SOIL FERTILITY ANALYSIS AND AGRONOMIC PRACTICES FOR BANANA ENTERPRISE MANAGEMENT IN THE RWENZORI REGION

MANY YEARS OF CONTINOUS BANANA PRODUCTIONWITH NO NUTRIENT REPLACEMENT!

KABAROLE RESEARCH AND RESOURCE CENTRE AND MOUNTAINS OF THE MOON UNIVERSITY, ON BEHALF OF THE RWENZORI REGIONAL THINK TANK

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PRA	Participatory Rural Appraisal
DS	Diagnostic Survey
INM	Integrated Nutrient Management practices
IITA	International Institute of Tropical Agriculture
NAADS	National agriculture Advisory Services
FAO	Food Agriculture Organization
DRC	Democratic Republic of Congo
KRC	Kabarole Research and Resource Centre
MMU	Mountains of the Moon University
PRA	Participatory Rural Appraisal
DS	Diagnostic Survey
GAA	German Agro-Action
SATNET	Sustainable Agricultural Trainers Network
RICNET	Rwenzori Information Centres Network
NORRACOL	????
CABCS	Community Agric Business Capacity Building Services
CPFs	Community Process Facilitators
SNV	Netherlands Development Organisation
MMU	Mountain of the Moon University

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EXECUTIVE SUMMARY

The East African highland banana (Musa spp. AAA-EA) is a primary food and cash crop in Uganda. Despite its importance, yields on farmer's fields remain poor in the region compared to that on research stations. Quantitative information on the status of soil fertility in banana land use, banana management practices and their adoption and the sources of social capital in Rwenzori region have been scanty. Therefore, what follows below is a summary of research results, from a research that was carried out in traditional banana growing districts of Rwenzori region. The study was carried out by the Rwenzori regional Think Tank, to find out the reasons for the declining productivity of bananas and suggest banana management technologies that can be adopted by farmers with the purpose to increase banana productivity at small holder farmer level. A sample of 357 banana farmers drawn from five districts of Rwenzori region and survey with a participatory Rural Appraisal (PRA) and Diagnostic Survey (DS) research design was used to collect the data.

The objectives of the study were to: (a) Characterize farmers' indigenous knowledge on banana management practices likely to influence banana yield (b) Characterization of factors affecting adoption of banana management technologies (c) Determine the soil fertility status of banana based land use type (d) Characterize banana production constraints and (e) Characterize effective sources of social capital that can facilitate farmer sharing, learning and adoption of banana management.

The research found out that Soil fertility status within the region can support commercial banana growing and falls within recommended critical PH, , Potassium and Magnesium levels. However,attention should be shifted to soil organic matter management, nitrogen and phosphorus that was found to be below minimum requirements. This study found out that, the major constraint to banana production in the region is not declining soil fertility as earlier suggested by previous studies but rather insufficient time dedicated by farmers to work on their plantations. There is increasing competition from other competitive enterprises like cocoa and maize which has compromised the management practices and the time available to work on banana plantations inadequate.

With climate change effects taking toll on the region, biotic constraints hitherto unknown such as diseases, mainly Banana bacterial wilt and" Toduura" and other pests are increasing and destroying many banana plantations. Similarly, negative attitude towards commercial banana farming, limited land, poor transport, lack of training, poor banana breeds, weather and climate changes, lack of labour and poor soil fertility management are other challenges of banana growing in the region.

The declining yields demonstrated by small bunches on most plantations is largely explained by poor adoption of agronomic practices, poor soil organic matter management, mulching, weeding and diseases mainly Banana bacterial wilt, Sigatoka and inadequate extension services available to the farmers. Although most farmers were aware of the best agronomic practices for banana and their importance, more than 90% of the banana gardens remained abandoned in the bush and very few had practiced recommended practices. This was mainly attributed to poor attitudes, labour constraints and lack of resources.

The research further revealed that, the use of demonstration gardens and model farmers by government through NAADS programme for technological diffusion was not very effective. This was based on individual characteristics like education and economic status than farmers' social networks and community values. Social networks have been more effective in technology transfer. Most farmers use knowledge acquired from their parents, fellow farmers who are well known to them than from service providers and demonstration gardens. It was also established that although some farmers have established contacts with some extension services, the relationship has not had a profound impact on farmers' productivity, compared to farmer – farmer extension method obtained from their neighbours or close relatives.

We do recommend therefore that new options to enhance adoption of banana management practices be explored. These include; using social networks in the banana production, supporting communities to adopt best agronomic practices. Technology transfer in banana management should also consider using approaches that are accepted by most farmers and can be easily adopted. There is also urgent need to explore social networks in tackling the threat of Banana Bacterial Wilt. This can facilitate the enforcement of sanitary measures and food security interventions by using group cohesiveness in the various associations the farmers are affiliated to. Unless banana production is taken as a business by farmers it may be difficult to improve production. Most farmers produce for domestic consumption and do not have a business approach to invest in this venture. Therefore, interventions should ensure that communities approach bananas as both food security and commercial enterprise. Finally, we recommend that participatory approaches be used to select and experiment with farmers by integrating community initiatives, knowledge and skills, so that only those innovations which farmers appreciate are the ones that are promoted.

CHAPTER ONE: INTRODUCTION

This chapter presents the background, problem statement, purpose, specific objectives, research questions, Theoretical and Conceptual frameworks, scope and significance of the study.

1.1 Background

In the East African Great Lakes region, bananas provide the staple food for over 20 million people in both rural and urban areas. Annual per capita consumption of bananas reaches 660 kg in some parts of the region, which is the highest in the world (FAO, 1998, Blomme, 2003). Uganda is the world's largest producer of bananas, nearly all of which are used locally. Consumption is estimated at 228 kg per year and per habitant (FAO data cited in Spore, 1998), making Ugandans the largest consumers of bananas in the world. More than 75% of the farmers in the country grow bananas, accounting for 54% of the total tonnage of fresh food produced (Ministry of Planning and Economic Development, 1998). Banana is considered as one of the most important food security crops in the country. This is because the plant fruits all year round, coupled with moderately high organic matter. Yields ensure continuous supply of dietary carbohydrate. In terms of rural revenue and returns to family labor, the banana is one of the most important cash crops in Uganda, contributing 8-22 % of the national agricultural rural revenue (Embrechts et al., 1996; Bagamba, 1994).

Current national production in the country is estimated at 9 million metric tons per annum, accounting for approximately 15 % of the total global production (Gold et al., 2000). An average farmer for example growing banana in southwestern Uganda is able to earn a minimum gross profit of about UGX 900,000 (USD 900) per hectare after meeting variable costs (Department of agriculture, Mbarara, 1997). According to UBOS (Uganda Bureau of Statistic), 2003, it estimates that two thirds of the banana crop is produced in the Western regions of Uganda. No doubt, these regions include the Rwenzori sub region. In order of importance, the groups of bananas grown in the country are; East African highland banana (AAAAAB), Cooking banana (ABB), Brewing bananas (AB, ABB), Dessert banana (AAA, AAB) and plantains (AAB)(Blomme et al,2003). The cooking banana is the most popular one in many households in Uganda.

Despite its importance as both the cash and food crop and its other potential uses, banana production in the country is generally declining. In recent decades banana productivity has been declining, from more than 18 kg per Bunch to, in some cases, less than 1 kg per bunch. On fields with a low soil fertility it is not uncommon to see bunches with less than ten fingers (Woomer et al., 1998). Between 1960 and late 1980s, banana production shifted from traditional growing areas in central region to the south west of the country (Gold et al., 1999; 2000) and during the same period, banana has become an important cash crop with increasing production in south western Uganda as farmers supply the expanding urban market in central Uganda. However, new studies indicate that banana yields are also declining in south western Uganda (Gold et al., 1999) which is the remaining production hub of the country and the fear is that what took place in central Uganda may be repeated in south western if quick interventions are not taken.

Although the yield decline of bananas in the country in literature vary, with some studies estimating average yield to have declined from 8.5 tons per hectare per annum in 1970 to current levels of about 5.7 tons per hectare per annum (Karugaba and Kimau, 1999) while other studies estimate that yields have declined from 9 tons per hectare per annum to 6 ha per year in 2005 (Asten et al., 2003),what remains clear is that yields are far from 60 to 70 tons per hectare per year that can be achieved on research stations (Tushemerirwe et al, 2001) and on certain farms (Smithson et al., 2001) in Uganda. This has raised concerns among banana researchers, farmers and other stakeholders thus raising concerns for further studies to determine the cause of this sustained trend.

There are conflicting reports as to the cause of this yield decline ,with some studies attributing it to soil fertility decline (Masefield, 1949;MacMaster,1962; Bekunda and Woomer,1996 and Sseguya et al.,1999) while other studies have found this not to be the case (Smithson et al.,2001; Ssali and Vlek(Unpublished). Other related studies have attributed it to banana pests (banana weevil and burrowing nematode) and diseases (especially Banana Bacterial Wilt and black sigatoka). This has necessitated further research to establish the real cause of reported yield decline particularly in Rwenzori area. Few studies have been carried out in this region to explain the cause of this decline while other studies, for instance, the one by Gold et al, (1999a), have pointed out that during the last few decades, banana management has deteriorated in central and south western Uganda and is most likely the root of banana productivity problems. This controversy among research findings compels area specific studies.

Although it is generally agreed that banana productivity challenges in Uganda are induced by a combination of pests, diseases, poor soil fertility and drought stress, it is very important to isolate area specific causes of this decline to be able to find the best alternatives. So far, many banana management technologies have been developed to improve banana yields in the country -but very few have been adopted by farmers.

Over the decades, lack of technological adoption and diffusion in agriculture has been major problems, with no leap forward solutions in sight. Adoption is the decision to continue full use of an innovation while diffusion is defined as the process by which an innovation spreads (Rodgers, 1995). Most studies on technology adoption have always focused on individual attributes as factors contributing to successful adoption and diffusion of agricultural technologies.

Although the role of social learning in technological adoption is well recognized in the literature (Foster and Rosenzweig 1995; Conley and Udry 2001; Munshi 2004), factors that intervene in the the sector are less known. A common assumption in adoption research has been that information from early adopters is freely available in the village and all potential adopters can equally access it (Conley and Udry 2001). Social capital depicts the features of social organizations, such as social institutions, networks or associations, less institutionalized networks of friends, relatives and acquaintances (or private social networks) and civic engagement, enable knowledge gathering and information exchange.

The Rwenzori region was chosen for this research because banana is one of their most important food crops, which are gaining commercial recognition. Traditionally every family has a plantation where food for sustaining the family is produced, but with less being produced for marketing. Banana forms the daily food menu for most of the families in this region to the extent that without it, a family feels there is no food. However, Bananas are mainly produced in low input systems on small farms and provide one of the main sources of income, surplus production being sold in urban centres through local traders. Therefore to address banana productivity problems in Rwenzori region, there is a need to develop strategies that address farmer requirements and priorities.

The research therefore hypothesed that systematic learning with farmers and banana stakeholders perceiving economic incentives are necessary for changing farming practices. Thus, experimenting with farmers provides evidence to analyse farmers' practices and perceptions to develop acceptable research objectives. Farmer's participation is key since problems are identified accurately and research activities reflect practices and materials that farmers are familiar with.

1.2 Rwenzori Region

The Rwenzori region is part of the East African West rift Valley and straddles the equator along the border between Democratic Republic of Congo (DRC) and Western part of Uganda. It is a heterogeneous society comprised of the Bakonzo, Batooro, Bakiga, Bamba, Basongora, Batuku, Babwisi, Banyabindi, Bafumbira and the minority Batwa among others.

According to the population projections of 2002 population census (Uganda population census 2001-2005) The region is comprised of five districts; Bundibugyo with approximately a total population projection of 2,557,678 people, that is in Kabarole, 404,006 people, Kasese 693,317 people, Kamwenge 372,567 people, Kyenjojo 494,471 people. There are various forms of land use in the region; most of the land is under small-scale. The Rwenzori region is predominantly an agricultural region with most of the land under small-scale farming but with a marked large scale cash crop production in tea for Kabarole; coffee and cotton in Kasese and organic cocoa in Bundibugyo.

1.3 KRC - MMU Partnership

Kabarole Research & Resource Centre is an indigenous non-governmental/non profit making organization, which has been operating in the Rwenzori region of Uganda since its inception in 1996. KRC's integral approach to development is geared towards the transformation of the social, political and economic spheres of the people in the Rwenzori region and Uganda at large. It involves the grassroots communities in identifying their needs, designing possible solutions as well as monitoring and assessing their own progress. Mountains of the Moon University (MMU), is a community trust, private, non profit University located in the Rwenzori region of Uganda. MMU received an official licence to become operational as a university, in 2005.

KRC, in partnership with University are in the process of establishing a Centre for African Developmental Studies, to study, research and create African knowledge and understanding and inform development processes. This is anticipated to permit new ideas that would effectively bridge the gap between local cultures and broader developmental opportunities that could be tried and tested for new development models for local competences in a holistic framework (KRC – MMU memorandum, 2007). In the partnership, KRC and MMU among other things are required to jointly undertake research and publish information as conceived relevant by either and both parties while contributing to the knowledge base and relevant information for various use within and outside the Rwenzori region. The Emergence and operationalisation of the Rwenzori regional Think Tank has facilitated the improved relationship between the two institutions that presently provide the technical backstopping for the Think Tank Researches.

1.4 The Regional Think Tank

The concept of the Rwenzori regional "Think Tank" emerged during the Kasunga III meeting[1] in 2008. In the previous Kasunga meetings, the leaders agreed to form a leadership team that could learn how to define the best development programmes for the region and prioritise them, create the best possible grassroots-based agenda for development. The Think Tank's aim is to develop the best thinking for the region's development by conducting and coordinating external and local research and synthesising them, with an objective of understanding regional needs and development constraints with the most useful understanding of relevant outside experience and how it could be applied. The Think Tank researches are coordinated by and primarily conducted by the small dedicated technical staff at KRC and MMU. These two teams use all means, including forming any linkages deemed helpful, in identifying key areas of need and formulation of development agenda for the region.

1 These are annual regional leaders' meetings organized by KRC that bring together leaders (culture, religious, members of parliament, Ministers, District leaders) to reflect on the regional development processes and constraints.

1.5 Statement of the Problem

Despite the importance of banana as a both cash and food crop and its other potential uses in Rwenzori region, its production is generally declining. In a regional meeting held by Rwezori regional Think Tank, banana farmers and other district stakeholders, identified declining banana yield as of great concern, because it is the staple food of the area and a measure of food security in many homes. Although uncertainties still remain over the size and the areas of yield decline, it's clear that yields are far from 60 to 70 tons per hectare per year that can be achieved on research stations (Tushemerirwe et al, 2001) and on farms (Smithson et al., 2001) in Uganda. Although many causes of this decline have been suggested by many studies ((Gold et al, 1999a; Smithson et al., 2001; Tushemerirwe et al, 2001)), few such studies have been done in the in Rwenzori region to explain the cause of this banana yield decline. This means that to address the yield gap in Rwenzori region, there was need for a research to find out area specific causes that have led to this yield decline of bananas in the Rwenzori and explain why banana management practices that are supposed to increase yields have not been adopted by farmers.

1.6 Purpose

The purpose of this research study was to establish the causes of banana production decline in the Rwenzori region and then explore the mechanism to increase banana productivity among small scale banana producers in Rwenzori region.

