THE IMPACT OF PARTICIPATORY PLANT BREEDING AND SELECTION ON ADOPTION OF IMPROVED SWEETPOTATO VARIETIES IN UGANDA

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DECLARATION

This thesis is my original work and has not been presented for any award in any other institution.

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This Thesis is being submitted with our approval as the University supervisors;

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Dr. Robert .O.M. Mwanga.

DEDICATION

This work is dedicated to the intended beneficiaries of the efforts of sweetpotato research, especially farmers who were part of the respondents for this study.

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ABSTRACT

A study was done on the impact of participatory plant breeding (PPB) and participatory varietal selection (PVS) on adoption of improved sweetpotato varieties (ISPV) in central Uganda. The study assessed how the two approaches influence farmers' uptake of the introduced sweetpotato varieties and determined socio-economic, bio-physical and institutional factors that influence the adoption of these improved sweetpotato varieties and their role to households. The target was sweetpotato farmers who participated in the two approaches and those who are sweetpotato growers but did not participate in either of the approaches. In its bid to popularize improved sweetpotato varieties, sweetpotato programmeof the National Agricultural Research Organisation (NARO) employed the two approaches to disseminate the improved sweetpotato varieties among farmers in major sweetpotato growing regions of Uganda. Therefore a survey was carried out in Kiboga, Luweero and Mpigi districts in Uganda. The study was done in areas where the PPB and PVS research activities were implemented to determine the factors that influence likelihood of adoption including farmers' participation in PPB or PVS.

Data were collected from 180 sweetpotato farmers (60 PPB, 60 PVS and 60 non-participants) using a pre-tested questionnaire. Before administering the individual questionnaire, a participatory rural appraisal was conducted to obtain information not included the individual interviews and to capture the spillover effects. Farmers from non participating subcounties were interviewed separately. Descriptive statistics on the socio-economic characteristics of the households including the usage of sweetpotato proceeds were generated using SPSS software. Using STATA statistical package, logistic regression was executed explaining the factors influencing likelihood of adoption of (ISPV).

Results show that extension services, training related to sweetpotato production, non-farm income; experience and participation in either PPB or PVS significantly influence adoption of ISPV at 1% level of significance. Results also show that PPB approach significantly influences adoption at 5% level while PVS influences at 10% level. Overall 91.7% of farmers who participated in PPB had adopted ISPV while 78.3 who participated in PVS had adopted. The results show that several factors including age, training, experience and non-income influence adoption of ISPV differently in the two approaches. Finally, the study revealed that farmers use proceeds from sweetpotato for different needs which include, expenditure on education, clothing, purchase of animals, medicine, food and land, and other requirements, save, invest in income generating activities, improve housing and others give to spouse.

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background

Over the years, Uganda has been self sufficient in food and also exports both cash and food crops. The country has an overwhelming potential of producing crop surpluses that could be exported to the growing markets in less endowed African and other countries. The production of food crops and traditional cash crops has declined and the rate of recovery is low (Bua, 1998). Since 1989 Uganda experienced a reduction of food production due to declining soil fertility, low adoption of improved crop technologies, uncertain weather conditions and pests and diseases, most notably the cassava mosaic disease, sweetpotato weevil and sweetpotato virus, and banana bacterial wilt (Bua, 1998). Lack or shortage of improved varieties that are acceptable to farmers and other end users is a primary constraint to sweetpotato production not only in Uganda, but the entire eastern and central African region (PRAPACE, 2003). The major cause of this problem is lack of formal systems in the country entrusted with the responsibility of producing and distributing quality-planting material of vegetatively propagated crops such as sweetpotato (Bashaasha *et al.*, 1995). By improved variety is meant those varieties that are more productive and more resistant to prevalent diseases and pests. These improved varieties include NASPOT1 to NASPOT10, Sowola, and PPB clones not yet released (Mwanga *et al*., 2001, 2003, and 2007, Gibson *et al* 2008).

