Only farmers with secondary education had a significant difference in perception of effectiveness (p=0.02) of ethnomedicinal products compared to the reference category of farmers with primary education.

As regards the method of application of ethnomedicinal products, results showed that, where the method of application was mix with water, there was 0.638 less chances of a farmer to rate the products effective with (P-value= 0.669) compared to the reference category apply on spot. Farmers who apply in bands were 1.479 times more likely to rate ethnomedicinal products effective although it was statistically an insignificant (P-value=0.44) likelihood as compared to reference category (i.e. Spot application). On the other hand, farmers who covered their products under soil were 20.929 more times likely to rate ethnomedicinal products being effective, indicated by the positive coefficient of 3.044 and (P-value=0.002) compared to the reference category (Spot application).

People with high income tended to perceive the products as not being effective as indicated by the negative coefficient of (-1.152). The odds of a high income farmer to perceive the products not effective were 0.316 times compared with a farmer of low income status although the difference was not significant (P-value=0.316).

Lastly is the contribution of the farming system to farmersô perception of the products. Compared to reference category subsistence farming, semi and commercial farmers had a negative perception of the effectiveness of ethnomedicinal products though the rating was not significant (P-value=0.687 and P-value= 0.595). This is shown by the negative coefficient of (-0.231) and (-1.084) compared to the reference category subsistence (Table 15).

4.4 Results for Objective 4

4.4.1 Measure of Banana Damage using Percentage Coefficient of Infestation (PCI)

Results indicated that farmers who used tissue culture planting materials if practicing good husbandry practices had a mean PCI of (2.28%±1.13). Those who used ethnomedicinal products had a back transformed mean of (3.88%±0.96), which was lower than farmers who used chemicals. Farmers who used chemicals directly on the mat had an average PCI of (5.02% ±0.92); those who applied chemicals on trap had highest PCI of (10.76%±1.35). This was higher than farmers who managed banana with good cultural practices with a mean PCI of (6.71%±1.15) (Table 16).

Table 16: Descriptive Statistics of PCI on Banana under Different Treatments (n=282)

Treatment	N	Transformed Mean	Back-transformed mean	Std. Dev	Range
Chemical	46	2.24	5.02	±0.92	3.88
Chemical trap	31	3.28	10.76	±1.35	5.39
Cultural	77	2.59	6.71	±1.15	5.04
Ethnomedicine	69	1.97	3.88	±0.96	3.98
Tissue cult	59	1.51	2.28	±1.13	5.06

The graph in Figure 13 indicated that farmers who used ethnomedicinal products had a mean damage score that was less than farmers who used chemicals on the mat or on traps. Farmers who used chemicals on trap had the highest score of weevil damage in their plantations. The score was higher than farmers who practiced good cultural practices. The results also demonstrated that farmers who used clean plating materials (tissue culture) with good cultural husbandry practises may not require any other invention to control banana weevils as they had the list damage score in their plantations.

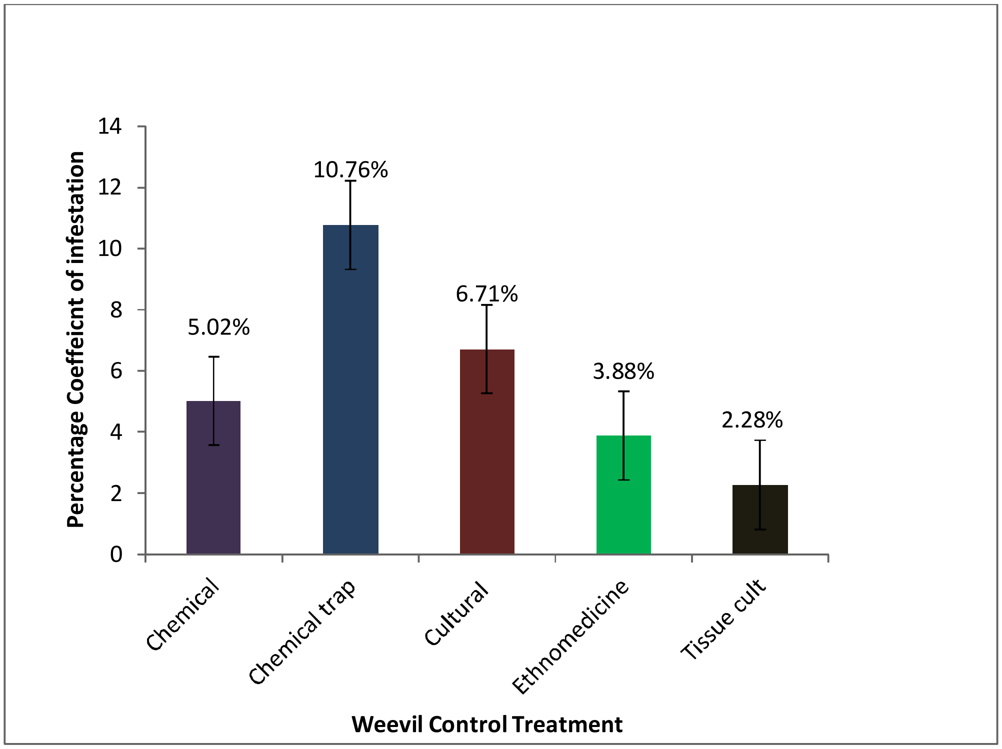

Figure 13: Graph showing the Average Percentage Coefficient of Infestation of Banana under Different Pest Control Treatments (n=282)

Results of the box plot re-affirmed that farmers who had tissue culture banana had the least mean spread of damage score. However, they had outliers whose damage score was very far above fourth quartile (Figure 14). This may signify that if routine management practices are not in place, weevils may as well multiply and damage the plants equally. The spread of damage among farmers who used ethnomedicinal products was slightly lower than where chemicals are used on mat. The highest spread of damage with the highest median was with farmers who use chemicals on traps.

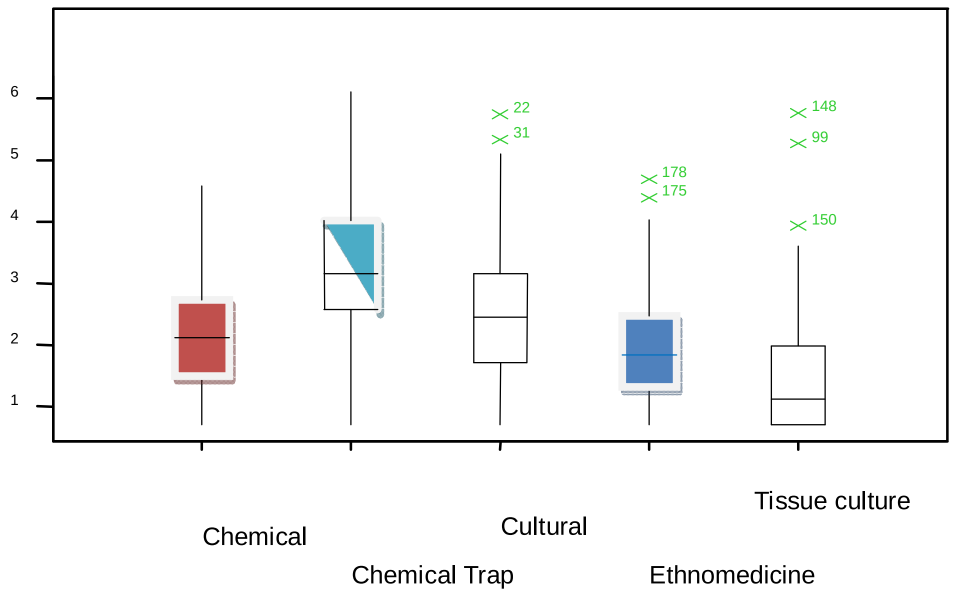

Figure 14: Box plots Showing Distribution of Infestation in Plantations where Different Products are used

4.4.2 Measuring Percentage Coefficient of Infestation (PCI)

The data was tested for normality, linearity and homogeneity of variance. It was not normal. Before analysis data was transformed through a square root transformation after adding a 0.5 ((x+0.5)*1/2.) as recommended by Tinzaara *et al.,* (2003). After using a square root transformed data was fairly normal (Figure 14).