1.7 General Objective

The general objective of this study was to generate baseline information on banana production technologies that will be used to support and improve the capacity of small scale banana farmers in Rwenzori region. Furthermore, to determine the contribution of soil fertility to declining banana yield and identify sources of social capital for farmers

1.7.1 Specific objectives

1. To characterise factors affecting adoption of banana management technologies in Rwenzori region
2. Characterise farmers' indigenous knowledge and practices likely to influence banana productivity in Rwenzori region
3. Determine the soil fertility status of banana based land use type in Rwenzori region
4. To Characterise banana production constraints in Rwenzori region
5. Characterise the effective sources of social capital that can be used to scale up banana production technologies
6. To examine alternatives for enhancing increased banana production in Rwenzori region

1.8 Research Questions

i. What are the farmers indigenous knowledge and practices likely to influence banana productivity in Rwenzori region

ii. What are the factors that influence farmers adoption of banana management technologies in Rwenzori region

iii. What is the soil fertility status of banana based land use in Rwenzori region

iv. What are the banana production constraints in Rwenzori region

v. What are effective sources of social capital that facilitate farmer sharing, learning and practice banana management technologies

vi. What are alternatives for enhancing increased banana production in Rwenzori region

1.9 Hypotheses

The study hypothesised that declining soil fertility and poor agronomic practices and their adoption explain the declining banana yield in the region.

1.10 Significance

It was anticipated that the study would be useful to the following stakeholders

1. To banana researchers in helping close the knowledge gap in banana research study.
2. To extension workers, the research results would be helpful to scale up the technologies to farmers and plan for the next step of action aimed at identified production constraints.
3. To farmers, it is anticipated to help them improve their banana productivity.

1.11 Scope and phases of the Study

The study covered six districts that include (Kabarole, Kyenjojo, Kasese, Kamwenge, and Bundibugyo). Focus was majorly on banana producing farmers and service providers in promoting banana production in the region. The study will be conducted in three phases but the results of the phase II and III will come in the next series

1.11.1 Phase I

This included a baseline study on factors leading to low levels of farmers' adoption of recommended banana agronomic practices, soil testing from the selected sites and general constraints affecting banana productivity in the region and farmers' perceptions on appropriate extension approaches and or methodologies for effective farmer adoption of recommended banana agronomic practices.

1.8.1.1 Target

The target for this phase were; Banana farmers' groups, model farmers, individual small holder farmers and agriculture extension workers.

1.11.3 Phase II

Conduct on-farm experiments designed using various treatments to monitor progress on the recommended alternatives based on findings. This phase is intended to scale up on farm tested technologies that will be identified by the community and used as avenues to diffuse these technologies. The methods to use will mainly be community participatory approaches

1.11.4 Target

Field plots for potential banana growing areas in the regional districts and farms for model farmers as will be identified by respective communities

1.11.5 Phase III

Establish Learning sites for farmers in the region, advocacy and marketing of working strategies and Stakeholders' reflection and action planning on working strategies for banana production in the region.

CHAPTER TWO: MATERIALS AND METHODS

2.0 Introduction

This chapter covers the study area, research design, population, sampling strategies, data collection methods and instruments, data quality control, procedure, model testing and data analysis used

2.1 Study Area and Characteristics of the farming system in the Area

The study was carried out in Rwenzori region in five districts of Kabarole, Kyenjojo, Kamwenge, Kasese, Bundibugyo and Kyegegwa which are the main banana growing areas in Western Uganda .The area lies at an altitude of about 550M above sea level and receives bimodal rainfall pattern varying between 1500 to 1800 mm per annum, with the first rains coming between February and May and second rains between August and December but some areas of Kasese and Kamwenge receiving only short rains. The soils in Kabarole, Kasese and Bundibugyo are classified as Acrisols (FAO, 1998). They are deep, black, well drained fertile volcanic soils mostly dark to brown rich in organic matter but some are yellowish brown loams and sandy clay loams but progress into Luvisols (FAO, 1998) which loamy brown and red soils in Kyenjojo and Kyegegwa..

The dominant types of banana grown in the area are the cooking East African highland bananas (EAHB-AAA), followed by the beer type and desert types (Sukali ndizi and Bogoya). In terms of food production, bananas are the most important crop grown in the area, followed by maize, beans, sweet potatoes and potatoes. Bananas are increasingly competing with cocoa and maize for land and are mainly grown for home consumption with few farmers growing for commercialisation.

The average farm size in the area varies between 1.8 and 2.0 hectares and 90% of the farmers are sole owners of land. The main crops grown in the area are mainly bananas, maize, sweet potatoes, cassava, beans and vegetables. Most farms have a few livestock and the mean numbers are 1.5 local cows, 0.2 improved cows and 12 chickens per farm

2.2 Research design

The study used both qualitative and quantitative approaches with a survey design. A Participatory Rural Appraisal (PRA) and Diagnostic Survey (DS) were carried out. The PRA involved group discussions and key informant interviews to identify farmers' perceptions on bananas management practices and this was to serve as a means of developing research- extension- farmer collaboration and DS was used to assess the onsite investigation of banana production constraints and their contribution to banana yield decline. The study focused on experiential learning to enhance farmers' capacity to observe and make informed decisions.

2.3 Sample size

A random sample of 357 of banana farmers was selected from 22 randomly selected sub counties of banana producing districts of Rwenzori region and participated through Focus Group Discussions (FGDs) and interviews.

2.4 Sampling Procedure

The sub county administrative unit was the primary sampling unit (PSU) followed by the parish (Local Council II) as Second stage Sampling Unit (SSU) and the third sampling unit was the village (TSU). Depending on the intensity of banana growing per district, four PSU were selected from Kabarole, Kyenjojo and Kamwenge Districts while three PSU were selected in Bundibugyo and Kasese District. The number of households selected from each SSU varied from district to district based on banana growing intensity, ranging from 20 and above which is the minimum sample size for conducting hypothesis tests on variables measured at community level where the households were randomly selected. Agronomic practices including cropping systems and soil fertility management practices were identified. With help of local administration chairperson (local council I), a list households within a village was obtained.

2.5 Data collection Instruments

Data was collected using a semi structured questionnaire in relation to factors that were thought to influence the use of banana Management practices was administered on individuals, from selected households. In-depth focus interviews were also carried out with key farmers as specialized informant and then observation of farmer's gardens was used to get onsite management practices and constraints of farmers. In addition, FGDs were used on farmers groups and organizations to triangulate and share information on practices and social capital.

2.6 Soil Sampling Procedures

Ten (10) Soil samples were taken random from 10 sites of sampled farmers' plantation from each randomly selected banana and then used to make composite samples from 10 banana farms from 22 sub counties of selected districts using 5cm diameter soil auger from the depth of 0-15 cm. The samples were then put in polythene bags and sent to Makerere university soil laboratory for mineral, textual and soil P^H analysis. The soil was air dried and sieved to pass thru 1 mm sieve and exchangeable bases –Ca, Mg K and Na determined. Ca and Mg were in ammonium acetate extracts of soil by titration with EDTA (versinate) and exchangeable K and Na were determined using flame photometer. Available P was analyzed by Bray-1 and Kurtz method; Total N by the regular macro Klejdar method. Soil pH was measured using glass electrode (1: 2.5 soil to water ratio and Total C was determined using Walkley and Black Rapid titration method and soil texture was determined using hydrometer method.

2.7 Validity and Reliability

Pre-testing of the questionnaire was conducted in October of 2010 by visiting and interviewing one model farmer with recommended banana practices .Adjustments were then made to the survey instrument following the pre-testing. Several questions were dropped and others added to ensure the correct format for data collection and that the final survey questions were appropriate. To avoid respondent bias, and by way of introduction of the research, a one -page statement of intent preceded the survey questions. Eight graduates in different fields and five agricultural extension specialists were enlisted to undertake the research. They were first trained on the data to be collected and instrument to be used .The team, which was well conversant with the regional local languages undertook an intensive one-day training session on data collection techniques prior to the survey. Each field assistant completed a total of seven questionnaires per day. Data collection took place in November, 2010 and both qualitative and quantitative primary data were collected by way of structured questionnaire administered through personal interviews with the selected respondents. Upon completion of the draft collection tools, the questionnaire and interview guide, the researchers piloted them to ascertain their reliability and validated them for purposes of building confidence and capacity of field data collectors in getting reliable data. The questionnaire was given to people of expertise to see whether the items were rightly stated and then tested using Croncbach Alpha method provided by SPSS (Foster, 1998).

2.8 Data Sources, Collection and Transformation

Data collection took place in November 2010. Both qualitative and quantitative primary data were collected by way of open-ended and structured questions administered through personal interviews with the selected respondents as outlined in the previous section. The final coded questionnaire is contained in Appendix D. The questionnaire contained 8 sections. Section A obtained demographic information from respondents. Section B contained background questions including information on general farming practices. Section C was more specific containing questions about farmer's knowledge banana agronomic practices used by farmers on their farms. Sections D-F had crop specific questions indigenous knowledge and practices in banana management. Sections G and H had question sections requiring information on sources of information and specific information received. The last section required information on factors affecting adoption of banana management practices, constraints to banana production, sources of social capital and actions to be taken by stakeholders to improve banana production

2.9 Data Entry, Analysis and Presentation

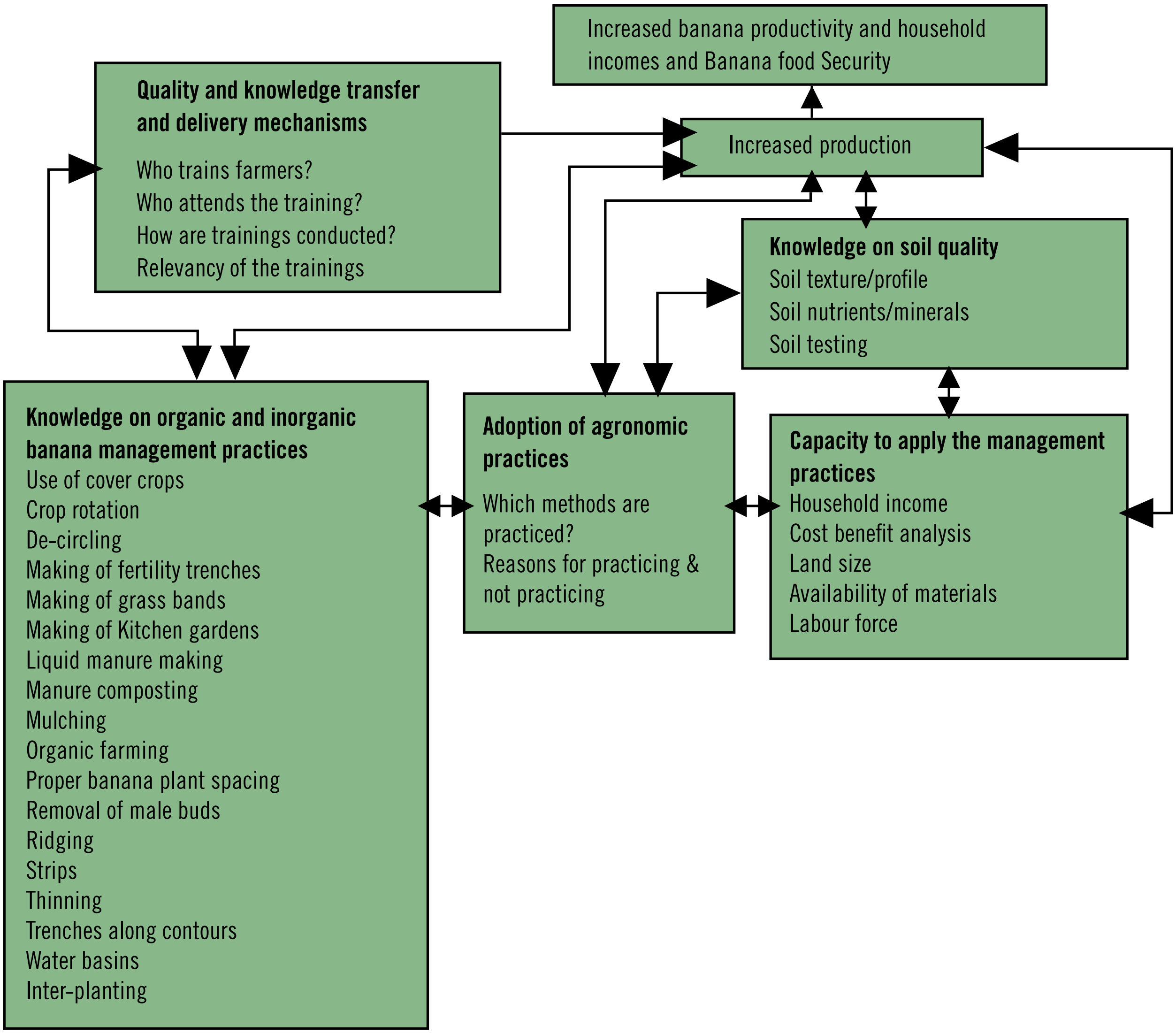
Both descriptive and inferential statistics were used to describe the farming communities and production systems in the study area. Data collected included farm area, demographic data, off-farm income, banana and banana management practice, banana constraints; soil fertility status of average bunch weights and number of bunches harvested, market sales. The completed questionnaires were then cleaned, edited and coded before the data were entered into the computer using the EPI-Info and analyzed through SPSS package. Data were then analyzed, and ANOVA and correlations between various farm practices determined for the sample to determine effects of different practices on banana yield

CHAPTER THREE: Conceptual Frame Work and Related Literature

Section 1: Conceptual Framework

The relationship between increased production and food security and marketing can be conceptualized as follows in Figure 1a.

Figure 1a: Analytical and Conceptual Framework



The Conceptual framework above is based on one stage relationship i.e. increased banana marketing and food security depending entirely on increased production with a number of intermediate variables namely; quality and knowledge transfer mechanisms, knowledge on organic/inorganic banana management practices, adoption of agronomic practices, knowledge on soil fertility and the capacity to adopt the management practices. The relationship between increased banana production and food security and adoption of best management practices and knowledge and assumes the following

- Knowledge on the nature of soils and agronomic practices combined with capacity and ability by farmers to practice the knowledge increases productivity levels of agriculture.

- Knowledge by famers on agronomic practices is dependent on quality of the transmitter, effective knowledge transfer/delivery mechanisms and attitude of the farmer.
- Nature of Soils is key in the growth of banana enterprise in the region. Knowledge by farmers on the soil mineral content enhances the capacity to understand and implement interventions for increasing and maintaining soil fertility.
- Adoption of Better soil feeding strategies and better soil fertility management practices are dependent on farmers' knowledge on soil quality (soil mineral content, soil texture and profile)
- Banana agronomic knowledge application levels at farmer level is dependent on farmer's accessibility to information, farmer's attitude and technology/practice affordability by farmers

In brief, to realize increased banana production, farmers should be knowledgeable on quality of soils, knowledgeable on recommended agronomic practices; and there should be effective knowledge transfer/delivery systems as well as ability by farmers to apply the recommended practices

Section 2: Related Literature

3.1 Banana Management practices and Farmers' Knowledge

Some of the common banana management practises among others include; mulching, desukering corm pairing, detrashing, soil and water conservation. Mulching is the covering of the soil between banana mats (plant stools). This is done to conserve soil moisture, control weeds. Various materials are used such as crop residues of maize stover, coffee husks, elephant grass. Mulching of bananas is an indigenous agronomic practice and was already in use before the colonial period (Jameson, 1970). Farmers favour mulching because they know that it suppresses weed growth, maintains soil fertility and conserves soil moisture for the shallow rooting banana crop. Traditionally, pruned banana leaves, and the plant parts remaining after harvest (harvest stools) are spread on the plantation floor. These are supplemented with organic materials brought in from outfields, fallow fields, and swamps. Banana peelings and other homestead wastes are also usually returned to the plantation. Farmers are aware of the importance of using mulches but have difficulty in distinguishing between the effects of different types of mulch or application rates. Banana residues are universally recycled within the farm (Bekunda 1999).

Desuckering is the removal of excessive plants on a mat to remain with only 3 plants. This ensures that good plant population is maintained resulting into health plants. This is a traditional practise and is commonly done by women (Karamura et al 2004). For example, according to Martney (1987) yield was found highest in the plants left with one sucker followed by those with two and three suckers and the lowest is in plants without removal of suckers because of nutrient competition.

Soil and water conservation is the making of bands especially along contours to control soil erosion. This is most common in hilly areas which have challenges of the surface run off water that removes the top soil. This ensures the most productive part of the soil is conserved to ensure sustainable production. In the Pre-colonial days in Uganda, this was done through bye lays that were enforced by agricultural officer (Bekuna 1999). After independence, there was low adoption. In the recent past, the NGOs have been promoting it in their extension messages.