The predominant disease and insect susceptible local sweetpotato varieties presented challenges to agricultural research institutions, development and relief organizations and farmers in providing short to long-term solutions in restoring and sustaining sweetpotato production in the country (Bashaasha *et al.*, 1995). NARO through the sweetpotato programme responded to this challenge by embarking on development of high yielding and disease resistant varieties. The sweetpotato programme employed several approaches to transfer and disseminate the improved sweetpotato varieties to farmers. Among the employed approaches included participatory plant breeding and participatory varietal selection. The key emphasis was on the participation of the farmers and rural people in all processes of problem solving although participation for different approaches was at different levels. Unfortunately, there has been variation in farmers' adoption of the improved varieties and there has been contradicting statements on which approach is more effective as there has not been any study to prove this. This research therefore was intended to examine the impact of participatory plant breeding/selection employed in the development, transfer and adoption of improved sweetpotato cultivars in selected districts in Uganda.

1.1.1 Global importance of sweetpotato

Sweetpotato (*Ipomoea batatus* L.) is among the world's most important and under exploited food crops. With more than 135 million metric tons in annual production, sweetpotato ranks the fifth most important food crop on a fresh weight basis in developing countries **(**FAO, 2003). It is cultivated in over 100 developing countries and ranks the fifth among the most important food crops (Scott and Maldonado, 1999). Only in the last decade has the crop been the focus of an intense, coordinated, global effort to realize its full potential as a source of food, feed, and income for millions of small farmers and low-income consumers in Africa, Asia and Latin America (Scott and Maldonado, 1999). China with an output of about 114,289,100 MT is by far the world's leading sweetpotato producing nation, followed by Uganda (FAO, 2003).

In Uganda, however, sweetpotato is the most important food crop after cooking bananas and cassava (Bashaasha *et al*., 1995), with annual production of 1.7 – 2.5 million tons harvested from 414,000 – 572,000 ha, making it Africa's largest producer of the crop and second after China in the world (FAO, 2003). In Uganda sweetpotato plays an important role in the diet and food security of the population as indicated by high per capita consumption, 85 kg/year (International Potato Center report, 1999). Sweetpotato is increasingly playing an important role as a ready source for cash income from sale of storage roots, vines and processed products in rural and urban markets. Sweetpotato yields in the country are very low (4.4 T /ha), however, compared to yields of over 20 T /ha (24, 26, 32 T/ha for Japan, the Cook Islands and Israel, respectively (FAO, 2003). Although there has been increased sweetpotato research activity in East Africa and in Uganda in particular, sweetpotato yields remain low and this may be partly attributed to effects of sweetpotato virus disease, poor soils, drought, sweetpotato weevil and/or low levels of adoption of the recommended varieties.

1.2 Participatory Approaches

Farmers are increasingly participating in agricultural research as scientists and development workers become more aware of the philosophy of "farmer first and its effectiveness" (Witcombe and Joshi, 1995). Many farmer participatory approaches are possible in farmer participatory research for improved crop cultivars by farmers. They are broadly categorized into farmer participatory varietal selection (PVS) and farmer participatory plant breeding (PPB) since they conveniently define two approaches that are very different, and are likely to have very different impacts. PVS and PPB methods employ differing levels of farmer participation and researcher inputs. Depending on the situation, either PVS or PPB can be the most appropriate method to use. PPB often follows from the successful participatory identification of cultivars (Witcombe and Joshi, 1995). Employment of such methods will help to reduce the possibility that farmers will be given obviously unacceptable varieties to test. NARO and collaborating organizations with the sweetpotato programme employed these approaches in the transfer of improved sweetpotato varieties to rural communities.

1.2.1 Participatory varietal selection

Participatory varietal selection always has three phases: a means of identifying farmers' needs for a cultivar, a search for suitable material to test with farmers, and experimentation on farmers' fields. This was the procedure which the Uganda sweetpotato project employed on one category of farmers while disseminating the new technologies. The approach is described in the sections below.