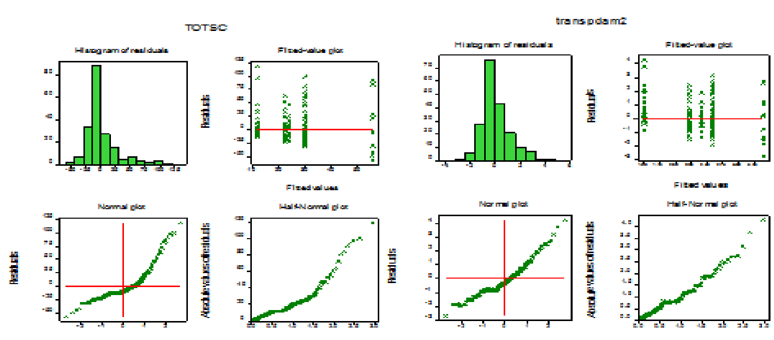

Figure 15: PCI Data before and after Square Root Transformation

The variance for factors ñTreatmentò and ñVarietyò was found to be statistically significant (P-value=0.001). The interaction between variety and treatment with (P-value= 0.262) was not significant (Table 17).

Table 17: Results of Percentage Coefficient of Infestation (PCI) using REML

Fixed term	Wald statistics	n.d.f	F statistics	d.d.f	F pr
Treatment	61.7	4	5.63	222	<0.001
Variety (CI)	88.32	26	6.10	222	<0.001
Treatment.CI	30.6	29	1.30	222	0.146
Dropping Terms	from model				
Treatment.CI	30.6	29	1.30	222	0.146
AIC	268.12		BIC	271.52	

4.4.3 Tukey's Multiple Comparisons

Comparisons were made between different treatments to assess whether there was any significant different between farmers who used different pest control options. Results are displayed in (Table 18) below:

Table 18: Tukey's Multiple Comparisons in ANOVA of Different Pest Control Treatments

Tukey's 95% confidence interval		
Treatment	Mean	Comparison
Tissue culture	1.506	a
Ethnomedicine	1.969	ab
Chemical	2.244	bc
Cultural	2.589	bd
Chemical Trap	3.277	d
a = Treatment with lowest PCI	b = Second best treatment	
c = Third best treatment	d = Treatment with highest PCI	

Farmers who used clean planting materials before the plantation was 3years (Tissue culture) had the least damage and were ranked as (a). Farmers who used ethnomedicinal products ranked as the second option (b) and could get as good results as those who used tissue culture (ba). A farmer who uses chemicals could get the same results as one who uses ethnomedicinal products (b) in this case they rank third (bc); at the same time results of farmers who apply chemicals were not significantly different with those of the farmers who employed good cultural practice (p=0.418). A farmer who uses good cultural practices ranked the same as the farmer who used basal application of chemicals (bc). If not done well the cultural practices yielded high damage (bd), as bad as farmer who applies chemicals on trap (d) which had the highest damage score and therefore was ranked fourth. However, farmers who observed good cultural practices had significantly lower weevil (PICI) damage than farmers who applied chemicals on trap with a P-value of 0.026 at 0.05.

4.4.4 Response of Selected Varieties to Banana Weevils

Results shows that ñNndiziò (Sweet banana), is the least affected by weevils and had the least percentage coefficient of infestation (damage score) of back transformed mean on the original scale of 0.89 % (Figure 15). Among the cooking banana type, varieties with the least mean (PCI) were: - ñNtikeò (2.97%), ñNsakalaò (3.84%), ñMpologomaò (4.11%), ñNakitembeò (4.12%), ñNakawereò (4.47%) and ñMbwazilumeò (5.01%). These were fairly resistant. The most affected were ñKisansaò (40.60%), ñKafubaò (23.98%) and ñGonjaò with a PCI score of (18.58%) but this need to be verified further.

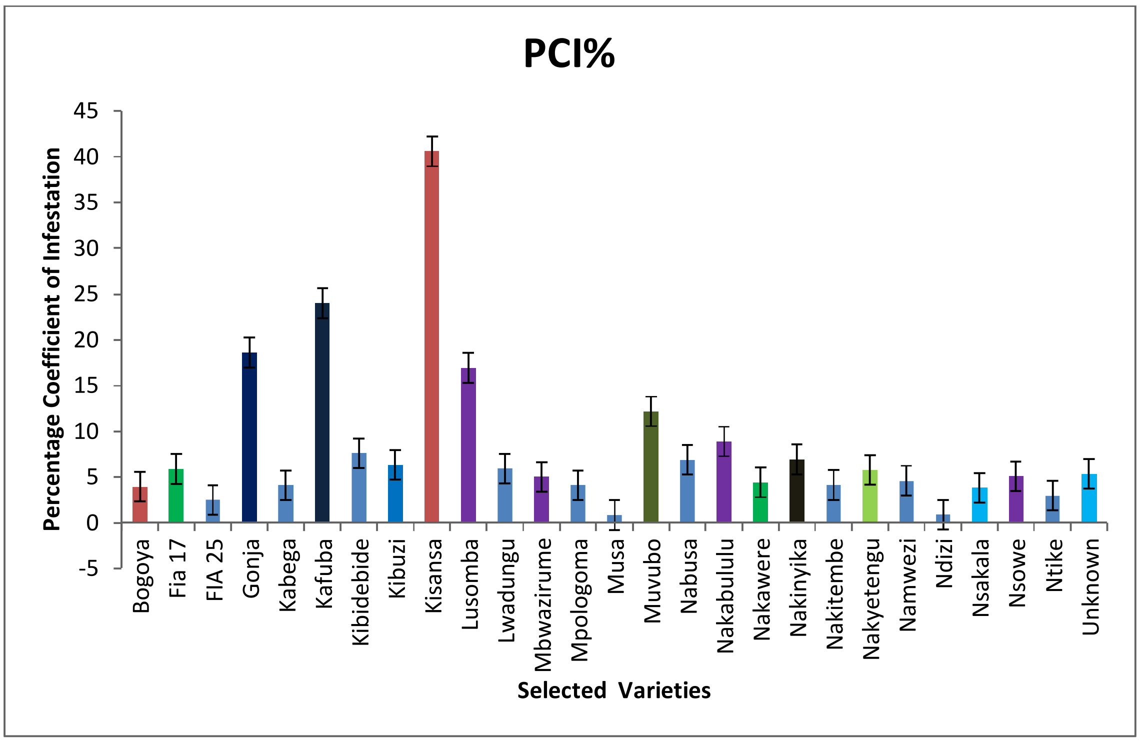

Figure 16: Predicted means Percent Coefficient of Infestation (PCI) for Different Banana Varieties (n=283)

Figure (16) show that different varieties responded in the same way to different treatments. This was evidenced by the p-value for interaction between variety and treatment of which was not significant (P-value =0.26).