Corm pairing is the removal of the outer sheath of the corm before planting. This is to control pests like banana weevil and nematodes. It is one of the traditional practises. This has been also promoted by extension staff. De-trashing is the removal of the old leaves. This is one of the traditional practises and commonly done by women (Karamura et al 2004).

Among the Post-harvest management practises of the banana stem is weevil trapping, stumping, splitting the pseudo stems and removal of the corm. These ensure pest and weed control. Manure application is done to ensure soil fertility management. This is by application of ash, composite manure (especially in the hole before planting), liquid manures of animal wastes. These are mainly organic. Use of Organic fertilizers been promoted by many NGOs involved in sustainable agriculture. The use of ash is an old practise handed down through many generations. There is also application of inorganic fertilizers such as NPK (Nitrogen Phosphorus and Potassium). This is not very common because of the cost implications after removal of agricultural subsidies under structural adjustment programmes. These practises are labour intensive and increases with acreage. In some parts of the country, farmers are joined by their friends from the associations they belong to implement them. This makes social capital relevant in adoption of the practises. Commercial farmers employ paid labour and subsistence farmers rely on household members. Where labour is limiting in relation to household members and financial capital, group members become very handy to employ on the farm.

3.2 Factors affecting adoption of banana management technologies

According to Rogers in his Early Adopter theory, individuals adopting any innovation differ in terms of characteristics such as age, gender, income and others. He suggests that adoption process is represented as the normal distribution when plotted over time. Innovators are defined as the first two and a half percent of the buyers to adopt a new idea. Early adopters are the next 13 and a half percent adopts the idea. Rodgers (2003) asserts that the five adopter groups differ in their value orientations, with innovators willing to try new ideas at some risk. Early adopters are guided by respect in that they are opinion leaders in their community and adopt new ideas early but carefully. The early majority are deliberate, meaning that they adopt new ideas before average person although they rarely are leaders. The late majority are sceptical and can only adopt innovations when the majority have tried it and finally , there are the laggards who are suspicious of change and will only adopt innovations when the innovations takes a measure of tradition.

In a study by Chi (2008), it was found out that the main factors affecting farmers' adoption of technologies were their perceptions of technologies, knowledge level of extension staff, methods of organization and management of the extension program and local conditions. Low education, low perception, lack of capital, small land, poor infrastructures and limited capacity of extension staff led to low technology adoption. Extension program for farmers in remote areas and information transmitted orally among trained farmers were not enough to increase adoption. Technologies that are labour intensive were difficult for poor farmers to apply.

Chi (2008) also found out that farmers with high education had better recognition of advantages of new technologies and acquirement of the technical knowledge and information. This implied that education was positively correlated with technological adoption. According to this study, it was further realized that farmer's attitude was a significant factor in technological adoption. Farmers did their old practices and hesitated to adopt the innovation because they were worried about the yield-loss due to application of new technologies

Socio economic status of farmers was also an important factor in technology adoption. Poor farmers were not adopting those practices that required financial capital. It is because they could not afford the technologies that required more capital inputs such as certified seeds and new rice varieties. It was found out that farmers with small holdings did not adopt new technologies. They thought that the technology could not be economical and therefore small rice field prevented the mechanization of harvesting and post harvesting activities (Chi 2008).

In light of growing challenges of population pressure, land degradation, and declining agricultural productivity, farming in sub-Saharan Africa is increasingly knowledge intensive. Agricultural households deal with different biotic pressures simultaneously (e.g. pest and disease infestations, drought, soil fertility) while trying to compete in the global market for their produce. Small-scale producers often rely on informal mechanisms of information exchange and knowledge sharing to address these challenges. Given the limited scope of formal extension programs, informal exchange is often the primary source of information about new technologies in sub-Saharan Africa.

The increasing role of informal mechanisms for information sharing has been recognized in the literature through farmer-to-farmer models of agricultural development (Eveleens et al.1996). Unlike the traditional extension model, which treats farmers as passive recipients of information, the farmer-to-farmer model recognizes that farmers actively gather information from fellow farmers to enhance their knowledge. This process of information gathering, or social learning, is characterized by pooling of information or observing the behaviour of others and imitating it. Most studies on technology adoption have always focused on individual attributes, as the factors contributing to successful adoption and diffusion of agricultural technologies.

According to Schuller et al., (2000), Social capital merits in shifting the focus of analysis from the behaviour of individuals agents to patterns of relations between agents, social units and institutions and reinserts issues of value into the heart of social scientific discourse such as terms of trust, sharing and community and community which control it. Thus the concept of social capital challenges economic analyses that rely on the notion of maximizing individual self-interest as underpinning all behaviour.

Although the role of social learning in technology adoption is well recognized in the literature (Foster and Rosenzweig 1995; Conley and Udry 2001; Munshi 2004), factors that intervene in the process are less known. A common assumption in previous research has been that information from early adopters is freely available in the village and all potential adopters can equally access it (Conley and Udry 2001). Differences in social learning have typically been attributed to endogenous factors, such as risk preferences, human capital and attitudes. Social capital is increasingly recognized as an intervening factor in the process of social learning and information exchange**.**

3.3 Soil Fertility Status and Banana Production

In a baseline study by the National Banana Research Programme and the International Institute of Tropical Agriculture (IITA), a number of key banana production constraints were identified and prioritised in banana growing areas of Uganda .These included declining soil fertility, a complex of pests and diseases, post harvest problems, socio-economic constraints and low genetic diversity (Gold et al.,1994). In absence of diseases, soil fertility is the major factor causing reduced banana yields (Stover, 2000). In study by Barekye et al.,(2000) in Masaka district, farmers ranked soil fertility as the third most important constraint to banana production after insect pests and weeds.

Several factors have been advanced as those responsible for this soil fertility decline in banana growing region which include among others, over cultivation, population pressure, lack of capital to purchase soil amendments and inputs as well as leaching of soil nutrients by excessive rains (Rubaihayo, 1991).

In a related study by Bwamiki et al., (1994), it was argued that one of the factors causing declining banana yields is reduced potassium levels in the banana growing areas of Uganda. The hypothesis that soil fertility decline contributed to declining banana yields in the region was first advanced by Masefield (1949) and McMaster (1962) and has been repeated ever since (Baijukya and de Steenhuijsen, 1998; Bekunda and Woomer, 1996; Sseguya et al. 1999). However, there is limited data to test this hypothesis. In Uganda, Smithson et al. (2001) and Ssali and Vlek (unpublished) have attempted to compare quantitative soil data from the 1960s and 1990s. Both studies failed to find a change in organic matter content, but Ssali and Vlek observed a decrease in soil pH, exchangeable Ca2+ and K+.

Most highland bananas are grown on ferralsols and acrisols soils, which have low fertility. However, a substantial proportion of the bananas in the region are grown near the homesteads (Rishirumuhirwa 1997, Rufino 2003). These homestead plots receive organic household residues and are more often mulched than plots further away. Bekunda and Woomer (1996) and Wortmann and Kaizzi (1998) found that most farmers transferred annual crop residues to banana fields. Farmers also tend to allocate their best land to the banana crop (Gold et al. 1999). Both land choice and soil management for bananas explain why banana fields contain more nutrients (especially Phosphorus (P) and Potassium(K)) than annual cropped fields and plots further away from the homestead (Bosch et al. 1996, Rufino 2003, Wortmann and Kaizzi 1998).

Researchers worldwide (Bertsch 1986, Delvaux 1995, Lahav and Turner 1983, Landon 1991, Lopez and Espinoza 2000, Rubaihayo et al. 1994, Twyford 1967, Walmsley et al. 1971) have published guidelines for the interpretation of chemical soil data for banana farmers. These guidelines mostly address commercial desert bananas (AAA). Although the minimum soil requirements published vary (from 0.2 to 1.5 meq 100g dry soil for exchangeable potassium), most banana soils in the region (Banananuka and Rubaihayo 1994, Godefroy et al. 1991, Rufino 2003, Smithson et al. 2001, Wortmann and Kaizzi 1998, Rubaihayo et al. 1994) have optimum soil fertility according to the average of the guidelines (Van Asten etal. 2004). However, one should be cautious to draw conclusions on nutrient deficiencies from soil chemical analysis alone, since most studies find a poor correlation between soil fertility parameters and bunch yields (Bananuka and Rubaihayo 1994, Rufino 2003, Smithson et al. 2001).

Most of the studies that used foliar analysis (Bosch et al. 1996, Gold et al. 1999, Okech et al. 2004, Rufino 2003, Smithson et al. 2001, Smithson et al. 2004, Ssali et al. 2003) identified Potassium deficiency as a major constraint, often followed by Nitrogen (N) and Magnesium (Mg). Phosphorus deficiency does not seem to be a frequent problem for East African highland bananas. Little research has been conducted on micronutrients. Bosch et al. (1996) found very low Zinc and Copper when compared to DRIS norms established for other AAA cultivars.

Soil physical properties and topsoil depth directly affect the root ability and water holding capacity of the soil. The later influences the ability of the roots to extract water and nutrients from the soil. Taulya (2004) observed that bunch weight increase from 8 to 16 kg when moving from soils with a shallow (less than 20 cm) to a deep (more than 30 cm) A-horizon. Despite the fact that soil moisture stress can lead to more than 60% yield loss (Okech, unpublished), soil physical aspects have received relatively little attention in the region. Over the last decades, bananas have increasingly become a cash crop in the region to satisfy the growing urban markets. As a consequence, more and more nutrients are being lost from the farm and end up in urban areas from which recycling back to agriculture is barely feasible (Bekunda and Manzi 2004) (Figure 1). The banana bunches, especially the peel, are particularly rich in Potassium and exportation of this element is of major concern. If nutrients exported from banana fields are not replenished by organic or inorganic fertilizers, then this leads to the mining of soil nutrient stocks and inevitably to yield decline in the long run. This problem can be observed in many African farming systems (Smaling 1993, Hartemink 2003).

Wortmann and Kaizzi (1998) found that loss of Nitrogen and Phosphorus at four Ugandan banana sites was compensated by the large amounts of organic materials that were transferred from other land use types (annual crops, grassland) to the banana plots. Although Nitrogen and Phosphorus balances might sometimes be positive for banana plots, the transfer of nutrients from annual crop plots and grassland plots to banana plots leads to an acceleration of soil exhaustion at the majority of the farm land and cannot prevent a general decline in soil nutrient stocks at the farm level. In addition, soils under annual crops lose many nutrients through harvest and erosion (Wortmann and Kaizzi 1998), a process that is further accelerated when vegetation cover is reduced due to soil fertility decline. Some researchers suggest that an increase in livestock should be part of the solution, but Bekunda and Woomer (1996) and Sseguya et al. (1999) have shown that the use of cattle manure is closely related to farm size and that the latter is continuously shrinking under increasing land pressure. Although both farmers and researchers agree that mulch is beneficial for banana plant growth, no recommendations exist on what the minimum mulch quality and quantity should be to economically address soil fertility, soil microclimate and soil pest constraints. Profitable minimum mulch recommendations are especially important now that access to mulch has declined due to the shortage of uncultivated land.

In order to compensate for nutrients lost, Smithson and Giller (2002) pleaded for the judicious use of mineral fertilizers to maintain soil fertility. According to them, the use of organic fertilizers and leguminous crops is important, but cannot compensate for all nutrients lost from the system in most cases. Most commercial banana growers elsewhere in the world use mineral fertilizers to sustain high yield levels. However, less than 5% of banana farmers in the East African highland region use chemical fertilizers (Bekunda and Woomer 1996, Sseguya et al. 1999, Kelly et al. 2001). In general, the use of mineral fertilizer in this region is amongst the lowest in the world. Both Bekunda et al. (2001) and Sseguya et al. (1999) showed that non-availability of credit is one of the major constraints for the adoption of chemical fertilizers. Also, farmers often lack knowledge on the best fertilizers to use -and how to apply them, and smallholder farmers tend to be risk averse.

The greatest problem is that, the cost of maintaining soil fertility may not be compensated by an increase in crop production. On the other hand, the costs to restore degraded soils may be higher than those required to maintain the soil in favourable condition for crop production (Hartemink 2003). This is particularly true in the East African highlands, where high transport costs lead to high fertilizer costs.

3.4. Pests and diseases

Banana production is threatened by a number of constraints among which the banana pests (nematodes and banana weevil) are the major ones (Rubaihayo and Gold et al., 1993, Rubaihayo et al., 1994). It's generally agreed that banana productivity problems in Uganda are induced by a combination of pests, diseases, poor soil fertility, drought stress and many of these factors can be largely influenced by farm management.

It is estimated that nematode damage can lead to damage of roots leading to toppling, loss of fruits and subsequent yield losses of East African high land banana (Speiger and Kajumba).

In a related study by Gold et al. (2001) banana weevil is identified as one of the major insect pest of African highland bananas (AAA-AEHB). The larvae bore into the corm, reducing nutrient uptake and weakening the stability of the plant and - in newly planted banana stands, can cause high levels of sucker loss and poor crop establishment (McIntyre et al.,2002, Messiaen,2002), even leading to crop failure. In another study by Gold et al..(1993), and Bosch et al., (1995), Banana weevil, Cosmopolites sordidus, is the primary constraint of highland cooking banana. The weevil may prevent crop establishment of suckers, predispose plants to snapping and toppling, prolong maturation rates and lead to reduced yields. Sustained attack over several cycles may result in up to 60 % yield loss (Rukazambuga, 1996) and sometimes can result in complete failure on many farms (Sengoba, 1986). Included among the most widespread biotic problems are weevils; black Sigatoka disease; Panama disease or Fusarium wilt; and banana bacteria wilt, which causes yield losses as high as 80 percent.

Numerous reports e.g. Gold et al, (1999a) state that during the last few decades, banana management has deteriorated in central and south western Uganda in which the Rwenzori region falls and is therefore the root of banana productivity problems.

CHAPTER FOUR: RESULTS AND DISCUSSIONS

4.1 Introduction

This chapter presents the data collected at different level i.e. household, group interviews and soil sample results. At household level, data has been presented and analysed in sub sections depending on the background characteristics of the respondents and the set research questions that focus on the following areas; the farmers indigenous knowledge and practices in influencing banana productivity; factors that influencing farmers adoption of banana management technologies; soil fertility status of banana based land use; banana production constraints in Rwenzori region; effective sources of social capital that facilitate farmer sharing, learning and practice banana management technologies.

4.2 Socio- economic Background Characteristics of Respondents

4.2.1 Distribution by Location, Gender and Ethnicity

In this sub section, the following information has been presented in different sub sections, comprising; parishes, sub counties and districts of the respondents, sex, age, education levels, tribes, income levels, farm land size and total banana production. The study was conducted on 357 households from 65 villages, 55 parishes, and 22 sub counties of the six banana growing districts of the Rwenzori region as follows as presented in Table 1.

From table 3.1, it was observed that 103 (about 29%) households from 4 sub counties from Kabarole district responded- Rwimi sub county with 8% respondents , Kibiito sub county - 8%, Kicwamba sub county-7%, Busoro sub county-6%). Kyenjojo district had 86 (19%) households from three sub counties, Bugaki with 6% of the households responding to the questionnaire, Butiti -7% Nyantungo-6%); In Kamwenge district, 57 (16%) households from 4 sub counties participated, Kahunge- with 5%, Ntara-5%, Busiliba-4%, Nkoma-2%); In Kasese district, 52 (15%) households from four sub counties mainly (Mukunyu with 7%, Kyondo-5%, Kitswamba-2%, Kyabarugira-1%); Bundibugyo had ,51 (14%) households from four sub counties (Busaru-4%, Ntotoro-3%, Bubukwanga-5%, Buganikire-2%) responding and Kyegegwa district with 26 (7%) households from two sub counties (Kyegegwa-6%, Kabwezi-2%).