1.2.1.1 Identification of farmers needs

A number of methods can be used, separately or in combination, to identify farmers' needs such as increasing household income and food security. Important methods are: participatory rural appraisal (PRA), the examination of the type of crops in farmers' fields at or near maturity, or the pre-selection by farmers of cultivars by the inspection of trials of many entries grown on a research station or in farmers' fields.

After the farmers' needs have been identified, the search process is carried out to identify suitable cultivars for testing with farmers. Amongst already released cultivars**,** one method employed in India, is to include in the search, cultivars that have already been released. A key assumption made in participatory varietal selection on released cultivars (Witcombe and Joshi, 1995) is that cultivar replacement rates are lower than optimal because farmers have not been exposed to a range of new cultivars. It is therefore assumed that amongst the released cultivars there are ones that will be preferred by farmers over those they are currently growing. All that is required is to expose the farmers to the suitable cultivars for the project area that already exists, but have not been released or are not available in that area. For many crops in India for example, cultivars can be introduced from other states for a participatory varietal selection program since many cultivars have only been released in single states. Evidence supports the assumption that farmers are not rapidly adopting new cultivars because most cultivars under cultivation are old (Witcombe and Joshi, 1995). There is also good evidence that only a few of the released cultivars are widely grown. For example, wheat in India, the average age of cultivars under breeder seed is 9 years, and the average of cultivars in certified seed production is 13 years in the three states of the KRIBP project, Gujarat, Madhya Pradesh and Rajasthan (Witcombe *et al*., 1995).

1.2.2 Participatory plant breeding

Participatory varietal selection has been extended to participatory plant breeding (PPB) on the assumption that if it is desirable to involve farmers in selection of cultivars then why wait until there are finished products? In PPB, farmers are involved at a much earlier stage whilst material is still segregating, i.e. the materials are still at seedling level before selection of the promising lines. Farmers are involved in raising of seedlings and monitoring their performance in the field in areas of drought and disease resistance, yield, vigour, maturity period, size of roots, and colour among other attributes. Farmers are also involved in monitoring the performance of the potential varieties in terms of taste. The Sweetpotato Programme of NARO based at the National Crops Resources Research Institute (NaCRRI) has combined the two approaches, PPB and PVS, in the testing and transfer of improved sweetpotato varieties.

1.3 Problem statement.

Despite considerable amount of research and introductions of improved sweetpotato varieties, the rate of adoption by farmers is low as shown by low production indicated above in section 1.1 (Bashaasha *et al.*, 1995). The major reason advanced for such behaviour is lack of farmer participation in screening and selection of varieties and the declining productivity because of the devastating effects of sweetpotato weevil (SPW) and sweetpotato virus disease (SPVD), (Bashaasha *et al.,* 1995). It is against this background that NARO employed participatory approaches in disseminating the improved sweetpotato varieties. As a result farmers are increasingly participating in agricultural research. Recently farmers' involvement in participatory sweetpotato research has been at different levels, i.e, participatory plant breeding and participatory varietal selection. However, the impact of these two different approaches on adoption of ISPV has not been quantitatively assessed. There is also lack of information about the factors that influence adoption and adoption patterns of these improved sweetpotato varieties under PPB and PVS approaches. The roles of improved sweetpotato varieties in the farmers' welfare and the benefits accruing to the farmers who have accessed these improved varieties in terms of wealth accumulation has not been assessed and documented.

Due to the low adoption and the declining productivity of sweetpotato because of the devastating effects of sweetpotato weevil (SPW) and sweetpotato virus disease (SPVD), there was need to give particular urgency to solving the Uganda food problem. In response, NARO and various developmental organisations used farming groups and individual farmers to multiply and distribute new sweetpotato planting material in the districts in central Uganda. A study was therefore needed to evaluate the PPB and PVS approaches employed by the Uganda Sweetpotato Programme and NGO's in selected districts of the country, and to analyse the benefits achieved, the adoption and factors that determine adoption of the improved sweetpotato varieties under different testing and transfer methods. Findings from PPB and PVS studies will be useful feedback to research community on farmers' variety preference, the lessons learnt can be useful for national and international organisations to improve the management and decision making process with respect to priority setting, implementation and management of research activities as well as technology transfer. This study is in conformity with the National Strategy of Poverty Eradication and Action Plan (PEAP).