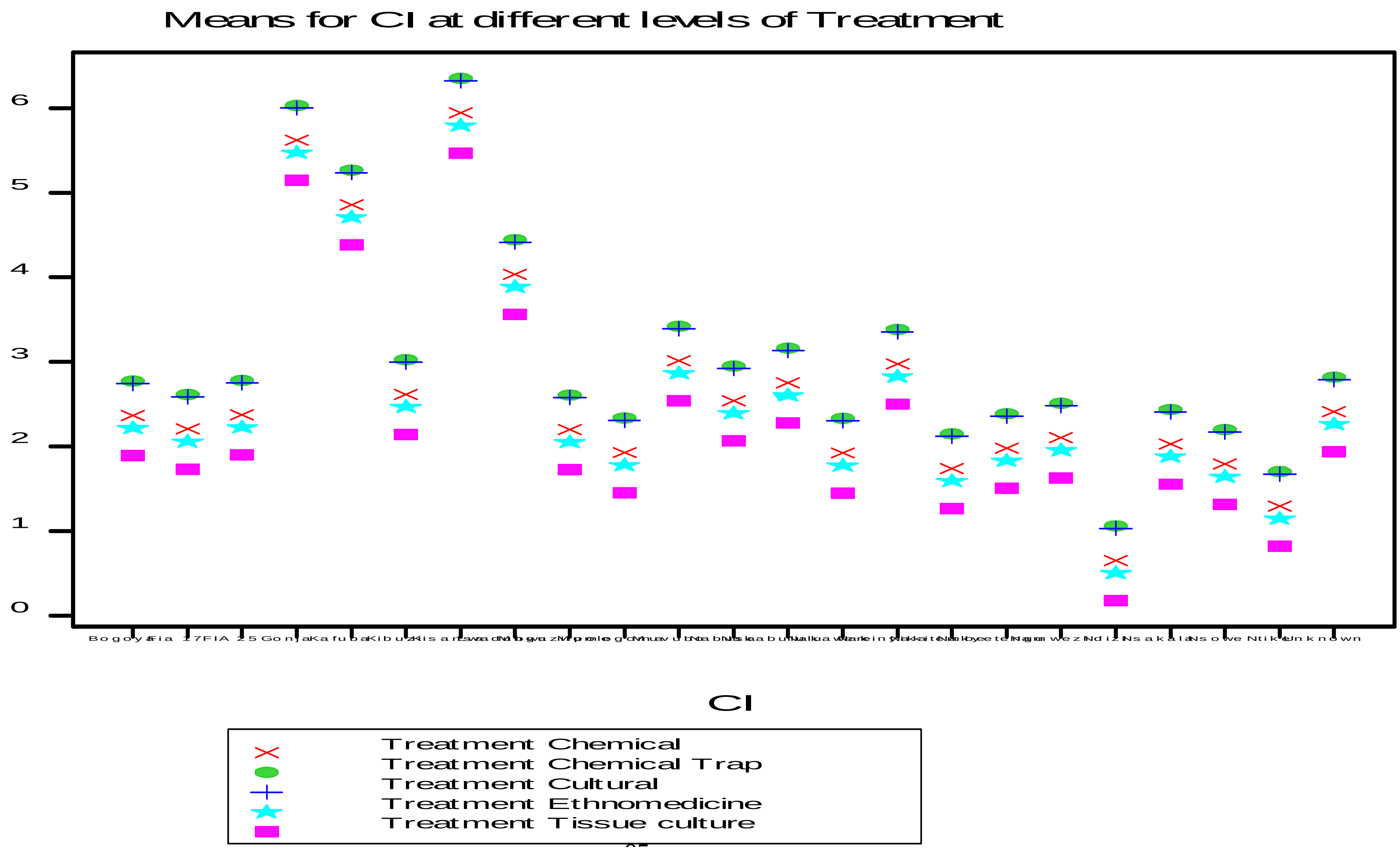

Figure 17: Variety Response to Different Pest Control Treatments (n=283)

CHAPTER FIVE

5 DISCUSSION

5.1 Demographic and Socio-Economic Characteristics of Banana Farmers in Masaka and Mpigi Districts

Information was corrected on the nature of farmers engaged in banana production in Masaka and Mpigi Districts. Majority of the farmers (99.2%) are still dependent on agriculture as their major source of income. This is above the national average of 71% for population census of 2002 and UNHC of 2003 (ILMS2006).

The proportion of women engaged in banana farming was higher than that of men (Table 2). Amanda *et al.,* (2006) had similar findings though it was lower; that 60% men and 49% women mentioned agriculture as their main activity. This implies that they were more women engaged in banana production than men compared to other farming enterprises. However, this is in close agreement with studies done by UBOS (2002): Erbaugh (2006) and Kamatenshi *et al.,* (2010) that estimated the proportion of females practicing agriculture which was as high as 80% compared to 20% male. This signifies that in the study area, women still play a key role in food production and other agricultural related activities. The results were in agreement with findings by Brown (2007) and World Bank (2008) that women are more active in farming than men and embrace farming with objective of producing food for household whereas men mainly produce for cash. Ogato *et al.,* (2009) stated that food production has a high association with child rearing and therefore is mainly controlled by women. In another study Odame *et al.,* (2002) stated that women are two times more likely to engage in agriculture than men. They produce most food crops and provide more than 50% of labour for cash crop.

In this study it was found that the most productive farming age was 30 -59 years. This did not differ significantly from what other researchers had found. However, the aging farmers of 60 years and above differ from that of Kamatenshi *et al.,* (2010) who estimated it to only 6%. Generally farmers that produce banana are of an aging population. This may impact on availability of labour for banana farming activities like preparation of ethnomedicinal products which is labour intensive.

Generally the literacy rate of respondents was slightly higher than that of National statistics that estimated literacy at 75% (UBOS, 2006). Males had a higher literacy rate by 11.7% over females. It has been established that education impacts on the rate of adoption of technology and oneös ability to progress from subsistence to commercial farming. Results of the survey indicated that most of the illiterate farmers practiced subsistence farming. Justin (1990) who carried out research on adoption of rice technologies in China came up with similar findings that education facilitates diffusion of new technologies. Results of the survey indicated that most of the farmers who used ethnomedicinal products had had some level of education and had attended training either with an NGO or from government extension services. It was further revealed that farmers who had completed secondary education adopt to use of ethnomedicinal applications for banana pest control better than their counter parts with primary or no formal education at all. They also progress to commercial farming better than farmers with primary or no education. The rate of adoption was worse with farmers who had no education. This is rather interesting as one would expect use of ethnomedicinal products to be popular with the low educated farmers who mostly carry out subsistence farming and are expected to rely mostly on indigenous knowledge to control banana. One paradigm to explain this may be that perhaps use of ethnomedicinal plants in banana has not so much been used traditionally apart from *Crassocephalum crepidioides* which is traditionally known to prevent banana from logging. It has been perceived by the farmers to have the potential of repelling banana nematodes from the garden and has been traditionally conserved in the banana gardens. Apart from this many farmers use ash for pest and diseases control in banana. This can be explained that use of ethnomedicinal products has been mostly promoted by organic movements, which often requires some level of education to join. Another explanation may be that use of ethnomedicinal products requires some equipment to prepare. Also the role of natural products as an alternative to synthetic chemicals has dominated the health agenda and hence this could explain the learned high use of ethnomedicinal products. There is also an element of labour intensiveness of the methods of preparation of ethnomedicinal products, which may prevent low income farmers from using them. This finding however, contradicts findings by Hiroki and Ashoka (2010) where adoption of conservation tillage in US was inversely proportional to level of education.

The study revealed that the average house hold size of 6.6 persons per household, is above the National average of 4.2 persons per household (UBOS, 2009/2010) for the Central Region in which the study area lies. The mean of 6.6 people per household suggests a high tendency to nuclear families although 11.6 % households with more than 10 persons per household suggest presence of extended and polygamous families. The study also found that there was also a weak relationship between the number of people in a household and type of banana farming system practiced. The mean of 6.6 persons per household and there being a relationship between number of people in household and farming system (P-value=0.049) suggests absence of labour for preparing ethnomedicinal products and other agricultural activities, which are labour intensive, since the children normally constitute two thirds (2/3) of the family and are in school most of the time. This conclusion is derived from Osiru (2006), who conducted a survey around the Kagera Lake Victoria Basin and found that most farmers rely on family labour. It can be may be true that family labour probably still play a major role in banana managements practices like preparing of ethnomedicinal products, weeding, pruning and harvesting.

The study established that most farmers had less than 2.9 acres (1.4 hectares) available for banana production and other farm crops. This is in agreement with National statistics (UBOS, 2006; Bagamba *et al*., 2003: Bekunda, 1999) that most farmers have an average landholding of 3 acres (1.7 hectares).

Findings from this study revealed that there is a significant relationship between sex of a farmer, cropping and farming systems of banana management practiced and amount of land owned. Male farmers (66%) owned bigger land (>3acres) and engage in income generating banana production. Majority of the women (79%) produced banana for subsistence and had less than 1.2 hectares of landholding. Judi (2010) attributed this disfranchisement to womenðs inability to access land; and the African traditional system that inhibit women from owning land whereas access to land is very critical in resource accumulation in rural areas.

Majority of the farmers mentioned farming as their major source of income. According to Nayenga (2008), the proportion of people engaged in agriculture in Uganda, has been increasing from 65.5% in 2002/03, 73.3% in 2005/06 to now 99.7% in 2012/013. However, in addition to farming, the elderly (38.8%) received remittance from children or relatives, which they use to purchase agricultural in puts and house hold needs. Thomas *et al*., (2004) had similar findings in Ghana and Zambia that the elderly farmers rely on remittance to finance household needs. The study also found that respondents who had side business and off-farm employment majority were women. This is perhaps because since women in rural areas produce for subsistence, they look for side business and off-farm activities to supplement household incomes. Nancy and Yan (2009) found that women are more likely to engage in off-farm activities and side businesses because it empowers them and increase their bargaining powers, to improve household welfare. Matse and Young (2004) also agrees that women engage in off-farm activities and side businesses to reduce on household cash constraints and be able to purchase external in puts. The relationship between external sources of incomes (capital flow) and product use were not studied in details. There is therefore need to study the capital flow among farmers especially as regards sources of capital to invest in agricultural production.

As regards the banana farming system mostly practiced, results indicated that it is still subsistence banana production but it had reduced to 56.2% from 90% in 2004 and 80% in 2005 (IFPRI, 2004; Oksma, 2005). Based on the above findings, there are indicators of marked progress to semi-commercial banana farming. However, purely commercial banana farming of 3% in this study was below national average of 6% (UBOS, 2009). The level of farming system practiced influence farmersô perception and choice of pest control products to use. In this study it was found that all commercial farmers used synthetic chemicals for banana production and semi commercial and subsistence farmers mostly used cultural methods and ethnomedicinal products with a significant association of P-value=0.003.