When the gender of the respondents was analysed, it was found out that, out of the 375 respondents interviewed, 51% were male and 49% female showing that the views from this study will be representative in terms of gender balance.

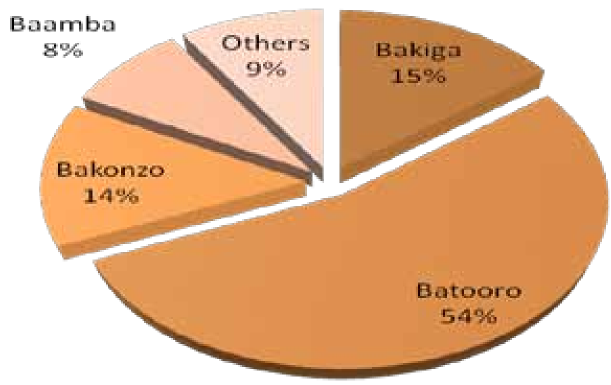
The study then Categorized respondents by tribe and the results shows appear as in Figure 4.1. From the findings, the majority of the respondents were Batooro (54%) occupying mainly Kabarole, Kyenjojo and Kyegegwa districts The second largest were Bakiga with 15% and these occupied all other districts with exception of Bundibugyo. However, Bakiga were mainly in Kamwenge. The third largest group were Bakonzo accounting for

Table 4.1: Distribution of Respondents by District

Name of the District	No. of Respondents	Percent
Bundibugyo	51	14.3
Kabarole	103	28.9
Kamwenge	57	16.0
Kasese	52	14.6
Kyegegwa	26	7.3
Kyenjojo	68	19.0
Total	357	100.0

14% of the respondents and living mainly in Kasese and Bundibugyo as seen in Table 4.1 and 4.2 and the Bamba who were only found in the sampled areas of Bundibugyo district. The study further revealed that beside the above mentioned groups, there were also others belonging to other tribes (both natives and non native of the Rwenzori region), accounting for 9% of the respondents as observed in table 4.2.

Figure 4.1: Distribution of Respondents by Tribe



The reason why the Batoro appear to be more than other tribes could be explained by the fact that the region/area is predominantly occupied by Batoro who attach great importance to matooke than other tribes in the region. The information above may reflect attachment different ethnic tribes give to Banana. Whereas the Batoro from Kabarole attach greater Importance to Banana as their staple food, the Bakiga predominantly are cereal eaters and are only migrants to Rwenzori region. Probably that is why banana was not a major food crop for them although many confessed they liked banana. Other tribes such as Bakonzo and Bamba do not attach great importance to banana. That is why there were few banana growers in Kasese and Bundibugyo as compared to Kabarole although they have the potential to grow the crop in the whole Rwenzori region.

Table 4.2: Distribution of Respondents by Tribe and District

Tribe	District												Total	
	Bundibugyo		Kabarole		Kamwenge		Kasese		Kyegegwa		Kyenjojo			
	No.	%	No.	%	No.	%	No.	%	No.	%	No	%	No.	%
Mutooro	3	1.6	92	47.7	9	4.7	5	2.6	21	10.9	63	32.6	193	54.1
Mukiga			5	9.6	38	73.1	3	5.8	2	3.8	4	7.7	52	14.6
Mukonzo	6	12.0	3	6.0	2	4.0	39	78.0					50	14.0
Mwamba	29	100.0	-	-	-	-	-	-	-	-	-	-	29	8.1
Others	13	39.4	3	9.1	8	24.2	5	15.2	3	9.1	1	3.0	33	9.2
Total	**51**	**14.3**	**103**	**28.9**	**57**	**16.0**	**52**	**14.6**	**26**	**7.3**	**68**	**19.0**	**357**	**100.0**

Additionally, it was observed that, while Batooro were found in all sampled areas across the region, other tribes did not appear in one or more districts .The dominance of Batooro in this region could be explained by the fact that traditionally, the greater Rwenzori region is the traditional home for Bakonzo and Batooro. Whereas the Bakonzo are concentrated in Kasese District, the Bamba are concentrated in Bundibugyo. The Bakiga are only migrants to this place

4.2.2 Distribution respondents by Age and Education

Table 4.3 and figure 4.2 show the distribution of respondents by their age and education. The youngest respondent was aged 16 years while the oldest was 72 years. However the average age of respondents was 41 years.

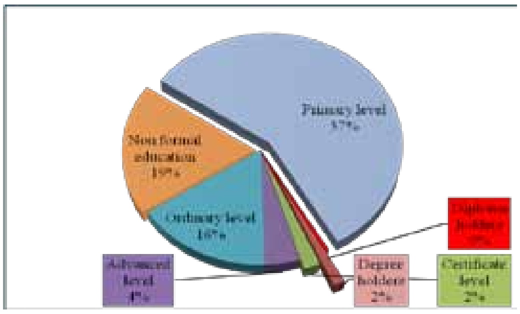
Table 4:3 Distribution of respondents by Grouped Age group

Age	No. of Respondents	Percent
16 - 19 years	5	1.4
20 - 23 years	24	6.7
24 - 27 years	36	10.1
28 - 31 years	40	11.2
32 - 35 years	43	12.0
36 - 39 years	30	8.4
40 - 43 years	39	10.9
44 - 47 years	21	5.9
48 - 51 years	29	8.1
52 - 55 years	16	4.5
56 - 59 years	9	2.5
60 - 63 years	21	5.9
64 - 67years	18	5.0
68 - 71 years	24	6.7
72 - 75 years	2	0.6
Total	**357**	**100.0**

About 68 % of the respondents were in the age bracket of 20- 47 years indicating that banana growing is being carried out by young generation. This is probably because, banana growing requires able bodied people and probably that is why few younger people below the age of 20 own banana farms with only one exception of a farmer who was on orphan and was only member of the family.

The analysis here in relation to the observed age groups is that, with advance in age, few people engage in banana growing because banana growing and application of banana agronomic management practices is labour intensive and probably this explains why many visited farms were left un attended to compared to other traditional crops like maize and cocoa either because casual labour was lacking or family members were few to provide all the labour required. In addition to the age, the study further looked at the education levels that characterised farmers in the Rwenzori region. Figure 4.2 presents the findings.

Figure 4.2: Distribution of Respondents by Education level



From Figure 4.2, it emerged that out of 357 respondents interviewed, 57% had attained primary education level, 4 % ordinary level, 4 % advanced level, 2 certificates, 2 % graduate while 19 % had non-formal education. This picture has implications on banana productivity. The impression here is that banana production is in the hands of farmers with minimal education levels (mainly Primary education) who may not have enough income base that may enable them to finance most of input requirements that banana growing requires. This is because such a population cannot be employed by the formal sectors and this may further have an implication on adoption of technologies because studies have established that adoption of agricultural technologies is positively correlated to the level of education. This information also suggests that as people get more educated, they tend to leave agriculture for white collar jobs. This picture may be quite different in developed countries because agriculture is not in the hand of resource poor farmers who cannot finance their agriculture activities and this may explain why the sector is performing poorly.

4.2.3 Income, Land size and Production levels

The study investigated the income levels of banana farmers in the Rwenzori. This was important aspect because the study wanted to estimate the proportion contributed by bananas to total farmer's household income. Table 4.4 shows the distribution of respondents by income.

Table 4.4: Distribution of Average Income by District

District	No. of Respondents	Monthly Household Income	Monthly banana Income	%age of income from Banana sells
Bundibugyo	51	239,410	26,600	11.1
Kabarole	103	121,360	56,660	46.7
Kamwenge	57	90,180	20,500	22.7
Kasese	52	93,650	27,700	29.6
Kyegegwa	26	129,800	41,900	32.3
Kyenjojo	68	164,110	45,690	27.8
Overall	357	137,970	39,220	28.4

An assessment of households revealed that both household incomes and incomes from bananas varied from district to district. At district level, respondents from Bundibugyo registered highest total household incomes (239,410/=) of which 11% (lowest percentage across all districts) came from banana production. This was because cocoa has outcompeted banana growing and being a high income generating crop, this was not surprising. Second highest household income earners were in Kyegegwa (129,800/=) of which 32.3 % was from banana production, followed by Kabarole (121,360/=) with (47%) of it from banana production. Kabarole district respondents registered highest proportion of household income (121,360/=) from banana. Kasese respondents' registered total household income of Ugshs 93,650/= of which about 30% was from banana production, Kamwenge had 90,180/= of which 23% was from banana. Overall, 28% of the monthly household incomes for the Rwenzori region farmers are from banana production and sales.

In terms of percentage house hold income from Bananas, Kabarole district registered the highest (46.7%), followed by Kyegegwa (32.3 %), Kyenjojo (27.8 %), Kamwenge (22.7 %) and the least being Bundibugyo district with 11.1 % coming from Bananas. From the above scenario, it was possible to realise why farmers in Bundibugyo had poorly managed banana plantations compared to their counterparts in other districts. The economic aspect is therefore important in shaping a farmers attention to a given crop.

However, analysis of the farmers' in the region in comparison to the national income ($1,100 or Uganda shillings 2,585,000/= per year or $ 92 or Uganda shillings 216,200 per month as of 2008 estimates), it is clear that with the exception of Bundibugyo; farmers in the region earn below the national average hence the need to improve the production capacities.

The study then assessed the actual income from banana production and production for consumption at district. This was meant to provide information on the value attachment to banana. Table 5 gives a summary of the categorized monthly banana income and also production levels for only consumption.

Table 4.5: Average Income from Banana Distribution by District

Income Interval	District												Total	
	Bundibugyo		Kabarole		Kamwenge		Kasese		Kyegegwa		Kyenjojo			
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
0 to 2,000	15	15.3	17	24.5	24	17.3	16	16.3	10	10.2	16	16.3	98	27.5
2300 to 9,000	3	13.0	6	26.1	6	26.1	3	13.0	1	4.3	4	17.4	23	6.4
10,000 to 12,000	6	17.6	12	35.3	8	23.5	2	5.9	2	5.9	4	11.8	34	9.5
15,000 to 18,000	1	7.1	4	28.6	3	21.4	2	14.3	2	14.3	2	14.3	14	3.9
20,000 to 24,000	10	24.4	10	24.4	9	22.0	6	14.6	2	4.9	4	9.8	41	11.5
25,000 to 30,000	1	2.9	8	22.9	3	8.6	9	25.7	2	5.7	12	34.3	35	9.8
32,000 to 48,000	3	14.3	8	38.1	1	4.8	3	14.3			6	28.6	21	5.9
50,000 to 60,000	7	21.2	10	30.3	6	18.2	4	12.1	1	3.0	5	15.2	33	9.2
70,000 to 100,000	3	10.3	8	27.6	4	13.8	6	20.7	2	6.9	6	20.7	29	8.1
111,000 to 600,000	2	6.9	13	44.8			1	3.4	4	13.8	9	31.0	29	8.1
Total	51	14.3	103	28.9	57	16.0	52	14.6	26	7.3	68	19.0	357	100.0

Majority (about 28%) of the respondents did not consider banana selling as important as observed in Table 4.5. At district level, majority (25%) of farmers were in Kabarole, which is considered a banana growing hub followed by Kamwenge (17%), Kyenjojo and Kasese (16% each). It was also observed that the highest income earned from banana sells ranged from 11,000/= to 600,000/= on average -and with , only 8% of the interviewed banana growers, falling in this category. At district level, Kabarole came first followed by Kyenjojo and majority farmers in this category were 45% and 31% of respectively (see Table 4.5 for details).

With only 28 % of the people being involved in commercial banana growing, this implies the importance of the crop on farmers' incomes and its future productivity. This is because farmers are not likely to invest in a crop where they do not realise much incomes. Banana growing is still dominated by subsistence farmers.

4.2.4 Education level effects on farmers total home Income

The study wanted also to find out whether the farmers' level of education was related to household income and income from the banana sale. This was done to determine whether the educated class can see banana as an economic crop compared to the uneducated banana farmers Correlating income earned both total monthly income and income from the bananas with education levels showed a weak positive correlation which was significant ($p<0.05$) for monthly income and income from bananas respectively) implying that the higher the education level, the high income from both total monthly and income from banana production. The correlations show a minimal difference between the normal monthly income and income based only on banana growing implying that education level did not very much significantly influence income from banana production. This was because bananas contributed a small portion of farmer's totals household income. There were cases of farmers in Bundibugyo who were not highly educated but reported monthly income of 7,000,000 (seven million from cocoa sales. This analysis is supported by the descriptive data presented in Table 4.6.

Table 4.6: Average Income from Banana Distribution by Education level

District	No. of Respondents	Monthly Household Income	Monthly banana Income	%age of income from Banana sells
Non formal education	67	95,400	26,470	27.7
Primary	204	117,050	39,490	37.7
Ordinary level	58	222,930	38,470	17.3
Advanced level	15	132,330	28,800	21.8
Certificate	7	241,430	119,290	49.4
Diploma	1*	200,000	-	-
Degree	5	436,000	134,000	30.7

*There was one Diploma holder and this could not contribute significantly to analysis

4.2.5 Household land size, Land under Banana and Production Levels

The study assessed land size, land under banana production and their relationship to the total banana output. This was to help to determine the average land owned by a farmer in the Rwenzori region and how this land is utilised to increase banana production. The study further looked at the land under banana production at two levels; namely farmland under well managed and under poorly managed banana plantation. It was observed that on average, a farmer had 4.6 acres of land of which 1.3 acres were under banana plantations. Out of about 1.3 acres, 0.83 acres were under well managed while 0.42 acres were under poorly managed bananas. At district level, on average Kamwenge and Kyenjojo farmers had relatively many acres of household farmland (6.46 acres and 6.26 acres respectively) followed by Bundibugyo (4.14 acres) while Kabarole, Kyegegwa and Kasese farmers had fewer acres of land for both banana growing and other uses (3.8, 3.5 & 3.1 respectively) acres as in table 3.7. This is .possibly because of high population density in these areas than in other districts.