1.4 Objectives and hypotheses of the study

1.4.1 General Objective

The broad objective of the study was to determine the impact of participatory plant breeding and selection on adoption of improved sweetpotato varieties in Uganda.

1.4.1.1 Specific Objectives

- To characterize a sample of sweetpotato farmers in Mpigi, Luweero and Kiboga.
- To establish the role of improved sweetpotato varieties in the farmers' welfare.
- To determine the major factors that affect the adoption of improved sweetpotato varieties in the study districts

1.4.2 Hypotheses

The hypothesis tested was:

Adoption of improved sweetpotato varieties is positively affected by participatory plant breeding and participatory varietal selection.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Farmers' selection criteria

Farmers generally select for multiple traits (Bellon, 1991; Brush *et al.*, 1992; Sperling *et al.*, 1993; Lando and Mak, 1994) and, depending on their circumstances, individual farmers may have different selection concerns that require the availability of several cultivars within each community to meet different requirements. The more selection criteria a farmer employs the more landraces s/he must necessarily plant to meet all his/her criteria (Teshome *et al.*, 1999). Farmers' selection criteria are generally based on a number of factors including, active participation in technology development, cropping system and family uses of crop and market; and these may vary with gender and age of farmers as well as socio-economic circumstances (e.g. access to credit).

Common crop characters used by farmers are large size, shape and colour of harvested component, absence of insect damage and maturity period (Johannessen *et al.*, 1970; Jensen, 1994; Salick *et al.*, 1997; Chiwona-Karltun *et al.*, 2000; Mkumbira *et al.*, 2003). Different cultivars are also selected and planted to serve as insurance against failure of one due to environmental stress (Kennedy *et al.*, 1997). Different markets are also exploited by farmers through selection of cultivars for which there is most demand. For example, banana farmers in south-western Uganda prefer cooking bananas which have large and compact bunches and are easy to transport to urban markets whilst farmers in Central Uganda usually select for types used for brewing (Gold *et al.*, 2002).

The Meso-American maize farmers select red kernels for chichu, black for soft tortillas and yellow for sale on the market. Kernels at the top or bottom of the ear are not used as seed as farmers believe that they grow into weak plants (Johannessen, 1982). Selection for biggest or longest ear is one of the major criteria for yield (Zeven, 1979). Maize farmers in Central and South America generally associate maize cultivars with pale kernels with a long growing season whereas ones with darker kernels are used for short growing seasons (Wilkes, 1995). Farmers also believe that certain landraces function as fertilizers for others whilst some also protect others against diseases, storms and drought (Bohrer, 1994). Most of these characters used by farmers are easy to select for but are rarely used in formal plant breeding. Differences in farmers' age and gender as well as their social status are important in farmers' selection. In Sierra Leone older women in the Iban hill tribe purposefully select rice meant for planting (Freeman, 1955) and in Ghana women control most post-harvest activities and so decide which cultivars to select for home consumption and which to sell in the market (Bennett-Lartey and Akromah, 1996). Other factors that affect farmers' selection criteria include, access to credit, traditional land tenure system, differences in ethnic cultures and availability of suitable land for new cultivars (Bellon and Taylor, 1993).

2.1.1 Farmers' selection of sweetpotato cultivars

In Uganda sweetpotato varieties are grown primarily on small farms where, several hundred landraces vary conspicuously in leaf, colour, and size, vigour, resistance to pests and diseases, maturity period, size, consumer preference, yield, taste, storability and adaptability to different environments (Bashaasha *et al.*,1995).

2.2 Participatory plant breeding and selection

Alternative approaches for identifying cultivars that are acceptable to farmers have been suggested and tried by a number of authors. Chambers (1989) reviewed the small amount of work published at that time on providing farmers with varied genetic material. Published examples now encompass India, Rwanda, and Namibia in rice, beans and pearl millet. In rice, Maurya *et al.* (1988) tested advanced lines with villagers in Uttar Pradesh and successfully identified superior material that was preferred by farmers. Joshi and Witcombe (1995) used farmer participatory methods to identify released rice cultivars that were not recommended in the research area.