5.1.1 Banana Cropping Systems and Pest Management Practices

The question addressed by this study, to find the banana cropping systems and pest management practices used, established that the most practiced cropping system is intercropping of banana with annual crops or medicinal plants. Advanced system (agro-forestry) involved intercropping of banana with coffee a cash crop and *Ficus natalensis* for production of backcloth a traditional cloth and shade; *Albezai chinensis* and *G. robusta* produced mainly for shade and timber. Ouma (2009) had similar finding in Kenya though he did not quantify the contribution of each system to banana production. Another study by Benkunda and Woomer (1996) established that intercropping of banana with another crop accounted to 69% of banana cropping systems; in this study it accounted for 77.7%. Reddy *et al*., (1998) had similar finding in Kenya where majority of small holder farmers intercropped banana with another annual crop with the most preferred being legumes. Our observation during the study showed that women are more likely to intercrop banana with medicinal plants and annual crop and men to intercrop banana with coffee or *Ficus natelensis*, which is commercial indigenous tree species for production of backcloth. The study found that farmers who practice agro-forestry are more likely to use ethnomedicinal products than cultural practices or chemicals with a significant relationship (P-vlaue= 0.024). The agro-forestry system accounting for 41% may be attributed to the farmersô argument to diversify income for the household and the decreasing land holding; but also agro-forestry provides easy source of firewood and raw materials used in preparation of ethnomedicinal products. Findings of this study also revealed that intercropping of banana with medicinal crops is mainly practiced by farmers who exercise cultural practices. This is mainly due to the banana plantation being the source of traditional medicine (home pharmacy) for primary health care, which according to WHO (2008) account for 80% in Sub Saharan Africa.

5.1.2 Pest Control Products used in Banana Weevils Management

The pest control products used in management of banana weevils is mainly use of cultural methods, ethnomedicinal products, and synthetic chemicals although use of synthetic chemical is low (Figure 8). Similar findings were reported by Reddy *et al.,* (1998) in a study conducted in Kenya 15 years back that found use of synthetic chemicals by the smallholder farmer insignificant. Result showed that men are more likely to use synthetic chemicals and women practice cultural methods with a significant association (P-value= 0.022). This signifies that gender, farming systems and pest control methods are closely related in developing countries like Uganda. This study found that there is a significant relationship between banana cropping systems and pest control methods practiced on farms with a significant association (P-value= 0.024). Agro-forestry system mainly practiced by men on commercial scale offers them cash to buy external in puts, whereas subsistence women farmers who practice intercropping with annual crops canőt afford to buy external inputs. They thus rely on cultural practices or ethnomedicinal products for pest control. Windy (2012) stated that when money is not enough farmers turn to the environment to sustain production.

5.2 Ethnomedicinal products Used, their Sources and Composition

In the study it was found that use of ethnomedicinal products in management of banana pests is gaining ground. Among other reason for the increased use of ethnomedicinal products is there safety to the environment and human. Use of ethnomedicinal products is supported by other scientist like (Nawal, 2012) who had a similar view that use natural pesticides is on the increase because of the side effects resulting from use of synthetics agro-chemicals. Apart from high cost of synthetic pesticide, farmersô perception might limit their usage in banana. Our observation during the time of study was that farmers who were interviewed feared the adverse health hazards that may results from use of chemicals. Also farmers mentioned past history of loss of banana as a result of using fake chemicals óDuduö. Others cited lack of capital and the low returns from banana. Some farmers said that they did not see any significant difference in yields between farmers who use chemical and those that use cultural or ethnomedicinal products methods. Use of ethnomedicinal products as an alternative is one IPM pillar that has not been fully explored, although some scientists like (Musabyamana, 1999; Tamara *et al.,* 2003 and Umel *et al*., 2010) studied use of ethnomedicinal products in controlling banana weevils with success.

5.2.1 Products used in Preparation of Ethnomedicinal Products

Farmers mentioned ash and a mixture of ash, urine and plant extracts as the major components used in preparation of ethnomedicinal products. Organic concoctions were also studied by Byenkya *et al.,* (2006). They also mentioned use of ash, urine and plant extract in preparation of biorationals. Ash which was used by 90.9% of the farmers is part of the traditional knowledge on banana pests and disease management. Ash, urine and plant extracts have also been recommended by Rozeg and Sofrinani (2009). The source of plants used is mainly those grown around home, intercropped with banana or collected from the wild. This is in agreement with the study finding that 43.8% farmers who used ethnomedicinal products practiced agro-forestry. Shahidullah (2007) had similar findings about sources of medicinal plants in Bangladesh. In this study it was found out that 27.3% of the farmers used urine in preparation of the products (Figure 8).

Some of the plants used in banana pest management have been researched upon by (Mwine *et al*., 2010; Kamatenesi *et al*., 2009). The most common ethnomedicinal plants used to make ethnomedicinal products were: pepper (*Capsicum frutencesis*); tobacco *(Nicotiana tabacum*) and Mexican marigold (*Tagetes minuta*). User value indicated which plant was assumed to be the most effective by the farmers. Pepper had the highest user value followed by tobacco and Mexican marigold which was similar in rank with what Mwine and Kamatenshi had found. The plant with the least user value in banana weevil management is Asplia *Africana C.D.* However, this study also found out a traditional plant used in management of banana weevils and nematodes namely, *Crassocephalum crepidioides*, of *Asteracea* family; which also was reported by Blomme *et al*., (2003) but no literature is available on evaluation of its efficacy. This may need further experiments to establish its efficacy on nematodes. Others which are known for their potency are not yet widely used by farmers for example *Tephoresia sp.*

Plate 1: Some plants use in Ethnomedicinal Products

5.2.2 Relationship between Mode of Preparation and Application of the Products

In this study it was found that the most preferred method of preparation of ethnomedicinal products is fermentation of products followed by powdered applications. Composting and mulching are the least used among the studied formulations (Table 10). Most of the methods of formulations used in preparation of banana biorationals are in agreement with research done by (FAO and NOGUM, 2009).

Fermentation is what farmers perceived to be the most effective method of preparation followed by powdered applications. The study found that most farmers extracted ethnomedicinal products with urine and then fermented before application. This had also been reported by Byenkya *et al.,* (2006). Use of processed powdered ethnomedicinal products had been studied by Tinzaara *et al.,* (2003). The least utilised and known methods are compositing and mulching of ethnomedicinal products. Mulching of neem tree leaves, has been studied by (Umel *et al.,* 2010; Blomme *et al.,* 2003) in Nigeria and Uganda, for control of banana weevils with recommendable results. However, compositing a method of preparing ethnomedicinal products was anew finding by this study. There was no literature found on composting as a method of preparing biorationals. Therefore this needs further investigation.

This study found out that the most preferred mode of application of ethnomedicinal products by all categories of farmers, which they also perceived very effective is applying ethnomedicinal products on spot, commonly known as basal application (on the cut corm or pseudo stem) especially after harvesting. The methods of application are similar to the conventional application of synthetic chemicals of applying on spot, band application and spraying in liquid form, but there was no available literature as regards the most effective mode of application of ethnomedicinal products in banana. There is still gap to establish the most effective method of applying ethnomedicinal products; whether to apply them on spot as powder, in band around the mat or to spray them in form liquids on banana. Currently, they are used by farmers in their unprocessed forms. All farmers who participated in the study still use organic pesticidal extractions in their crude form. It is important to note that ease of acquisition and quantities available for application may influence mode of preparation. Results showed that methods of preparation determines the mode of application of ethnomedicinal products with significant association (P-value=0.001).

For example all farmers who composted the product, covered the products under soil. Almost 87% of farmers that fermented the products applied them on spot or in band. It was also found out that more likely; farmers who own livestock prepare ethnomedicinal products by fermentation since they have urine, a medium used in extraction of biorationals. This study came to a conclusion that modes of preparation and application are mostly determined by available labour and materials used. There is need however, to undertake research on preparation of other plants especially those locally available and how they can be made affordable to poor smallholder farmers.