Analysis of correlation between land size and banana production showed highly significant positive correlation ($P \leq 0.05$) implying that the size of the land farmed had influenced the surplus banana production for sale. This is probably due to the fact that those who had resources to acquire large land possibly had resources also to finance activities of banana production. This can be seen from Table 4.7

Table 4.7: Household Land Distribution by District and banana Production

District	No. of farmers	Farmland size	under banana	Well managed	Poorly managed
Bundibugyo	51	4.14	1.19	0.53	0.67
Kabarole	103	3.83	1.36	1.04	0.32
Kamwenge	57	6.46	1.34	0.68	0.64
Kasese	52	3.13	1.11	0.72	0.36
Kyegegwa	26	3.5	0.93	0.72	0.39
Kyenjojo	68	6.26	1.33	1.02	0.75
Overall	357	4.63	1.26	0.83	0.42

Assessing the farmers' land under banana production, as seen in table 4.7, there was almost no difference in the land put under banana at district level. However assessing farmers on the portion of land under well managed bananas, it was observed that Kabarole and Kyenjojo farmers had about one acre of land under well managed plantation while the rest had less than one acre of well managed bananas (see Table 4.7 and 4.8). This could be attributed to the importance attached to bananas. In Kamwenge and Bundibugyo, banana management is not very robust, save for areas like Nyabani and Kicece. In some areas, banana plantations are completely abandoned under the bush and emphasis is instead placed on maize and cocoa respectively. In Kasese, though not in the bush, but they are not cared for

The study also explored the relationship between land under poorly managed banana farms and those that are well managed,with total production on the farm and the correlation was not significant ($P \geq 0.05$) and significant positive correlation ($P \leq 0.05$) respectively. This meant that banana management greatly influenced total yield production with well managed plantations giving significant yield while poorly managed fields did not. This did not only influence what the farmer can produce at his farm but also food security. There was also significant correlation between land availability and total banana yield. Respondents who had enough land at their disposal produced significantly higher than those who did not. This implied that land accessibility could be one of the limiting factors of banana production in some areas like Kabarole and Kyenjojo. There was also a significant correlation($P \leq 0.05$) between total land size and well managed banana plantation probably suggesting that those who had access to land also had resources to manage their plantations. The details are in Table 4.8

Table 4.8: Distribution of Respondents by Total Farmland size owned

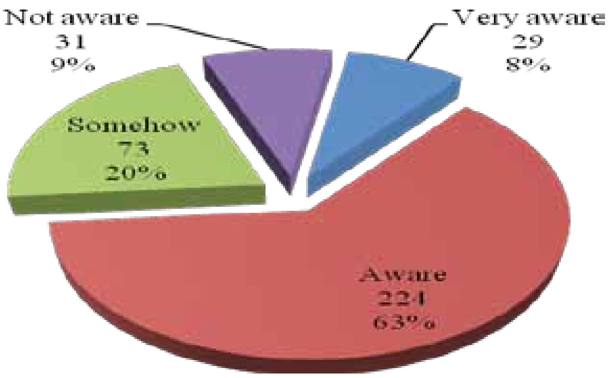
Total farm land			Land under banana plantation			Land under well managed bananas			Land under poorly managed bananas		
Land Acres)	No. of Farmers	Percent	Land (Acres)	No. of Farmers	Percent	Land (Acres)	No. of respondent	Percent	Land (Acres)	No. of respondent	Percent
1	74	20.7	0.1	23	6.4	0.0	90	25.2	0.0	205	57.4
2	66	18.5	0.2	1	0.3	0.1	13	3.6	0.1	13	3.6
3	54	15.1	0.3	4	1.1	0.1	2	0.6	0.2	2	0.6
4	43	12	0.3	13	3.6	0.3	2	0.6	0.3	5	1.4
5	58	16.2	0.4	20	5.6	0.3	11	3.1	0.4	9	2.5
6	8	2.2	0.5	71	19.9	0.4	17	4.8	0.5	46	12.9
7	9	2.5	1	118	33.1	0.5	67	18.8	0.8	3	0.8
8	10	2.8	1.2	2	0.6	1	91	25.5	1	47	13.2
9	1	0.3	1.4	1	0.3	1.2	1	0.3	1.2	1	0.3
10	10	2.8	1.5	11	3.1	1.5	5	1.4	1.5	3	0.8
12	6	1.7	2	49	13.7	2	35	9.8	2	12	3.4
15	11	3.1	2.2	1	0.3	2.4	1	0.3	3	4	1.1
18	1	0.3	2.5	3	0.8	2.5	1	0.3	3.5	1	0.3
25	1	0.3	3	17	4.8	3	11	3.1	4	3	0.8
30	1	0.3	3.4	1	0.3	3.5	1	0.3	5	3	0.8

38	1	0.3	3.5	1	0.3	4	4	1.1			
40	1	0.3	4	11	3.1	5	3	0.8			
50	1	0.3	5	5	1.4	5.2	1	0.3			
85	1	0.3	5.2	2	0.6	6	1	0.3			
			5.5	2	0.6						
Total	357	100	6	1	0.3	Total	357	100	Total	357	100
			Total	357	100						

4.3 Farmers' Indigenous Knowledge and Practices in Banana productivity

The first objective of the study was to characterise farmers' indigenous knowledge and practices of banana management technologies in the Rwenzori region. Farmers were required to tell whether they were aware and knowledgeable on any banana management practices as recommended by agricultural experts, and practiced by various farmers. In response, it was observed that 63% of the farmers said to be aware, followed by 8% who were very aware, 20 % somehow a aware while 9% said they had no knowledge of any banana management practices as indicated in figure 4.3

Figure 4.3: Distribution of Respondents by awareness of Banana Management Practices



From the figure 4.3, it can be observed that about 91% of the respondents reported to either be very aware or aware or somehow aware. The very aware and aware constituted about 71 %.This was the biggest proportion of farmers. If this percentage of people who confessed to be aware of agronomic practices required in banana management were also practicing farmers, then some headway in increased banana production in the region would have been expected. However pictorial evidence and physical visitation of banana farmers did not match awareness with practice. There were however, farmers who really were not aware of any management practices although they owned banana gardens.

The study then wanted to determine the distribution of respondent on their level of awareness based on their districts and the results based on in table 4.9, It emerged that the majority of farmers who were said to be aware were in Kabarole, followed by Kyenjojo and Kamwenge while very few were in Bundibugyo. On average, Bundibugyo had the least of farmers who were very aware (2.0 %), followed by Kasese and Kyegegwa, (7.7 %), followed by Kyenjojo and Kamwenge(8.8 %) and Kabarole had the greatest number of those who were very aware (10 %), the greatest number of farmers who were a aware (75 %) while Kamwenge had the least (49.0 %). Other districts were between 62 % to 69 %.

Among those that were not aware of the banana management practices (both indigenous and modern banana management practices), majority were in Kyenjojo (17.6 %), followed by Kamwenge, Bundibugyo, Kasese, then Kabarole and Kyegegwa districts coming last with 4.9 and 5.1 % respectively.

Table 4.9: Respondents by Level of Awareness on Farm Management

Level of Awareness	Bundibugyo		Kabarole		Kamwenge		Kasese		Kyegegwa		Kyenjojo		Total	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Very aware	1	2.0	11	10.7	5	8.8	4	7.7	2	7.7	6	8.8	29	8.1
Aware	32	62.7	78	75.7	28	49.1	36	69.2	13	50.0	37	54.4	224	62.7
Somehow	14	27.5	9	8.7	18	31.6	9	17.3	10	38.5	13	19.1	73	20.4
Not aware	4	7.8	5	4.9	6	10.5	3	5.8	1	3.8	12	17.6	31	8.7
Total	**51**	**14.3**	**103**	**28.9**	**57**	**16.0**	**52**	**14.6**	**26**	**7.3**	**68**	**19.0**	**357**	**100.0**

Multiple regression analysis of education level and the level of awareness on the banana management practices indicated a significant ($p<0.05$) relationship between respondents that had acquired certificates and advanced education level and were aware of the banana management practices. Thus education level seemed to have a great effect on the level of awareness and this shows that technology adoption should consider literacy as critical issue but this is likely to have limited impact because few farmers have an education level greater than primary level, with few highly educated entering the banana business.

It was also observed that there was a significant ($p<0.05$) correlation between those that said to be very aware and those that acquired certificate education. Thus the level of awareness increases with level of education. The challenge was whether the level of education and awareness matched the level of adoption.

We therefore wanted to find out whether the level of awareness influenced practice and adoption of banana management practice. The findings were however surprising, the research found no significant relationship between level of awareness on the management practices and the level of practice ($p>0.05$). This meant that the level of awareness of banana management practice did not influence practicing a given management practice. There was also no significant relationship between awareness on the management practices and banana plantation population on the farm, acreage size under banana plantation, household income, income from banana production and tribe. Although awareness increased with the level of education, advancing education did not significantly influence practice.

It was possible to find educated people with poorly managed plantations and this meant that other than education, other factors may come into play to influence practice a management technology. Those promoting technology adoptions should not put too much focus on the level of education in selecting those individuals to adopt technology. There is need to consider other factors like the profitability of the banana enterprise and farmers interests. Factors for consideration may include access to finance, land availability and labour availability, the desire for commercial production

4.4 Banana Management Practices and banana yield in Rwenzori region

The research also assessed the farmers on the various types of good banana management practices, the source of the knowledge and the levels of practice and the reasons attributed to the practice levels observed. Knowledge and practice or application was assessed on the following management practices:- grass/crop residue mulch, animal manure, composting, desuckering, splitting or chopping of the pseudo stem, banana corm removal, the practice of weevil trapping, pruning, pest and disease control, inorganic application, weed control , banana leaf management and male inflorescent removal. The research required respondents to highlight on each of these in terms of awareness and the sources of the knowledge on these practices and their level of practice.

In relation to the above, direct observations were made to assess the level of practice on farm and the reasons for the observed level of practice. Figure 3, shows that on average, 91% of the respondents were either very aware, aware or somehow aware on both the indigenous and modern ways of banana management. Data in Table 4.10 details banana management practices and farmers level of awareness.

Table 4.10: Proportion of Farmers by Awareness on Status on Banana Management practices

Banana management practice	Aware		Not aware	
	No.	%age	No.	%age
Grass/Crop residue (okwalira)	325	91.0	32	9.0
Animal manure (obusa)	318	89.1	39	10.9
Compositing (okujunza)	313	87.7	44	12.3
Desuckering (okwitiza)	325	91.0	32	9.0
split/chop pseudo stem (okutematema emikonde)	319	89.4	38	10.6
Corm removal (okwiiha enkonya)	323	90.5	34	9.5
Weevil trapping (Okutega ebihuka)	312	87.4	45	12.6
Pruning (Okusalira)	328	91.9	29	8.1
Pest control (Okurwanisa ebihuka)	331	92.7	26	7.3
Disease control (Okurwanisa oburweire)	311	87.1	46	12.9
Inorganic fertilizer application (Okukozesa orwezo rwekijungu)	308	86.3	49	13.7
Weed control (okwombera)	352	98.6	5	1.4
Leaf management (Okubalira embabi)	322	90.2	35	9.8
Male inflorescent (Okusara enkanana)	340	95.2	17	4.8
Overall	**323**	**90.6**	**47.1**	**9.4**

As observed from Table 4.10, nearly all (98.6 %) of the farmers were aware of weed control measures, followed by male inflorescent removal (95%), pest control practices (93%) and pruning (92%). Among the least known management practice included; knowledge of on inorganic fertilizers application as only 86% said to have knowledge on it, followed by banana diseases control and weevil trapping (only 87%) respectively) and composting -as only 88% said to be knowledgeable. On average, 90.6 % were aware of most banana management practices/technologies while 9.4 % of the farmers were not aware of most management practices.

Some research studies have shown that good management practices like mulching, sanitation, pruning, corm removal, pest and disease control are associated with high banana yields (Mukasa et al in Bloom 2003; Banananuka and Rubaihayo, 1994). For example, the level of banana crop management had a direct effect on bunch weight, total leaf area, corm weight, corm root length and root weight (Mukasa et al in Bloom 2003). The same study also found out that the highest yields were obtained in well managed fields whereas the lowest, were obtained in poorly managed fields. For example Mpologoma produced fresh bunch weights of 23.97 kg and 13.06 respectively for the well and poorly managed fields respectively.

According to this research, few farmers practice indigenous methods to manage soil fertility, pests and diseases. Even though most farmers practiced weed control (72.6 %), pruning (72.5%), desuckering (70.6%) and grass/crop residue (68.5%), the level of practice was below the recommended levels. This suggests that although farmers were aware of these practices, they did not appreciate their importance and therefore did not benefit. For this reason, such farmers should be supported through extension services in their areas. The least practiced methods were fertilizer application (83.6%), Splitting/chop pseudo stem (68.8 %), and weevil trapping (67.0%), Animal manure (62.5%), Compost manure application (58.9 %).

A sizeable number of farmers do not control diseases and mulch. This low level of practice in issues of soil fertility management explains low levels of organic matter in most fields, nitrogen and phosphorus deficits, prevalence of weevils and diseases. Using, compost manure, farm yard manure and mulching as useful practices would have corrected most of those deficiencies since it adds nutrients to the soil, improves soil structure for water retention and enhances yields (Inzaule et al in Bloom et al., 2003). Mulching which helps to conserve moisture also adds nutrients to the soil during decomposing.

In the study by Gold et al. (1997), it was found out that farms which practice field banana sanitation (Pseudo removal) significantly reduced weevil damage levels. Therefore there is a need to place focus on extension messages in these critical areas especially in districts of Kamwenge, Kasese and Bundibugyo where sanitation and pest and disease management practices are comparably very low.

However, multivariate analysis of the level of awareness on management practices, as a factor by their sources as dependent variable, yielded insignificant ($p \geq 0.05$) relationship – implying that no any source of information mentioned, could be accountable or attributed to the known practices. However descriptive data shows as in Table 4.11, the different sources of knowledge on banana management mentioned.

Table 4.11: Distribution of Respondents by Source of Knowledge

Sources of Knowledge	No. of Households	Percent
Passed from the parents	128	39.9
NAADS	51	15.9
Fellow Farmers	51	15.9
Indigenous knowledge	28	8.7
Kyembogo Datic / KAWANDA	24	7.5
School education	13	4.0
Extension workers	11	3.4
Radio	8	2.5
Sub County meetings	5	1.6
AAP / RDC training	2	.6
Total	**321**	**100.0**

However analysis of the level of practices in relation to awareness measure, yielded significant ($p \leq 0.05$) relationships among those that were aware and observed to have partially or fully practiced grass/crop residue mulch. The relationship was positive among those that said to very aware – implying that those that practiced were very aware $(\beta = 3.3)$. The major reasons as to why they practiced were that they wanted to improve soil fertility while others said to have had small pieces of land. While there was a negative $(\beta = -4\ .2)$ relationship among those that just said to be aware – implying that while many farmers were aware of the banana management practices, only a few apply them and the major reason was that the activity was labour intensive which they could not easily afford, followed by attitude problem. There was such a similar relationship between the application of animal manure and the level of awareness $(\beta = 3.3)$ but a significant ($p \leq 0.05$) relationship among those that partially and fully practised Composting respectively and the very knowledgeable on the banana management practices while no significant relationship existed among the other awareness status as presented in Table 4.12.

Table 4.12: Parameter Estimates of practice and level of awareness on the Banana management practices

Type	Parameter estimates and associated significance levels (sig)			
	Level of practice	Intercept (sig)	very aware (sig)	aware(sig)
Grass/crop residue mulch	Fully Practiced	17.342(0.000)	2.429 /0.000	-13.678 (0.000)
	Partially practiced	18.035(0.000)	1.484/0.000	-14.185 (0.000)
Animal manure	Fully Practiced	17.342(0.000)	2.429/0.000	-13.678 (0.000)
	Partially practiced	18.035(0.000)	1.484/0.00	-14.185 (0.000)
Composting	Fully Practiced	-1.754 (0.000)	1.849/0.001	0.648 (0.107)
De-suckering	Fully Practiced	-0.795 (0.014)	2.741 (0.000)	1.066 (0.003)
Split/chop pseudo stem	Fully Practiced	17.221 (0.000)	3.376 (0.000)	-12.877 (0.000)
	Partially practiced	17.760 (0.000)	1.685 (0.016)	-13.456 (0.000)
Corn removal	Fully Practiced	2.708 (0.009)	8.978 (0.000)	17.008 (0.000)
	Partially practiced	3.296 (0.001)	17.392 (0.000)	16.296 (0.000)
Weevil trapping	Fully Practiced	2.197 (0.037)	16.814 (0.000)	16.887 (0.000)
	Partially practiced	2.565 (0.013)	15.435 (0.000)	16.101 (0.000)
Pruning	Fully Practiced	18.422 (0.000)	2.801 (0.000)	-13.817 (0.000)
	Partially practiced	18.808 (0.000)	1.589 (0.010)	-14.603 (0.000)
Pest control	Fully Practiced	17.485 (0.000)	2.709 (0.000)	-13.847 (0.000)
	Partially practiced	18.373 (0.000)	1.282 (0.024)	-14.875 (0.000)
Disease control	Fully Practiced	1.107 (0.000)	2.185 (0.000)	-14.847 (0.000)
	Partially practiced	19.018 (0.000)	0.798 (0.189)	-15.380 (0.000)
Organic fertilizer application	Fully Practiced	-18.574 (0.000)	16.729 (0.000)	16.467 (0.000)
	Partially practiced	-17.651 (0.000)	16.316 (0.000)	15.226 (0.000)
Leaf management	Fully Practiced	18.451 (0.000)	3.053 (0.000)	-14.324 (0.000)
	Partially practiced	18.928 (0.000)	1.477 (0.027)	-14.868 (0.000)

4.5 Factors affecting farmers' adoption of banana management practices

The research also investigated among the farmers, factors that influenced them to or not adopt the proper banana management practices. (Practice the recommended agronomic practices). To achieve this, respondents (both practicing and not practicing) were required to explain whether the practice they were aware of, was being practiced and to give reasons for the observed level of management. It was also imperative to observe the characteristics of adopters and non-adopters.