In Rwanda, farmers selected 21 varieties from a wide range of bean cultivars grown in their fields that they had first selected in on-station trials (Sperling *et al*., 1993). In Namibia, Lechner, (1992), used farmer evaluation of pearl millet in on-station trials. The farmers selected a cultivar that was subsequently released and became popular. In collaborative research between the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) and Rajasthan Agricultural University farmer participatory research was used to identify pearl millet cultivars suitable for Rajasthan (Weltzien *et al*., 1995). All of these examples can best be defined as participatory varietal selection, since farmers were given near finished or finished products to test in their fields. In contrast, participatory plant breeding involves farmers selecting genotypes from segregating generations. There are few examples in the literature of participatory plant breeding. Sthapit *et al*., 1996 (volume 3) carried out PPB with farmers in Nepal to select chilling tolerant rice from F5 bulk families. Joshi and Witcombe 1995, created a broadly based maize composite for participatory plant breeding in India, and the first selection by farmers was in Gujarat in the 1995 *kharif* (rain season) .

2.2.1 Relevance of participatory plant breeding

Participatory plant breeding (PPB) also termed collaborative plant breeding (CPB) (Soleri *et al*., 1999), farmer participatory breeding (FPB) (Courteois *et al*., 2000) and participatory crop improvement (PCI) (Witcombe *et al*., 1996) evolved from a participatory research model developed by Rhoades and Booth (1982) initially referred to as the "Farmer-Back-to-Farmer" model. PPB has since been used to bring farmers, researchers, extension agents and other beneficiaries of plant breeding together in the process of developing new crop varieties (Witcombe *et al.*, 1996; Hardon, 1996; Smale *et al*., 1998, Cleveland *et al*., 1999). PPB claims to facilitate close interaction among farmers, researchers and other actors in crop genetic improvement (Weltzein et *al*., 1999; Cleveland *et al*., 2000; Fukuda and Saad, 2001), allowing researchers to respond more closely to the needs and preferences of resource-poor farmers and their market clients (Rhoades and Booth, 1982; Farrington, 1988; Badu-Forson, 1997; Cleveland *et al*., 2000). PPB also claims better identification of criteria that are important to the local community, targeted local environmental conditions and varieties obtained from this process are developed more rapidly, are more diverse and have higher adoption rates (Sthapit *et al*., 1996; Kornegay *et al*., 1996; Pandey and Rajataserrekul, 1999; Witcombe *et al*., 2003).

As earlier mentioned different forms of farmer participation have been described by different researchers. Farmer selection of finished or near-finished varieties is termed as participatory varietal selection (PVS), while farmer selection of segregating materials with a high degree of genetic variability is known as participatory plant breeding (PPB) (Witcombe *et al.*, 1996). Ceccarelli *et al*., (2000) also described testing and selecting in the different locations representative of the target-breeding environment as decentralised breeding. Decentralized breeding can be carried out without farmer involvement and participatory breeding and participatory varietal selections do not necessarily mean that they are done in multiple environments (Morris and Bellon, 2004).

Depending on the approach and the objective of the participatory breeding, the process could be described as either researcher-led or farmer-led (McGuire *et al*., 1999). In this way the lead position is taken by either the farmer or the researcher depending on the objectives and the expected outcome of the breeding process. Biggs (1989) also identified four types of participation: a). “Contractual”, where farmers provide scientists with land and services only; b). “Consultative”, where scientists consult farmers about their problems and then develop solutions; c).