Plate 2: Basal Application of Ethnomedicinal Products

5.2.3 Use of Ethnomedicinal Products and how they relate to Demographic and Socio Economic Factors

This study demonstrated that knowledge of the products significantly ranked high among the factors that influence farmers to use ethnomedicinal products (P-value=0.012). This was perhaps because knowledge of ethnomedicinal products was also highly correlated with a farmer being trained (P-value= 0.002) in to use ethnomedicinal products. It there follows that farmers who do not go for training are less likely to acquire knowledge on how to use ethnomedicinal products. Closely related to source of knowledge is training and use of ethnomedicinal products with a association of (P-value=0.02). Most of the farmers who applied ethnomedicinal products, had received training. More than 56% who did not use ethnomedicinal products had also received training and were quite knowledgeable about them (Table 10).

In relation to training as a source of information for ethnomedicinal products, 34% farmers mentioned NGOs as the major source of knowledge for ethnomedicinal products. This was followed by 20% farmers who got information from government extension services and research. Farmers who got information from extension services provided by government and research and from NGOs counted for 54 % (Figure 11). Similar finding were reported in Kenya by Rees *et al.,* (2000). In the study area chances of a farmer, especially women, to use ethnomedicinal products without training was less than 5%. The study conducted by Adenyi (2010) and Jemal (2010) showed that women are less likely to access knowledge on the use of agricultural information. This is another area of concern highlighted by this study. CTA (1998) had also reported that women have very little access to agricultural knowledge and technologies offered through extension. Women have less time for mobility out of the farm. In addition to cultivation they are involved in other family cores like child upbringing, cooking, washing clothes and cleaning the houses. When asked why they donôt have time to attend trainings, they said that usually training is done in the morning when they have household core to take care of.

Equally, income status had a high ranking of association (P-value= 0.035). High income earners are more likely to use ethnomedicinal products than the low income earner counter parts. This may be due to majority of low income earners being subsistence farmers. It was established that majority of subsistence farmers use cultural practices as their preferred mode of controlling banana pests. Probably due to lack of capital, they lacked resources used in preparation of ethnomedicinal products. Income status and use of ethnomedicinal products were of interest to this research. There seem to be a paradox as to why people with high income status are the ones who mostly used the products; and also to how income and the method of preparation influenced the adoption of ethnomedicinal use.

On education, it was found that ethnomedicinal products were used by farmers of some level of education. The relationship between education and use of ethnomedicinal products was significant (P-value=0.008). The conclusion derived is that use of ethnomedicinal products is likely to be a new innovation in this area. Uneducated farmers mostly rely on cultural practices learned from within the community and they are less likely to attend trainings. This is supported by the study findings where use of ethnomedicinal products was correlated with farmers having been trained.

Presence of livestock though not significant, influenced use of ethnomedicinal products. People who had livestock (88.3%) used the products. This is because of the attachment farmers had on the use of urine as a medium for preparing ethnomedicinal products. Also gender was not significant though more women than men used ethnomedicinal products (P-value=0.093). Although, gender and livestock did not influence use of ethnomedicinal products, later when fitted in the logistic model they were found to be significant determinants of farmersô perception on effectiveness of ethnomedicinal products. This is perhaps because of high number women (69 .4%) who used the products compared to men (30.6%); although the association between farmers who used and did not use ethnomedicinal products was not significant as regards gender (P-value=0.938).

5.3 Farmers' Perception on Presence of Banana Pests and Diseases

This study like the previous studies by Gold *et al.,* (2001) found that banana weevils; other pests and diseases are of great challenge to the banana industry. Banana Weevils (P-value=<0.001); Panama wilt (p=0.004) and Banana Bacterial Wilt (BBW) (P-value=<0.001) were of economic significance to banana production to farmers in Masaka and Mpigi. It was only nematodes which was not considered a significant disease to banana by farmers (P-value=0.467). Failure to recognize nematodes as a significant pest may be due to farmersô inability to identify the signs and symptoms of the pests properly or even not knowing the pest at all. Also very few farmers could clearly identify the signs and symptoms of banana nematodes from weevils other than logging of the plants. Lyne and McHugh (2003) attributed farmersô failure to recognize the effect of nematodes to the pestôs ability to stay in the soils without being observed until they cause severe damage to the plants. The knowledge of banana pest was significant to this study because according to the farmers it determined the method of pest control. For example farmers traditionally controlled nematodes by intercropping banana with *Crassocephalum crepidioides* and apply ash to control banana weevils.

All banana varieties were perceived to be susceptible to banana bacterial wilt (BBW). Panama wilt (PWD) was mainly identified by farmers to attack the dessert type which was in agreement with available literature on banana and susceptibility to diseases by scientists (Reddy *et al.,* 1990; Tinzaara *et al.,* 2003). However, farmers could not clearly distinguish between BBW and PWD symptoms. Therefore, there is need to develop simple identification tools for pests and diseases presence to be used in farmers training programs as early identification is one of the strategies for managing most diseases and pests.

Plate 3: Banana Weevil Infestation

5.3.1 Farmers Perception and Factors that Influence Perception on Effectiveness of Ethnomedicinal Products in Management of Banana weevils

Findings of this study established that 56.2% of farmers perceive ethnomedicinal products as effective on banana weevils. However, this contradicts with the constant of the logistic model, which indicted that farmers perceived ethnomedicinal products not effective. This was evidenced by the negative constant coefficient which was statistically significant (P-value=0.001). This may be empirically true as model predicts using the multiple factors and how they interrelate. Use of ethnomedicinal products is considered indigenous knowledge (IK) which, according to (Briggs, 2005) is in tension with western scientific knowledge. However, generally, development has been

contextualized to mean acquiring western technology. Use of ethnomedicinal products and IK is considered as residual, traditional and backward way of life that is parochial, un-intellectual, primitive, emotional contrary to western science that is systematic and objective (Briggs, 2005).
This notwithstanding, in the descriptive statistics, the farmers who said that ethnomedicinal products were effective (56.2%) were more than the farmers who said they were not (43.7%). Farmers whose view is that ethnomedicinal products are effective are supported by research by scientists, which have found use of organic options as an alternative. Tinzaara *et al.,* (2006) and Mushabyerimana (1999) have recommended use of ethnomedicinal products in the IPM. Other scientists who support the hypothesis include (Govender *et al.,* 2008; Umel *et al.,* 2010). They found ethnomedicinal products effective and recommended their use. Factors in the full model that emerged as having statistically positive rating for ethnomedicinal products were:-gender, presence of livestock, farmers who had more than six acres, farmers whose education was secondary and those who covered ethnomedicinal products under soil.

The study found that women were 3.6 times more likely to rate ethnomedicinal products more effective than men. This may be attributed to the fact that most women were subsistence farmers, which mean that they did not have resources to buy synthetic chemical and their directly being responsible with preparation of food. Thus they were not willing to use food that may affect the health of the household. Therefore, they were more likely to use options that are within their reach, save income for other needs of the family and ensure safety of their households. It had already been established that women participated in off-farm activities and petty business more than men which was evidence that what they got out of farming is not enough.

However, they might have been driven by their being innovative. Studies conducted by World Bank, (2008) presented women in Africa as the major drivers of new technology and innovations. Kagri, n.d stated that innovation in rural areas is value based and has a bearing to social norms. Women are more likely to try out options that will give the safest custody of their family. One of the female farmers, who was interviewed and was a horticultural producer as well, said that she could use chemicals on crops for commercial value but not on banana and vegetables for home consumption. This implies that farmers are aware of the health hazards brought about by synthetic chemicals and that perhaps why more women embraced use of ethnomedicinal products especially on products for consumption.

As regards landholding, there seems to be relationship between size of land owned and the rating of ethnomedicinal products. In this study it was found out that as land size increases to more than five acres, the odds increased by almost six times compared to that of farmers in the reference category (0-2.5 acres) with a significant relationship (P-value=0.003). This is supported by the analysis, which indicated that ethnomedicinal products were significantly more likely to be used by farmers of high income status as compared to low income farmers (P-value=0.001). It is the well off farmers that normally own bigger land. In this study most of the farmers who had less than 3 acres were subsistence farmers who mainly employed cultural methods to manage banana pests and diseases. It has been observed that small farmers donùt care about adopting new technologies and because they are poor they cannot afford technologies that require extra capital (Truong, 2008). They were therefore less likely to use ethnomedicinal products that required equipment like buckets to prepare them in addition to the labour costs involved.

As regards education, results of the logistic model (Table 15) indicated that education increases farmersô perception of ethnomedicinal product as being effective. This is in agreement with (Shalie and Zaidi, 1992; Justin, 1990) who asserted that educated farmers have a better attitude towards agricultural innovations. In this study, it was found that the low educated farmers were more likely to use cultural practices than the new technologies. Farmers with high education had recognition of the advantages of the new technologies and the argument to acquire knew knowledge and information. On the other hand, farmers who hold on old practices hesitate to adopt new technologies and worry of yield loss that may result from use of unknown new technologies (Truong, 2008). Although education seems to increase the level of perception, in this study farmers with tertiary education had a negative perception of the products compared to farmers with primary education as shown by the negative coefficient of -0.152. It was found that farmers with tertiary education were more likely to be commercial farmers. It therefore follows that they are more likely to use synthetic chemicals that require less labour to apply than ethnomedicinal products and bring quick results on pests. After all they are more likely to afford them compared to the less educated who are mostly subsistence.