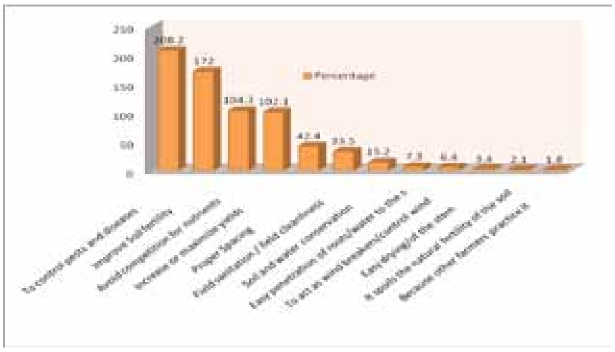
To achieve this, background characteristics of respondents were correlated with the level of practice and analysis showed thus: The level of practiced was rated as fully practiced, partially practiced or not practiced. The analysis of correlation between income level of the farmer, tribe, education, age group, sex of the respondents, name of the district and home income were all insignificantly correlated with level of practice and with the exception of home income from bananas ($p \leq 0.05$).

This meant that the level of practice (adoption) did not significantly depend on income because most of the income did not come from banana production. There was also no significant correlation between the level of practice and gender. However, on average men were adopting most of the practices than females. This can be explained by the fact that men are likely to have more income than their female counterparts -and have extra income that they can use to finance some of most of recommended practices. However, it was not easy to separate the one who adopts the practice because gender of the respondents did not mean that the respondent was the decision maker at household level.

There was however, significant correlation between the level of income got from banana farm and the level of practice, probably indicating that those farmers who were expecting to get income from bananas were those that are likely to adopt banana management practices. This has a lot of implication because it appears that farmers who did not indeed consider banana production as a commercial venture did not bother to adopt recommended practices -as long as they were able to meet their daily needs for home consumption. There was no significant correlation between the level of practice of banana management practices with age group, tribe and total family income.

Figure 4.4 presents the reasons provided by the respondents why respondents either fully or partially practiced proper banana management. The reasons given below do not relate to only one practice but all practice that were under the study.

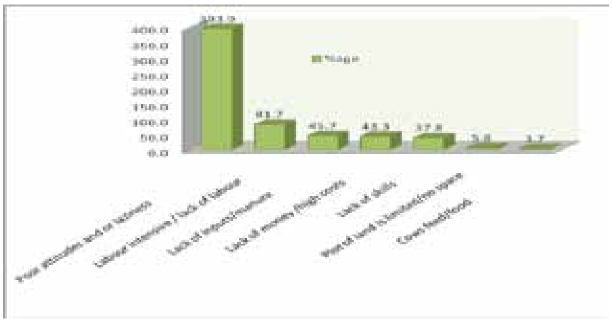
Figure 4.4: Reasons for Adopting Banana Management Practices



From Figure 4.4, it was observed that most responses(208%) indicated that the need to control pests and diseases is fundamental in influencing farmers to adopt proper practices. This was followed by the need to improve soil fertility as supported by 172% responses. Another reason for adoption of the proper management practices was to avoid or reduce competition for nutrients. This especially provided for de-suckering, pruning and weed control. Other reasons for adoption included; the need to increase or maximise banana yields (102%), have properly spaced plants (42%), field sanitation and cleanness (34%), the need to conserve water in the soil and to easy penetration of the roots as mentioned (15%) and 7% respectively among others. However, there were also some farmers who did not adopt the recommended practices although some were aware of the practices for good banana management.

Ranking the responses on the adoption and non adoption, it was observed that, despite majority of the respondents indicating having acquired proper banana management knowledge (indigenous and non-indigenous), majority did not practice them. Among those that did not practice, the reasons were provided as presented in Figure 5.

Figure 4.5: Reasons for failing to adopt proper Banana Management



As observed in figure 4.5, the major challenge mentioned for not adopting proper banana management was the poor attitudes and or laziness as supported by 94% over the all practices investigated. This was followed by about 82% responses indicating that adoption of the proper banana management practices were labour intensive yet household labour was minimal as earlier indicated. Lack of inputs like manure was another reason for failing to use the acquired knowledge as indicated by 46% of the responses, followed by lack of money or the adoption strategies were costly to them as indicated by 43% of the responses, lack of skills (39%), having small or limited farming space, supported by about 6% responses.

These findings agree with those of Okech et al.(2003) in Bloom et al(200) who found out that farmers attitude was the biggest constraint to banana production in Ntungamo district and served as the means of design research intervention.

4.6 Soil Fertility Status and its effects on Banana yield in Rwenzori region

The research examined the soil fertility status of the banana based land use type in Rwenzori region. To determine this, soil analysis was done for both macro and micro nutrients, soil organic matter, soil PH and texture and were compared with critical requirements for bananas as by Okalebo et.(1993) as in table 4.13

Table 4.13: Chemical and physical properties of Top soil in farmers' fields in Five Districts of Rwenzori region (Soil depth of 0-15cm)

Name of the sub county	pH	OM	N	Av.P	Ca	Mg	K	Na	%Sand	%Clay	%Silt	Textual class
Bugaki	5.9	2.16	0.21	9.14	9.0	1.90	1.31	0.03	71.0	13.0	16.0	Sandy loams
Harugali	6.0	1.02	0.23	29.61	7.5	1.96	0.88	0.04	63.0	19.0	18.0	Sandy loams
Isunga	5.0	3.06	0.29	1.22	4.1	2.07	0.57	0.06	67.0	19.0	14.0	Sandy loams
Kyondo	5.7	1.26	0.28	42.6	7.2	1.90	0.82	0.03	55.0	23.0	22.0	Sandy loams
Butiti	5.7	1.26	0.21	3.6	6.0	0.95	1.23	0.04	67.0	19.0	14.0	Sandy loams
Kicwamba	6.3	5.22	0.15	55.62	14.4	1.85	2.31	0.02	53.0	19.0	28.0	Sandy loams
Munkunyu	6.0	1.29	0.27	49.21	11.0	1.98	1.03	0.04	57.0	23.0	20.0	Sandy loams
Rwimi	6.6	6.21	0.20	41.61	20.7	2.19	1.15	0.09	55.0	21.0	24.0	Sandy loams
Kitwamba	6.0	5.18	0.29	56.2	15.0	2.30	1.66	0.11	75.0	13.0	12.0	Sandy loams
Kahunge	5.5	1.02	0.19	12.12	5.4	2.58	0.97	0.17	57.0	19.0	24.0	Sandy loams
Kyegegwa	5.9	1.62	0.22	2.21	8.4	2.12	1.00	0.08	53.0	25.0	12.0	Sandy clay loams
Nyantungo	5.7	3.21	0.29	16.21	12.3	2.12	2.46	0.07	51.0	27.0	22.0	Sandy clay loams
Kasitu Bundibugyo	6.2	1.11	0.18	19.6	9.9	1.97	1.54	0.04	67.0	19.0	14.0	Sandy loams
Butiiti	5.8	4.96	0.38	26.4	7.5	2.12	1.57	0.08	69.0	13.0	18.0	Sandy loams
Ntara	5.8	4.16	0.18	48.2	9.3	2.13	1.23	0.08	67.0	19.0	14.0	Sandy loams
Bubukwanga-Bundibugyo	6.6	1.02	0.33	62.12	9.0	2.02	0.77	0.06	53.0	25.0	22.0	Sandy clay loams
Busoro	5.8	3.92	0.15	32.16	11.1	2.90	1.69	0.24	63.0	21.0	16.0	Sandy loams
Kibiito	6.0	3.37	0.20	7.62	5.9	1.54	0.88	0.06	45.0	37.0	18.0	Sandy clay loams

Table 4.14 *Critical levels for banana nutritional requirements (Source: Okalebo et al., 1993)

ca	K	N	Na	OM	P	Sand	Silt	clay	P^H
›4.0	›0.44	›0.20	‹1.00	›3.0	›15.0				›5.2

Bananas require a deep, well drained, loam soil with high humus content (Purseglove, 1988). They do not stand poor drainage but otherwise seem to tolerate a wide range of soils, parent material, textures and nutrient status (Sys et al., 1993). Highly acidic soils are not suitable for bananas and would require considerable amounts of mineral nutrients to maintain high yields. A PH range of 5.6-7.5, salt level of less than 500mg/kg, an exchangeable sodium percentage of less than 4 are optimum soil conditions for bananas (Sys et al.,1993). Bananas will also grow well in areas with adequate supply of potassium, nitrogen, magnesium, calcium (ca) and phosphorus (Tushemerirwe et al. (2001).

According to Table 4.13 and table 4.14, all the sub counties had favourable soil PH which is greater than 5.3 and less than 7.5. This falls within the critical soil PH range of 5.2- 7.5 recommended for banana growing according to Okalebo et al.(1993) and Sys et al.(1993). Apart from Isunga which had the PH of 5.0. However, according to Sys et.(1993), the ideal soil PH for bananas is between 5.6 -7.5. This means that according to this guideline, all these sub counties had favourable soil PH for bananas and these were Bugaki (5.9), Harugali(6.0), Kyondo(5.7), Butiti(5.7), Kicwamba (6.3), Munkunyu(6.0), Kyegegwa (5.9), Rwimi (6.6),Kitswamba(6.0), Kasitu (6.2), Butiti (5.8), Ntara (5.8).Bubukwanga (6.6), Busoro (5.8) and Kibito(6.0). The only sub county that does not meet this benchmark was Kahunge (5.5) and Isunga (5.0). From the above observation, it's reasonable to conclude that most soils in Rwenzori region have favourable soil PH for Banana growing. This is because soils with PH value above the minimum requirements do not hinder vigorous banana growth (Tumuhairwe et al., 1994) and give good nutrient availability without toxicity problems (Wortman and Kaizi, 1994).

This PH range of 5.2-7.5 (Moderately acidic to slightly alkaline), falls within a range that is favourable for most agricultural crops and PH has implication on soil nutrient availability. Within this range, Macro nutrients such as Nitrogen, Phosphorus and potassium increase in solubility as soil PH increases from acidic conditions to PH 6.5.. This makes them readily available for crop plants. Secondary, nutrients such as Ca, Mg and Sulphur (s) increase in solubility and become available to plants and micro nutrients except Molybdenum . Therefore, it was reasonable to conclude that with in this soil PH range, most soils in Rwenzori region have favourable conditions for nutrient availability for bananas. Rwenzori region has volcanic soils that are considered fertile for banana production.

According to Okalebo et al. (1993) the critical amounts of organic matter for banana growing, should be greater than 3 %. (›3.0 %). Table 23, shows that that it was Isunga (3.06 %), Kicwamba (5.06%), Rwimi (6.25%), Kitwamba (5.18%), Nyantungo (3.25%), Butiti (4.2%), Ntara (4.16%), Busoro(3.95%), Ntara 2 (4.2%) and Kibito (3.37%), that had soil organic amounts that favour banana growing. All other remaining sub counties had lower than required minimum levels of Organic Matter (OM). It is not surprising that Rwimi had higher levels of organic matter because banana management practices were the highest in the whole research area. Low levels of organic matter points to poor management of banana plantations in most farmers fields. High organic matter percentage is one of the good indicators of good soil health because organic matter has implications on high nutrient availability and high cat-ion exchange capacity as it acts as the store for primary nutrients such as N, P and K and S. Our observation is that poor banana yield observed on most farmers' fields can be explained by poor organic management because most farmers' fields had lower organic content than the recommended (Lower than 3 %). About 9 sub counties out of the twenty three had lower organic matter than the critical levels recommended (Okalebo et al.1993).

Bananas grow well in areas with adequate supply of Potassium, nitrogen, Magnesium, calcium and phosphorus and according to table 3.13; Phosphorus could be a limiting factor in some areas which have less than the required threshold of (›15 Av.P). These include Bugaki (9.14), Isunga (1.22), Butiti (3.6), Kahunge(12.12), Kyegegwa(2.21), Kiibito(7.62).However, Phosphorus is not the major nutrient required by bananas and therefore can easily be managed by conscious farmers. The potassium which is the critical nutrient for bananas was enough for banana growth in all visited areas but nitrogen which is the second major nutrient could be a limiting factor of banana production in some areas like Kitswamba in Kasese (0.15), Kahunge (0.19), Kasitu(0.18), Ntara (0.18) and Busoro (0.15) which was less than the critical nitrogen amounts of greater than 0.22. Calcium was also with in the acceptable range. Low levels of N, P and K (below the critical value have been associated with slow growth and low yield of bananas (Bhargava et al.,1992).

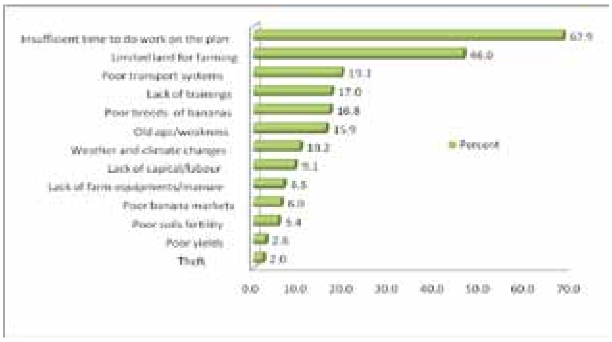
Our analysis of the soil fertility status is that soils are not so poor as not to allow the commercial growing of banana. This is possible if farmers can manage their banana plantations very well especially through organic matter management. Although most farmers point to soil fertility as the biggest problem that may be limiting banana productivity, the findings do not support this assertion . Our findings agree with those Smithson et al (2001) but differ slightly from those of Ssali and Vlek (unpublished) because organic matter management seem to be the biggest problem especially in those plantations where weed management was not taken care of. It's important to explore more whether textual class could have played a role because most soils had sandy loam soils apart from a few that had sandy clay loams recommended for banana (Rivera, 2004). However Sandy Loams are susceptible to leaching.

It's possible that poor banana in some areas could be explained by inadequate rain fall in some areas of Kasese, Kamwenge and parts of Kyenjojo and Kyegegwa The crop is heavily affected by moisture stress. Further research therefore can focus on this issue to see to what extent this banana yield variation could be explained by rainfall amounts received. We conclude that generally soils in Rwenzori region are fertile enough to support commercial banana production if farmers can enforce good management practices recommended. Our findings agree with those of Rubaihayo et al (1994) and Bananuka and Rubaihayo, (1994a) who observed that the average soils in Uganda have optimum soil fertility according to the average of the guidelines (Table: 3.14).However, we take caution that although these soils in the region seem to lie within the recommended limits, conclusions taken from soil analysis needs to be taken with caution and therefore should not be taken in isolation
(Asten et al in Bloom 2003).

4.7 Constraints to Improving Banana Production

The objective five was to characterise the production constraints of banana production. Assessing the constraints farmers encountered in improving banana production revealed as in Figure 4.6, that a number of challenges fell into 4 categories, namely; time management, economic, climate related and labour.

Figure 4.6: Constraints to Improving Banana Production

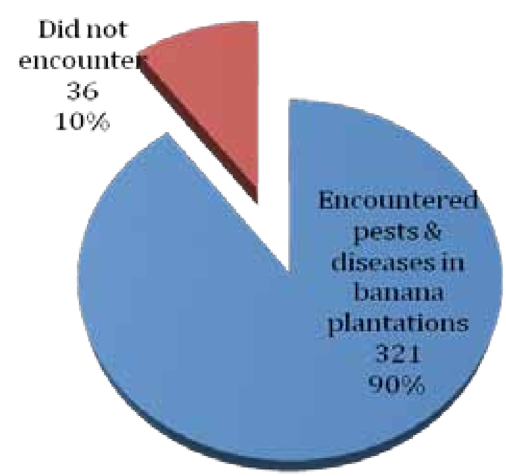


As observed in Figure 4.6, majority (68%) of the responses show time management to accomplish farm work according to plans was a challenge. This was followed by the an economic challenge of limited land for farming, as supported by 46% of the responses, poor transport systems (19%), lack of trainings and possession of poor breeds of bananas (17%) respectively. Other challenges included old age and or weakness, Weather and climatic challenges, lack of capital and labour, lack of farm equipments and fertilizers, lack of market for bananas a, declining soil fertility, poor yield and theft in their descending order of importance. None of these challenges were place specific (parish, Sub County or district) as they were seen to be crosscutting from one area to another.