Accordingly, the study established that being knowledgeable (awareness) was positive (1.151) and statistically significant (P-value=0.05) because of the relatively large positive odds (3 more times) over the farmers who were not knowledgeable. This was in agreement with study finding which found use of ethnomedicinal products correlated with knowledge and training. It is also in agreement with studies carried out by Mukadsi and Lusiba (2006) that had similar findings in Naksongola. Another study conducted by Muzarai *et al.,* (2012) in South Africa came to a similar conclusion that acquiring knowledge is usually synonymous with education and attending trainings.

In this study, it was also established that having livestock increased the perceived effectiveness of ethnomedicinal products (P-value=0.04). This is in agreement with Mukadasi and Lusiba (2006): Kizza and Henk (2010) findings that livestock is perceived highly relevant to crop production. This is because livestock provided urine, which is used in preparation of the ethnomedicinal products. Livestock also produces manure that improves soil fertility. The positive coefficient of (1.612) means that possession of livestock increased the likelihood that farmers would rate the products as being effective. It therefore follows that perhaps farmers, who did not have livestock, lacked the basic ingredient for extracting ethnomedicinal products and therefore did not use or rate ethnomedicinal products positively.

As regards perceived effectiveness of ethnomedicinal products and cropping systems in reference to farmers who intercrop with annual crops, this study demonstrated that farmers who practice agro-forestry generally had a negative perception about effectiveness of ethnomedicinal products and those that practiced pure banana cropping system had a positive rating about their efficacy. A research conducted by Ngeleza *et al.,* (2011) found that a cropping system is determined by farm internal factors like available resources, household constraints, as well as external factors like policies, transport and political influences. Government extension and policy tend to favour use of synthetic agricultural inputs and a coffee banana intercrop in the coffee banana agro-system. This might be one of the reasons why banana farmers practicing agro-forestry, although they were the ones who mostly made use of ethnomedicinal products, shifted to synthetic chemicals due to the government policy of promoting external inputs and the notion that organic farming canôt sustain production. The agro-forestry system, especially the coffee-banana, provides farmers with extra resources which they can employ to purchase chemicals as compared to intercropping with annual crops which is mainly subsistence. As regards farmers who planted in pure stand, Jules (2002) identified one of the limitations of mono-cropping as the quick depletion of the soils from nutrients. It is therefore probable that farmers who plant banana in pure stand use ethnomedicinal products because of the extra benefit they get for fertilization of banana. This is supported by results which gave by the positive coefficient of 0.56 to the farmers who planted banana in pure stand. Although cropping system was not statistically significant a chi-square test had found cropping system significantly related to choice of pest control product used (P-value=0.024).

5.4 Measurement of Banana Infestation using PCI to assess Effectiveness of Ethnomedicinal Products

The results of this study, demonstrated that farmers who use synthetic chemicals had a high average percentage coefficient of infestation in their gardens than farmers who use ethnomedicinal products (Figure13). This may imply possibilities of resistance to chemicals by the banana weevils and poor methods of applying the chemicals as evidenced by the high PCI of 10.76% by farmers who apply chemicals on traps. This can be attributed to the weak policy of importing agricultural drugs characterised by lack surveillance to check quality of imports to the country. There have been reports of adulteration of chemicals on Ugandan `market (Mcguigan *et al*., 2005).

Famers who used cultural practices had a relatively low PCI though it was higher than where chemicals were used on mat but not statistically significant (P-value=0.418). This was in agreement with Tinzaara *et al.,* (2003) findings in Lwengo where cultural practices significantly reduced banana weevils below economic injury levels especially among smallholdings. Given that this study established that farmers who used ethnomedicinal products, had better results than farmers who used chemical and a statistically better PCI (P-value=0.006) than farmers who practiced cultural methods, this reaffirms the argument to promote ethnomedicinal products to enhance cultural practices. This is supported by findings of (Musabyimana, 1999; Umeh *et al*., n.d, ICPE, 1997, as cited by Reddy *et al.,* 1998) that found biorationals effective on banana weevils. However, findings contradict earlier results by Tinzaara *et al.,* (2003) which did not find a significant difference between farmers who used biorationals and other pest control practices. Best results with less than 2.28± 1.13 PCI were with farmers who practice good husbandry techniques and had planted clean planting materials using tissue culture before 3 years of banana plantation. Gold *et al.,* (1999) had recommended use of crop rotation and clean planting material despite the challenge that banana is a perennial crop and the cost of putting up new plantations is high. However, the duration of this study of 9 months was too short to make deceive conclusion. With the recommendations of (Gold, 1998) there is still need to research on the best combination of strategies, to come up with the optimum IPM practices in banana.

5.4.1 Response of Selected Varieties to Banana Weevils

Our observation during the study showed other than host resistance to pest diseases farmersô preference of a given banana species was determined by other factors like taste and utility. Women were more likely to grow the traditional óMattookeô type and men the beer type. Improved varieties had a high host resistance (< 5% PCI) as compared to the local varieties (> 5%PCI). This is in agreement with (Reddy *et al*., 1998; Kiggundu, 2000) reports that improved varieties expressed higher host resistance to banana weevils than the ñMatookeò type (Figure 16). Among the dissert types, the results of study were in agreement with findings by Kiggundu, (2000) but contradicted another study by Reddy and Lubega (1993) in which, Gonja was found to have higher survival rate than ñNdiziò.

Even when improved varieties had a high resistance to banana weevils, very few farmers planted them preferring the landraces. Among the reasons why very few improved varieties are kept by farmers were that they lack some attributes like food aroma and taste. Therefore, there is need to breed improved varieties that have the required attributes by farmers in order to increase their adoption or to take the new varieties to new areas to banana production or where banana has been greatly hit by pests and diseases. Varieties that had a lower PCI should be evaluated further, especially under organic condition to find suited varieties. Further analysis to find the response of the different varieties to the different pest control treatments showed all varieties responding the same to different pest control options.

CHAPTER SIX

6 SUMMARY, CONCLUSION AND RECOMMENDATIONS

6.1 Summary

This study was prompted by the low productivity of banana, resulting from high cost of controlling pests and diseases, which has created fear and challenges among resource poor smallholder farmers in Masaka and Mpigi. Banana failure among smallholder banana farmers resulting from high incidence of banana weevils and other pests and diseases has resulted into loses in yields, food insecurity and has reduced economic growth among the banana producing communities. With losses in yields, farmers cannot afford to buy synthetic chemical and other inputs to improve productivity of banana. Use of ethnomedicinal products offers alternative especially to smallholder farmers many of who are women. This study was carried out to find efficacy of ethnomedicinal products based on findings that famers perceived them effective. The study employed both experimental and social economic survey approaches. Social economic survey was conducted using interview guides; this was followed by collection of data on PCI to measure damage caused by weevils in plantation where ethnomedicinal applications were applied and where they were not. The study used purposive sampling to select the 2 districts, 4 sub-counties and 8 parishes in which this work was carried out. A random sample was used to select the 24 villages and 144 household sampled. Snowball sampling was used to select farmers from which data on PCI of weevils in banana was collected. Descriptive and inferential statistics specifically percentages, chi-square tests, binary logistic regression were used to assess perceptions and REML was used to assess variance in PCI resulting from different treatments i.e. synthetic chemical applications, ethnomedicinal products and cultural practices used.

Results of the study found that they were more female (70.2%) engaged in banana production than male (29.8%). That more than 80% of the farmers, was more than 40 years of age and had household size of 6.6 persons per household which implies that 2/3 of the households were school going children. It was also found out that for majority of banana farmers, their highest education was primary school. Most respondents were subsistence banana farmers. The methods used to control banana weevils, most farmers (50.4%) employed cultural practices; followed by use of ethnomedicinal (30.6%) and only 19% of farmers used synthetic chemical products to control banana pests. The most banana cropping system practiced was intercropping banana with annual crops or medicinal plants followed by agro-forestry with coffee or *Ficus sp*. Gender and education significantly influenced the type of farming one practices, the cropping system and pest control method used. It also influenced ones perception about pest control products used with women more likely to have a positive perception on use of cultural practices and/ with ethnomedicinal products and men on the contrary more likely to use synthetic chemicals. Presence of livestock, knowledge a farmer, cropping system and size of land also influenced perception about the use of ethnomedicinal products. It was further established that farmers who used ethnomedicinal products had a lower PCI than farmers who used chemicals or cultural practices only. Improved varieties expressed host resistance to banana than the Matooke type (AAA) even under limited pest treatments. Based on the study findings, ethnomedicinal products may be recommended for use to control banana pests especially among smallholder farmers supplemented by good cultural practices. Nevertheless there is need to find the best mode of preparation and application that would make them more affordable and easy to use by the resource poor farmers especially women.

6.2 Conclusions

Since majority of farmers 79.6% were subsistence banana farmers whose household size was on average 6.6 person per household and given that two third (2/3) are children, the study concludes that the category of farmers who used ethnomedicinal products, most of whom were women, were constrained by labour to prepare ethnomedicinal products which are also labour intensive and lacked capital necessary to buy equipment to prepare them.

During the study it was found out that most of the farmers (53%) especially women, intercropped banana with an annual crop or medicinal plants. This study concludes that other than limited incomes, which many subsistence farmers especially women encounter, medicinal plants intercropped in banana plantations still play a major role in supply of households with medicine for human, livestock and crop protection. Banana plantation is also used to intercrop other food crops like beans. This can be attributed to the limited land size available for other crops given that almost 50% of the farmers had less than 3 acres.

In the study, it was established that most farmers (50.4%) still rely on cultural practices to control banana pests and diseases followed by (30.6%) farmers who use ethnomedicinal products and (19%) that use synthetic pesticides. Compared to synthetic chemicals, they are more farmers who use ethnomedicinal products; this is perhaps because ethnomedicinal products complement cultural pest control methods and are environmentally safe. It was also established that women were more likely to use cultural practices and ethnomedicinal products on a subsistence level of production and men were more likely to use chemicals on commercial scale. This study therefore concludes that:-

- Women use cultural practices and ethnomedicinal products because they are poor and cannot afford to buy synthetic chemicals. However, it may also imply that women are more aware of the adverse effects of synthetic chemicals since they directly deal with food.
- Since most banana plantations are intercropped with medical products, it can be concluded that cultural systems still play a role in determining the cropping and farming system of an area.

Given that use of ethnomedicinal products (30.6%) was higher than use of synthetic chemicals (19%); it can be concluded that ethnomedicinal products may be more acceptable to farmers than synthetic chemicals especially women. This conclusion is supported by the high number of female farmers that are registered in the national organic movement (NOGAMU, 2010).

Disregarding the constant in the logistic model which was negative, among the interviewed farmers 55.2% against 43.8% indicated that ethnomedicinal products were effective. The logistic model also indicated that women were more likely to rate ethnomedicinal products effective than men ($p=0.004$). Based on finding of the study it can be concluded that it is because women were the main producers of banana. This is further supported by descriptive statistics which found that they were more women than men engaged in banana production in a ratio of almost (4:1). Nevertheless most of the women (63.3%) as compared to men (38.8%) were subsistence farmers. Therefore, they did not have resource to buy external inputs. This forces them to use available resources e.g. ethnomedicinal products as compared to men who used synthetic chemicals and since they were using the ethnomedicinal products they were more likely to observe their effects.

Being knowledgeable (aware) about the product was a significant factor in adoption of ethnomedicinal products and farmersô perception about them. People who had knowledge of ethnomedicinal products had a positive perception towards them. They were 3 times more likely to rate the product effective than those who had no knowledge (P-value=0.05). It was also revealed that 54% of the farmers mainly acquired knowledge on ethnomedicinal products use through contacts with extension workers either from government or non government organizations (NGOs). Yet the primary managers of the banana, the women, could hardly find time to attend these trainings. Therefore, it can be concluded that the current training approach may not be efficient in reaching all stake holders especially women. On the other hand, it was found that training was highly significant (p=0.008) for women who used ethnomedicinal products as compared to men (P-value=0.235); where training did not significantly result in usage of ethnomedicinal products. This study therefore concluded that women may not access information if it is delivered through traditional workshops and seminars due to the fact that trainings take place during the time they engage in other child rearing activities.

Most farmers who had livestock regarded ethnomedicinal products effective 5 more times than those who donꞌt keep livestock (P-value= 0.041). Livestock provide urine which is mainly used in extraction of active ingredients from plants. It can therefore be concluded that farmers regard ethnomedicinal products mixed with urine more effective on the pests than where it is not and thus a major component in preparation of ethnomedicinal products. This conclusion is supported by the high number of farmers (63%) who prepared ethnomedicinal products by fermentation. Although urine may not be effective in controlling weevils, it supplies extra nutrients required by the banana thus, high vigour and thus resistance to pests and diseases.

Based on the results of the PCI collected from various plantations where different pest control products are used (ethnomedicinal products, cultural practices, synthetic chemicals) and from earlier findings, it was found that there was no significant difference in damage caused by banana weevils between farmers who applied synthetic chemicals and those who applied ethnomedicinal application (P-value=0.678). Yet the mean difference of weevil damage in plantations where ethnomedicinal products were used was lower (3.88%) than where chemicals were used (5.02%). Since there was no significant difference in PCI where synthetic chemicals and ethnomedicinal were used (P-valu=0.678. It can therefore, be concluded that more studies are need on processing and application of ethnomedicinal products in banana pest management ; and that ethnomedicinal products a may be effective; and can be recommended to be used by farmers to control banana weevils together with cultural control methods.

6.3 Recommendations

i. Women were more likely to use ethnomedicinal products then men. Also it was observed that men were more likely to produce for commercial and women for subsistence. It is therefore recommended that women are empowered through better pricing of banana produced under organic production systems so as to attract men to the technology. This is due to the findings that use of ethnomedicinal products was labour intensive which made it hard to be used by women alone.
ii. This study recommends that further studies on the ethnomedicinal plants that can be intercropped with banana be carried out to identify those that promote productivity of bananas at the same time providing traditional ethnomedicinal benefits to people.
iii. It is recommended that other information dissemination channels be used to reach out to women with the most promising being ICT and radio.

iv. Policies to safeguard biodiversity should be strengthened in order to identify and conserve those species which have been found effective in management of human, livestock and crop pests.

v. Owing to the fact that results of the study indicated positive signs of ethnomedicinal products being effective as compared to synthetic chemicals, further studies should be carried out to assess efficacy of the identified potential plants with pesticidal properties under controlled experiments. The study also identified that methods of preparation and application of ethnomedicinal products for banana pest management has not yet been documented. They should therefore be research upon.

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APPENDIX

Appendix 1: Questionnaire

Farmerôs number ☐

(*Please I request you kindly to answer this questionnaire. The information given will remain confidential and names will only be used if there is any clarification needed*)

Bio Data

A.District é .

B.Sub-countyé é é é é é é é é é é é é é ....

C.Parish é

D.Villageé é

E.GPS Coordinates

Attitude	Latitude	Longitude	Accuracy

F.Name of farmer é

G.Sexé é

H.Ageé é

I.Level of Education

☐1 Primary ☐3 Tertiary

☐2 Secondary ☐4 None

I. Number of people in households...

1. What is your major source of income? (*Tick all relevant*)

i.Farming 1 iv.Business 4

ii.Salaried earner2 **v.**Others5............................

iii.Remittance from Children 3

1b. What are the major expenditures of your income? (*give ascending numbers according to rank*)

☐1Food ☐3School fees ☐5Clothing

☐2Medication ☐4Agro inputs

2. If Farming is included what type do you practice (*circle relevant number*)

☐1Commercial farmer ☐3 Subsistence farmer

☐2Progressive smallholder farmer

3. What is the average acreage of your total farm holding?

□1-2.5 acres$_1$

□3-5 acres $_2$

□5acres and above $_3$

4. What are the different crops grown?

i.Cash crop

□ $_1$Coffee

□ $_2$Banana

□ $_3$Maize

□ $_4$Others

ii.Food crops

□$_1$Banana

□$_2$Cassava

□$_3$Potatoes

□$_4$Maize

□$_5$Beans

□$_6$Others (________________,______________,_)

4b. Do you keep livestock ?

□$_1$Yes

□$_2$No

4c. What products do you get from livestock and for what?

Livestock	Product	Uses

(If banana is included)

5. How long have you been with a banana plantation?(*Years*)

5(b) what is the cropping system used for bananas?

□ 1Pure stand

□ 2Agro forestry

□ 3 Intercrop with annual

5(c) What varieties do you grow and why?