From our findings, it emerged that farmers did not consider declining soil fertility as the biggest challenge as earlier hypothesised but instead thought of time constraint due to competition from other labour intensive enterprises in the region, like maize, cotton and tobacco to be the main challenge. Our findings differ from those studies by Barekye et al in Bloom et al.(2003) who found out that declining soil fertility was the leading constraint to banana production. Our findings on soil fertility status confirm that farmers in this region do not consider soil fertility as the greatest challenge. However, our findings seem to agree with the above authors because the complex of pests mainly weevils and diseases like banana bacterial wilt and sigatoka are reported by about 90 %. Our field observation indicated that almost all farmers experienced banana bacterial wilt. In Bundibugyo it was threatening to wipe out banana plantations even when banana plantations were not managed. By leaving the gardens an attended, the innoculum had accumulated that it was easy to move from farmer to farmer

An assessment was also made to establish proportion of farmers who encountered pests and diseases on their banana plantations. The findings as presented in Figure 4.7 indicate that 90% of the respondents faced banana pests and diseases while 10% said not have this as a challenge. Lack of time to work on banana plantation is a reflection of other competing activities farmers engage in. In this region, casual labour is also scarce but also banana growing is still on small scale that hired labour is not critical

Figure 4.7: Banana Pests and diseases Problems



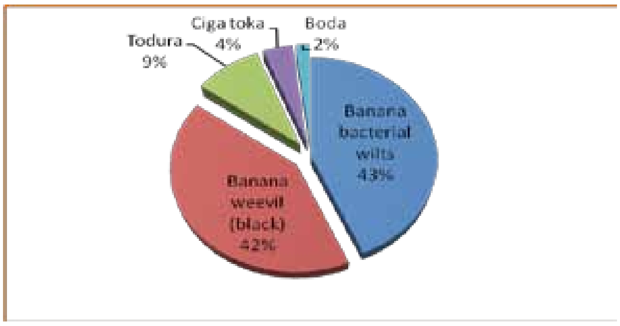
Assessing the challenge of banana weevils by district indicates as in Table 4.15 that much as all district were greatly affected, Kasese farmers were the most (94%) affected with banana weevils and other diseases, followed by Bundibugyo and Kyenjojo farmers as accounted for by 90% of the respondents respectively.

Table 4.15: Proportion of Respondents by District on Pests and Disease Encounter in bananas

District	Encountered Pests & diseases				Total by District	
	Affected		Not affected			
	No.	%age	No.	%age	No.	%age
Bundibugyo	46	90.2	5	9.8	51	14.3
Kabarole	92	89.3	11	10.7	103	28.9
Kamwenge	50	87.7	7	12.3	57	16.0
Kasese	49	94.2	3	5.8	52	14.6
Kyegegwa	23	88.5	3	11.5	26	7.3
Kyenjojo	61	89.7	7	10.3	68	19.0
Total	321	89.9	36	10.1	357	100.0

Kabarole district was the fourth most (89%) affected, followed by Kyegegwa with about 89% of the farmers and Kamwenge with 88% of the farmers. Although it possible to do comparison, on average almost all farmers reported that they are affected by pests and diseases with the greater percentage being attributed to banana weevils and banana bacterial wilt. Respondents ranked the types of pests and diseases that they encountered on their farms. Figure 4.8 presents them in order of their popularity among farmers across the region. From the Figure, it was observed that majority (43% and 42%) of the farmers had encountered banana wilt and banana weevils respectively and these were ranked as the commonest pests and or diseases respectively among the banana producing farmers.

Figure 4.8: Names of Pests and Diseases Encountered

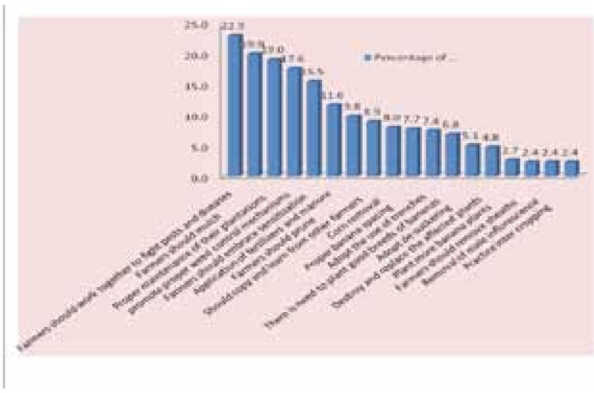


Other pests and diseases encountered included; "todura", Siga toka a as seen in figure 4.8.

4.8 Farmers' Opinions towards Improving Banana Production

\An inquiry was made among the farmers on what could be done to improve banana production. This raised a number of opinions as summarized in Figure 4.9.

Figure 4.9: Farmers' Opinions towards Improving Banana Production

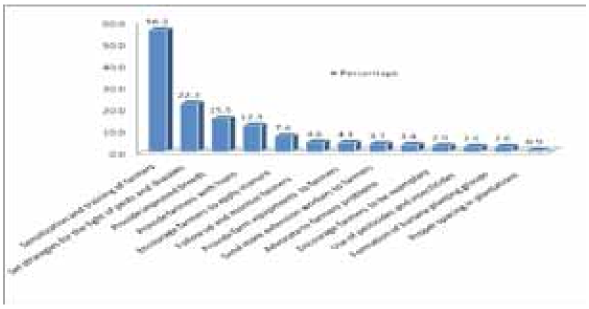


In Figure 4.9, it can be observed that majority (23%) of the responses required farmers to work together in the fight against pests and diseases in the banana plantations. This shows the importance of social capital in banana disease and pest control measures. This was followed by the need for all farmers to apply mulch in their plantations as supported by 20% of the responses. This is closely related to the opinion that all farmers should maintain proper maintenance of their banana plantations accounting for 19% of the responses. Other opinions suggested; the need to promote proper weed control mechanisms (18%), the need for the farmers to embrace sensitization programs on good banana management (16%), the need for farmers to apply fertilizers and manure into banana plantations (12%) and the need for farmers to prune . This means that for extension staff to reach the people they need to see the areas where the need is most and that can form the entry point for scaling technology.

4.9 Actions Stakeholders Should Enforce to Improve Banana Production

The study required the farmers to give opinions for stakeholders' enforcement purposely for increasing banana production in the Rwenzori region. Figure 4.10 presents the summarized opinions. As observed in Figure 4.10, majority (56%) of the responses said that all stakeholders should sensitize and train farmers of proper banana management practices, followed by the need to set strategies for the fight against pests and diseases (22%), farmers need to be provided with improved breeds of banana suckers (16%) and the need to facilitate farmers with agricultural loans (12%). In areas like Kamwenge and Kyenjojo, farmers expressed the need to access the improved banana breeds. One farmer in one discussion group is quoted saying "For us we hear that NAADS provides farmers with planting materials but none of us has ever been approached for seedlings and even if we wanted them where can we get them. Government needs to take care of this" Other responses indicated the need to encourage farmers to apply manure on their farms, regularly monitor farmers' fields for increased guidance, provide basic and essential farm equipment, send more extension workers in the community and put in place strategies that could advocate for solving farmers' problems among others as in Figure 3.10.

Figure 4.10: Actions Stakeholders Should Enforce to Improve Banana Production



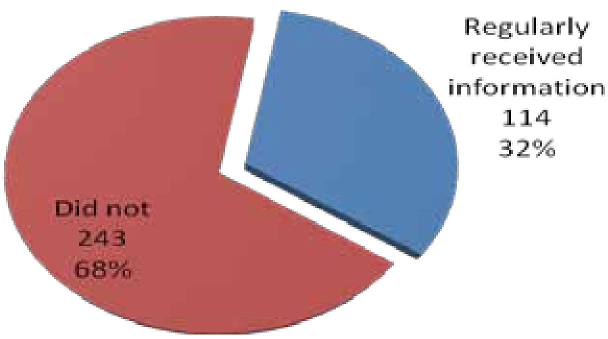
4.10 Effective Sources of Social Capital Facilitating Farmers' Sharing, Learning Practices

Objective five of the study was to characterise the effective sources of social capital that can facilitate diffusion of technology, farmer sharing, learning and practice of banana management practices. This area focused on information sharing concerning improving banana production. It also looked at specific information, sources and channels of information accessibility. The study in this section further assessed how the acquired information was applied and the characteristics of the people that farmers preferred to share information with.

4.10.1 Accessibility to information

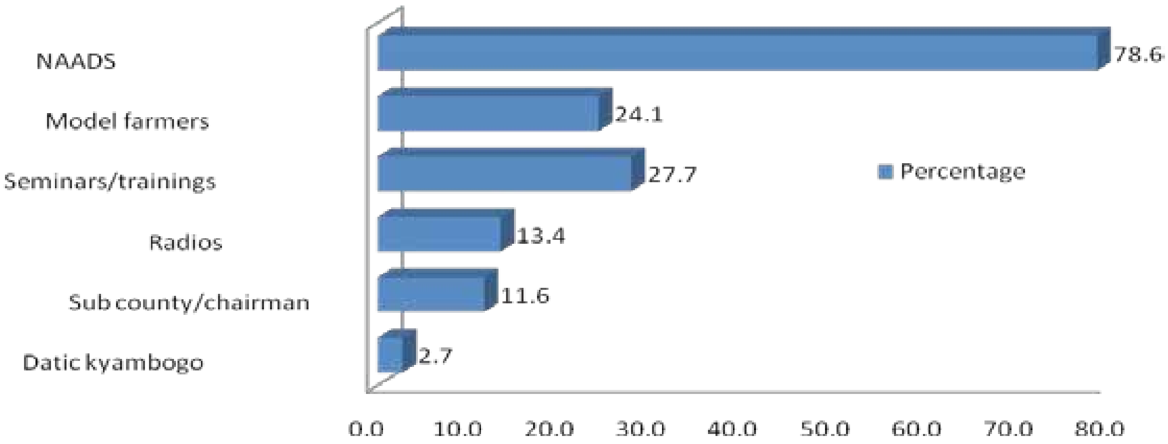
Assessing access to information indicated majority (68%) of the banana producing farmers did not have access to information concerning improving banana production while only 32% reported to have received information on banana management. This lapse in information accessibility can explain why most farmers are doing their own things with researched and field tested information. The research revealed that most farmers were using knowledge inherited from their parents. The presence of trained personnel to farmers was greatly lacking and those who were called service providers either were themselves ignorant of what to do and or were very few if they were educated

Figure 4.11: Accessibility to information



The research then was to examined the sources of information for those farmers who are said to be receiving information on banana production. Further analysis of 32% of the respondents who reported that they receive regular information on banana management, provided the following in Figure 4.12 as the information sources.

Figure 4.12: Information sources on Banana Management



As observed, majority of the respondents (79%), accessed information from the NAADS officials. This was followed by seminars and trainings (28%), model farmers as (24%), radios (13%), sub county officials and chairpersons (12%) and Kyambogo Datic (3%). Further analysis of the sources of information at district level, revealed that only NAADS as a source of information was significant ($p \leq 0.05$) among farmers in all the other districts with the exception of Kyegegwa. This means that apart from NAADS as an extension agent, no other extension service provider that has had effective presence on the ground. This might explain why most farmers (68 %) have not received agricultural information in formal ways. Our analysis shows that most farmers have learnt agricultural information from either their parents or friends which may not be an effective source of information. Other source of information that come near NAADS are model farmers and seminars and trainings, However, our observation was that most farmers were not ready to learn from their Neighbours which NAADS program considered as model farmers. It was common to see farmers near the model farmers with hardly any practice copied from them because most farmers did not either appreciate them or did not consider them their friends and did not approve how they were elected and as the result, the whole project of demonstration farmers did not help in scaling up technologies and because it is important to develop alternative approaches to diffuse the banana management technologies.

In the study by Chi (2008), it became apparent that well organized mass media and people associations play important role in farmers' adoption of Integrated Pest Management (IPM). It was also found out that farmers could spray their gardens with pesticides as long as they their neighbors spraying even when there was no visible pest in their gardens. The above observation shows the strength of the neighbors on technology adoption. As long as social networks are utilized other than economic credentials in choosing model farmers, they would be much easier in spreading technology. The study also established that strong extension services had greater impact on the level of adoption of IPM in rice.

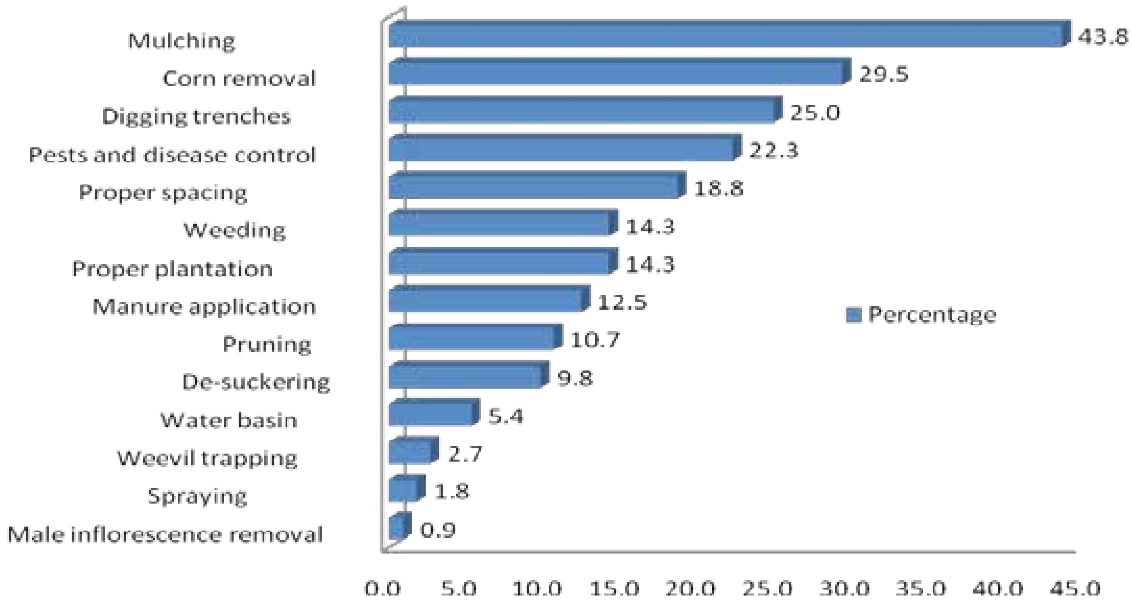
Our findings also agree with those of Conley and Udry (2001) who recognized that information on agricultural innovations diffuses through social networks rather than being freely available in the village. Information from other farmers diffuses through pooling and copying mechanisms (Collier 1998). Pooling of information is a two- Practices way mechanism where the individual involved indirect interpersonal interactions gives some information and/or obtains some from others in return. Copying is a one-way mechanism that takes place by physical observation of the others' experiments without a direct interaction between agents. Pooling through face-to-face interpersonal interactions; copying is viewed as being nested in the pooling mechanism.

By information exchange, we mean any form of information sharing among rural households, whether as recipient, provider or both. Unlike formal sources where information is transferred from providers to the consumers in a unidirectional manner, information diffusion through informal mechanisms is multidirectional. In other words, individuals simultaneously receive and provide information to each other. Although information exchange through informal means generally tends to be less costly compared to that from formal sources, it is not cost free. The cost to information acquisition and provision to account for the time and effort it takes to exchange information. is an important factor farmers may consider before taking up information

4.10.2 Specific Information Obtained

In relation to the sources of information, the study looked information acquired about the specifics of the shared information obtained in relation to banana management. Figure 3.13 presents the responses given.