Varieties	Reason

6. What are the major banana pests and diseases that destroy your bananas?

Pests	Diseases

6b. Which varieties are more susceptible to given pests and diseases (*tick relevant*)

Variety	Pest /disease	Very susceptible 1	Susceptible2	Moderately Susceptible4	Not Susceptible 5

7. How do you control the pests and diseases in banana? (*if 2 is mentioned go to 8*)

Pest /Disease	1. Synthetic	2.Ethnomedicinal	Cultural	Others

7b. (*If 2 is not included in the answer)* Do you have any knowledge on ethnomedicinal products used in management of banana pests?

□Yes

□No

7c. If ñNoò why?

8. If 2 for 7(a) or Yes for 7(b) which plant parts are used ?

Plant	Source	Leaves	Stem	Roots	Fruits /seeds

9. How are the products prepared?

□1Compositing

□2Use Mulch

□3Fermentation

□4Others

9b.Describe and explain how the products are made.

___

___

___

10. What is method of application?

□1Spot application

□2Band application

□3Mix with water and spray

□4Cover under soils

11. How do you rate their efficacy?

Product	Remedy for	Very effective =4	Effective=3	Fairly effective =2	Not effective=1

12(a) What are the indicators of product being effective? (Ability *to bring the desired effects on pests not the outcome e.g. size of bunch)*

List

i. ___

ii. ___

13. Why did you decide to use these products other than synthetic chemical?

___

___

____

14. What challenges do you face while preparing the products?

Collecting materials	Preparing materials	Applying products	Any others

15. How and where did you get this knowledge?

____

____

Part C

17. How many bunches do you harvest from your plantation after product application?

Product___________________________

Home consumption	Sell	Social

18 On average what is the cost of a bunch from your garden?

(i)1000-5000

(ii)6000- 9000

(iii)10000-15000

(iv)>1500

Thank you very much to give me your time

Appendix 2: Test for Model Fitness

Omnibus Tests of Model Coefficients

		Chi-square	df	Sig.
Step 1	Step	32.113	16	.010
	Block	32.113	16	.010
	Model	32.113	16	.010

Model Summary

Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
1	117.638a	.238	.331

a. Estimation terminated at iteration number 20 because maximum iterations have been reached. Final solution cannot be found.

Appendix 3: Test for Multicollinearity

Coefficients

Model		Co-linearity Statistics	
		Tolerance	VIF
1	Female	.725	1.379
	Illiterate	.308	3.247
	Primary	.241	4.149
	Secondary	.287	3.489
	acre.3_5	.656	1.524
	acre._6	.553	1.808
	com.farm	.716	1.398
	semi.com	.649	1.541
	has.liv.stock	.815	1.227
	pure.stand	.717	1.394
	agro.forest	.690	1.449
	not.use.ethn.pdts	.546	1.830
	no.knoldge	.730	1.371
	Ethnomedicinal	.486	2.059
	Chemical	.527	1.896
	band.apply	.785	1.274
	mix.water	.812	1.231
	cover.und.soil	.771	1.296
	trained	.608	1.645
	Hi.income	.342	2.920
	annual yields	.308	3.251

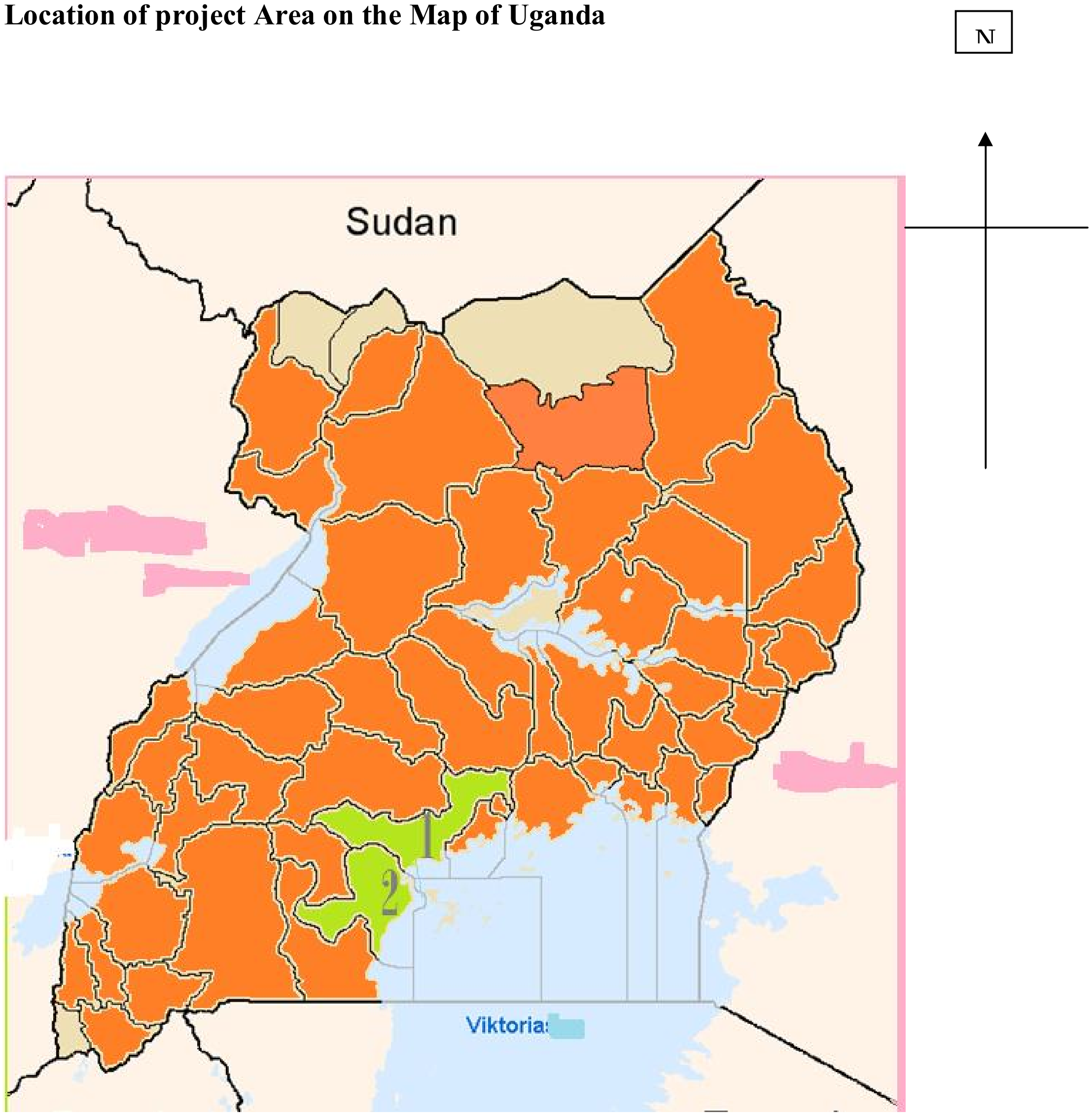
a. Dependent Variable: effective

Appendix 4: Names of Respondents

Name of Participants who participated in Prioritization of Indicators of Banana infected with Weevils Seminar at Bukoto on 6th March 2013

Name	Sex	Farmer Group	Telephone
Mtangwa Nuwa	M	Tuvuddewala	0751768151
Najja Paulina	F	Twekembe	0778996321
Lutta Gonzaga	M	Kisenyi A.C.C.T	0778869251
Ssemakula Ponsiano	M	Nkoko Farmers	0785606644
Ndugwa Davis	M	Kasenyi	0758586445
Kabuye Vicent	M	Basookakwavula	0782530735
Katende Ceasar	M	Bukoto Central	0772950083
Mrs Oliva Mukasa	F	Nkoko farmers	0779878159
Herman Ssekayi	M	Tuvuddewala	
Mwaga Hannington	M	Busookakwavula	0791693898
Ssemakula John	M	Bukoto Central	0776186854
Kakooza Simon	M	Nkoko Farmers	0757889975
Mutaka Peter	M	Kuteesa Farmers group	0751061720
Nalwanga Norah	F	Kuteesa Farmers group	0779908971
Isaaca Kirtu	M	Kuteesa Farmers group	0784446575
Namnde Francis	F	Kisenyi A.C.C.T	0701436626
Matwugola G.W	M	Kakunyu Farmers	0752486942
Muiru Disan	M	Tuvuddewala	0751768766
Lukwago Taddeo	M	Tuvuddewala	0768190239

Appendix 5: Location of project Area on the Map of Uganda



Key:-

Project Area: 1. Mpigi District 2. Masaka District