Figure 4. 13: Specific Information Obtained



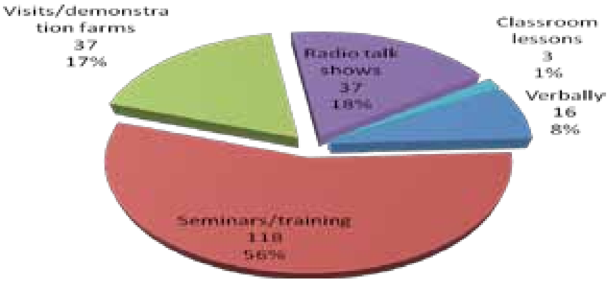
The study further wanted to analyze what sort of information farmers were getting. As observed in Figure 4.8, majority (44%) of the responses indicated that they regularly received information on mulching, followed by the importance of corm removal (30%), digging of trenches (25%), pests and diseases control (22%), proper banana spacing (19%), Weeding and proper planting as supported by 14% of the responses respectively. Other information shared concerned application of manure, pruning, de-suckering, using of water basins, weevil trapping, and spraying and male inflorescence removal.

Application of the multivariate regression test to study the association between the specific information obtained and the source, indicated a significant (p-values = 0.000, 0.008 and 0.029) relation between those who said received information on mulching and NAADS, Kyambogo Datic and training/seminars respectively as sources as the most available extension agents. Although these extension services are mentioned, there impact is almost nowhere to be seen and farmers barely adopt the recommended practices, this calls for a different approach altogether if farmers are to pick up. In some places like Kamwenge farmers expressed surprise to see that they were visited by trained staff. One farmer expressed "This the first time for me to see people come to my village to teach and visit our gardens. I believe if such visits can be frequent we can be able to improve" Most farmers were willing to take us to their gardens so that we can see whether what they are doing is recommended. However, some farmers were reluctant to accept to reduce their number of plants per stool for fear of reducing yields.

4.10.3 Strategies used in Accessing Information

Assessing the strategies used by the farmers in accessing information indicated that majority (56%) of the respondents that received information got it through seminars and trainings while others got either through radio talk shows, visits/demonstration farms, verbally and classroom lessons as seen in Figure 4.14.

Figure 4.14: Strategies used in Accessing Information



4.10.4 Application of Information to Improve Production

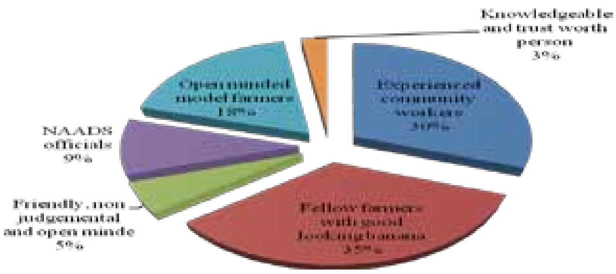
Assessing the usage of the acquired information obtained from various sources in banana management showed that getting information did not necessarily use it on farms. This implied that either the farmers did not get sufficient information to build their confidence in usage or they did not trust the information in causing improvement. In relation to this, respondents were required to mention their preferred sources of information, and as seen in Figure 4.15 farmers mentioned 5 key sources namely: experienced community workers, open minded model farmers, NAADS officials, friendly, non-judgemental and open.

4.10.5 Preferred Persons to Share Information with Farmers

As observed in figure 4.10, majority (35%) of the respondents preferred to share information with fellow farmers with good looking banana plantations, followed by experienced community workers (33%), open minded model farmers (18%), NAADS officials and friendly, non-judgemental (9%) and open minded individuals (5%) respectively. These social networks are very important for spreading information among farmers. Our findings point directly to findings of Collier (1998) who found that Farmers have long history of sharing agricultural information among themselves and these social networks can be utilised by extension agents in diffusing technology. Conley and Udry (2001) have shown that agricultural innovation diffuses through social networks rather than being freely in the village. Therefore, it's sometimes not availability of information that allows diffusion but how available that information to farmers.

Studies have also shown that many farmers tend to copy from each other by observing other farmers experiments without the interaction between agents. Unlike formal sources where information is transferred from providers to consumers in unidirectional manner, information diffusion through informal mechanisms is multidirectional. Therefore extension agents should choose model farmers and demonstration gardens based on how interactive a member is with his village, the number of farmer the model farmers receives in his home daily on friendly basis not on ones level of education, income and resources. Although these are important for an individual, they are not key for technology diffusion

Figure 4.15: Preferred Persons to Share Information with Farmers



In the study by Pallis et al (2002) on social capital and diffusion of pest management technology in Phillipines, they found out that the major sources of social capital were kin network, house neighbourhood, farm neighbourhood and membership in a farmers' association. It was found out that farmers interacted more with their kin than non kin in sharing farming based information than non-kin implying that farmer's personal network was kin-based. Our findings also agreed with similar studies by Rolda (2000) and Jocano (1997) who found out that kin interaction occurs regardless of whether the relative is a house neighbour or farm neighbour, than a house neighbour. Therefore, farmers are likely to transfer skills from their farm neighbour than from their house-neighbour. As long as social network between two farmers, it's not likely to copy from each other thus explaining partly why it was possible to find demonstration farmers whose skills were not shared by his neighbours.

CHAPTER FIVE: CONCLUSIONS AND RECOMMENDATIONS

5.1: CONCLUSIONS

5.1.1 Key Socio- economic Characteristics Rwenzori Banana Farmers

- **Age factor:** Majority of the farmers in the region are in the age bracket of 20- 47 years indicating that banana growing requires able bodied people and probably that is why few younger people below the age of 20 own banana farms. The study revealed that with advance in age, few people engage in banana growing because banana growing and application of banana agronomic management practices is labour intensive.

- **Education factor:** Banana production in the region is mainly in the hands of people with minimal education levels (mainly Primary education) who may not have enough inconomic base that may enable them to finance most of input requirements. . This may have an implication on adoption of technologies because studies have established that adoption of agricultural technologies is positively correlated to the level of education. Banana is both capital and labour intensive.

- Education had an effect on the level of awareness but this is likely to have limited impact since fewer farmers in the region have an education level greater than primary level while few highly educated are the banana business. The study also showed that farmers specifically trained at certificate level in banana management technologies, practiced and or adopted new technology.

- **Income factor:** The study indicated that, with the exception of most cocoa growing farmers in Bundibugyo district; farmers in the Rwenzori region earn below the national average income and therefore can use banana enterprise to raise and supplement their home incomes as the market for this crop has regularly expanded to Neighbouring countries of Kenya, Sudan and Rwanda.

- **Land size and Plant population:** Most farmers have fewer plants on their farm than the recommend 400 plants per acre implying that their farms are underutilized because farmers in some areas had about 5 plants around their home stead while some had so many plants than the recommend. These two extremes can have negative effect on total yield and bunch size. The study showed that most of the farmers produced bananas only for consumption and only a few farmers did have surplus production for marketing at household level. But using the Bunch weight of 50 kg per bunch as the bench mark and more that can be achieved on research station and on some farmers' farms that are well managed, most farmers in this region fall far short of the expectations because about 17 percent of the farmers can get 40kg weight bunch and above that can attract high market price. Although indications from almost all districts indicate potential of producing high bunch weight, few farmers actually aim to achieve it due to poor management practices and adoption of Banana Technologies in Rwenzori Region

- **Knowledge and Practice:** The study also noted that not all who were knowledgeable on the banana management technologies, practiced and therefore awareness does not necessarily mean practice. The minority farmers who had sufficient knowledge had confidence and practiced good management practices. However farmers who showed some knowledge did not have confidence to practice good management practices. Generally the level of practice (adoption) depended on level of awareness.

5.1.2 Factors Affecting Low Adoption of Banana Management Technologies in Rwenzori Region

- Attitude limiting practice: The study found out that on average 80 % of the farmers in the region were either aware or somehow aware of recommended agronomic practices for banana and their importance in improving banana yield but the level of awareness did not influence the practice of the recommended practices and the result most farmers gardens in the region remained poorly managed, which has severely affected the banana yield. Bundibugyo had the least of the farmers who were very aware and aware and Kabarole had the highest number of farmers who were very aware and as the result Bundibugyo had the most disappointing banana management and least banana yield compared to other districts.

- Value attached to Banana enterprise: The findings revealed that the rate of adoption in the region was largely influenced by the level of income from banana yield, availability of land and level of education. Those farmers who took their bananas as the source of income made sure that their level of banana management was high. Fortunately most of these farmers had a good level of education and sizeable land for banana growing. However, land was not a significant factor influencing the level of adoption of management practice because most farmers had enough land and even those who seemed not to have enough land, their small banana plantations were still poorly managed. Most farmers who had adopted good management practices were in Kabarole district, particularly in Rwimi and Kibiito sub counties and most farms which were poorly managed were in Bundibugyo, Kamwenge, Kasese and Kyenjojo districts in their descending order.

- Inappropriate information delivery mechanisms/ approaches: The other factors related to the information sources and the delivery approaches. The information delivery approaches do not integrate gender and decision dynamics at household level. For example while most women indicated knowledge acquired and also provided most farm labour, they were neither resource/ finance power holding centres nor decision making agents at household levels, hence failed to practice technologies. However in households, where both female and male counterparts had interest in farming, there was increased evidence of good banana management practices.

- Existing model farmers were not preferred by other farmers: Majority farmers revealed that NAADS provided general farming information. This means that apart from NAADS as an extension agent, no other extension service provider that has had effective presence on the ground. Other sources of information that come near NAADS are model farmers and seminars and trainings. However, our observation was that most farmers were not ready to learn from their Neighbours –the ones the NAADS program considered as model farmers. It was common to see farmers near the model farmers with hardly any practice copied from them because most farmers did not either appreciate them or did not consider them their friends.

- The available forms of knowledge transfer are not to be effective vehicles of knowledge transfer. Although farmers confess to receive information through workshops, training and media, these seem not to be appearing to be the effective ways of scaling up technology.

- Limited hands-on extension services: Assessing preferred information sources, majority of the farmers preferred getting banana management information from fellow farmers with properly maintained or good looking banana plantations, followed by through experienced community workers. Relating the current sources of information to the farmers and farmers own preference sources could partially explain the low adoption and poor attitude towards adaptation. According to the farmers, fellow farmers with practical knowledge through observed field experiments would build confidence and sense of relevance in the information acquired hence adaptation.

- Social Capital essential for adoption: The results indicate that different aspects of social capital shape the decision to use and the extent of use of improved management practice but the nature of the effect is specific to the practice as well as the form of social capital. Participation in farmers association and the characteristics of the association are important determinants of banana management decisions. The participation in associations by farmers are in turn influenced by household wealth, education and social heterogeneity. Social capital is also very important in control of diseases and pests. Farmers should work together in the fight against pests and diseases in the banana plantations for example banana bacterial wilt.

- Market and household priorities: Market incentives and household factors will be important factors in decision making regarding the use of improved banana management practices and improvement of banana productivity in the region

5.1.3 Soil Fertility Status of Banana Based Land Use Type in Rwenzori Region

- All the sub counties had favourable soil PH which is greater than 5.3 and less than 7.5. This falls within the critical soil PH range of 5.2- 7.5 recommended for banana growing apart from Isunga which had the PH of 5.0. Rwenzori region has volcanic soils that are considered fertile for banana production. However, according to Sys et.(1993), the ideal soil PH for bananas is between 5.6 -7.5. These were Bugaaki (5.9), Harugali(6.0), Kyondo(5.7), Butiiti(5.7), Kicwamba (6.3), Munkunyu(6.0), Kyegegwa (5.9), Rwimi (6.6),Kitswamba(6.0), Kasitu (6.2), Butiiti (5.8), Ntara (5.8).Bubikwanga (6.6), Busoro (5.8) and Kibiito(6.0). The only sub county that does not meet this benchmark was Kahunge (5.5) and Isunga (5.0). From the above observation, it's reasonable to conclude that most soils in Rwenzori region have favorable soil PH for Banana growing.

- Regarding soil organic matter management, subcounties of Isunga (3.06 %), Kicwamba (5.06%), Rwimi (6.25%), Kitwamba (5.18%), Nyantungo (3.25%), Butiti (4.2%), Ntara (4.16%), Busoro(3.95%), Ntara 2 (4.2%) and Kibito (3.37%), had soil organic amounts that favour banana growing. All other remaining sub counties had lower than required minimum levels of Organic matter. It is not surprising that Rwimi had higher levels of organic matter because banana management practices were the highest in the whole research area.

- Phosphorus could be a limiting factor in some areas which have less than the required threshold of (›15 Av.P). These include Bugaki (9.14), Isunga (1.22), Butiiti (3.6), Kahunge (12.12), Kyegegwa (2.21), Kibiito(7.62). The potassium which is the critical nutrient for bananas was enough for banana growing in all visited areas but nitrogen which is the second major nutrient could be a limiting factor of banana production in some areas like Kitswamba in Kasese (0.15), Kahunge (0.19), Kasitu(0.18), Ntara (0.18) and Busoro (0.15) which was less than the critical nitrogen amounts of greater than 0.22. Calcium was also within the acceptable range.

5.1.4 Banana Production Constraints in the Rwenzori Region

- Effects of Climate Change: Due to climatic change effects in the area, almost all farmers experienced increased pressure from biotic constraints such as banana bacterial wilt. In Bundibugyo, it was threatening to wipe out banana plantations even when banana plantations were not managed. Currently the disease has spread to the district of Kabarole and almost all sub counties which are growing bananas are on the risk of losing their plantations to the disease

- The major constraint identified by farmers was time management to accomplish farm work which was mainly the result of labour availability. This was followed by the economic challenge of limited land for farming, poor transport systems, and lack of trainings and possession of poor breeds of bananas.

- Other challenges included old age, lack of capital and labour, lack of farm equipment and fertilizers, poor access of market for bananas a, poor soil fertility management and theft in their descending order of importance. None of these challenges were place specific (parish, Sub County or district) as they were seen to be cross cutting from one area to another.

5.2 Alternatives for enhancing increased banana production in Rwenzori region

The following were identified as the strategies to improve banana productivity in the region

- Joint community action to combat the threat of pests and diseases in the region
- Introduction of high yielding banana varieties that are disease resistant to prevailing biotic constraints
- Availability of clean planting materials at affordable costs
- Local bylaws to enforce community action and proper maintenance of plantations

- Repackaging of extension service and training of farmers in well tested banana management practices and availability of inputs like fertilizers to farmers

5.3 Recommendations

Rwenzori region, with its unique climate, well distributed rainfall, favourable volcanic fertile soils and strategic location along the tarmac road to Kampala, remains the one of the places where the commercial growing of bananas can be developed in the country; however this should only be done in the context of climate change effects in the region.

- We do recommend therefore that new options to enhance adoption of banana management practices be explored such using community social capital to tackle the adoption of agronomic practices and repackaging banana management technologies in forms that are accepted by farmers and can be adopted.

- There is also urgent need to explore using social networks in tackling the threat of Banana Bacterial Wilt. This can facilitate the enforcement of sanitary measures and food security interventions by using group cohesiveness in the various associations the farmers are affiliated to. Unless banana production is taken as a business by farmers, it may be difficult to improve production. Most farmers are subsistence and therefore do not have a business approach to invest in this venture. .BBW may soon wipe out the growing of banana in the region. Banana Bacterial wilt outbreak was observed in December 2005 in Kabende parish of Hakibaale Sub county. Since then it has spread sporadically in all Sub counties in the District and therefore community action is required to tackle this problem

- Therefore any interventions should ensure that communities should approach bananas as both food security and commercial enterprise. Finally, we recommend that participatory approaches be used to select and experiment with farmers by integrating community initiatives, knowledge and skills, so that only those innovation which farmers appreciate are the one that can be promoted

- With banana being of great importance in food security and contributes to farming household incomes in Rwenzori region , the enterprise should be prioritized by local governments and the Ministry of agriculture. These two entities should increase budget allocation that can cater for an effective extension methods to reach the farming households, carryout robust disease control measures,, research in new varieties and practices and fighting pests and diseases.

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