"Collaborative", where scientists and farmers collaborate as partners in the research process; and d). "Collegial" where scientists work to strengthen farmers' informal research and development system. Participatory plant breeding/participatory varietal selection has been used in many developing countries to evaluate and improve crop production over the last two decades (Rhoades and Booth, 1982; Sperling *et al*., 1993; 1994; Witcombe and Joshi, 1996; Ceccarelli *et al*., 1997; Witcombe *et al*., 2003). Reported work includes both seed and vegetatively propagated crops (Kornegay *et al*., 1996; Joshi and Witcombe, 1996; Ceccarelli *et al.*, 2000; Weltzein *et al.*, 2000; Fukuda and Saad 2001; Witcombe *et al*., 2003). Although the majority of these studies are located in subsistence agriculture systems in biophysically and socio-economically marginal areas, this approach is also being used in areas suitable for commercial production (PBG/PRGA Programme, 2000).

PPB represents a change not only in breeding approach but also in the organisation of their work as it usually involves more people, working at a greater number of sites, with different types of information managed (Cleveland *et al.*, 2000; Bellon, 2001; Franzel *et al*., 2001; Coe, 2002; Morris and Bellon, 2004). With PPB, breeders can provide farmers with a wide range of genetic diversity. In this way participatory plant breeding may also increase the success of breeding for complex farming systems in diverse and marginal environments (Wolfsen *et al*., 1989; Lowenberg-DeBoer, 1994; Stern and Bernsten, 1994). Early participation of farmers in the selection programme offers a solution to the problem of fitting the crop to a variety of both target environments and users' preferences (Ceccarelli, 1996; Kornegay *et al.*, 1996). Farmers are required to be partners to increase the efficiency and effectiveness of the breeding programme, though farmer participation is also advocated on the basis of equity (Ashby, 1997). Selecting for cultivars with specific adaptations is particularly important in breeding crops predominantly grown in unfavourable conditions, because unfavourable environments tend to be more different from each other than favourable environments (Ceccarelli *et al*., 1997). In PPB, greater emphasis is placed on increasing yield in marginal environments, at reducing production cost and targeting the many of the world's farmers who have not adopted modern varieties but whose landraces have inadequate yields (Cleveland *et al.,* 2000).

2.3 Factors affecting adoption of improved agricultural technologies

It is generally observed that many new agricultural technologies are available but are not being used by farmers as they should (Bahizi, 1996; Semana, 1998) despite the fact that new technologies offer an opportunity to increased agricultural production and income. This has been partly attributed to limited resources allocated to activities related to promoting adoption of proven technologies particularly in less developed countries of Africa (Bahizi, 1996). Since the majority of the population in developing countries derives its livelihood from agricultural production, there is a realization that concerted effort be directed towards enhancing adoption of proven agricultural technologies that lead to improved production and income (Feder *et al*., 1985). Rogers (1995) identified a sequence of stages in the adoption process as knowledge, persuation, decision, implementation and confirmation.

According to CIMMYT (1993), these stages depend on the degree and pattern to which the technology is appropriate for farmers' conditions, local farming systems, how the technology is supported by marketing and how it is represented by extension and other information systems. The decision to adopt or not adopt an innovation by individual farmers is preceded by careful evaluation of a number of technical, economic and socio factors (CIMMYT, 1993; Colman and Young, 1989; MacDonald and Heale, 1984). Farmers will continue using the innovation depending on how well the change satisfies their needs (Collinson, 1993). The innovation has to be the best course of action available in that situation for the farmer to adopt it and he or she may decide to drop the innovation after it had previously been used (Rogers, 1983). Adams (1987) observed that a technology, which meets the specific need in a specific situation, is more appropriate and desirable. Several factors influence the scope, degree and patterns of adoption of new technologies. Lionbreger and Gwin (1982) noted the adoption of agricultural technologies by farmers is influenced by general factors, which relate to the farmer concerned and the situation in which the farmer and the technology interact.

Studies elsewhere identified and categorised factors influencing adoption of new agricultural technologies into: farm and farmer associated attributes, technology associated attributes and the farming objective (CIMMYT, 1988; Adesina and Zinnah, 1992; Mishra *et al.*, 1997). Similarly, Ruttan (1997) identified personal, socio-economic, cultural, communication and situational factors as having significant impact on adoption process. Bisanda *et al.,* (1998) on the other hand highlighted farm size, experience, education, agricultural extension services, household size, access to input sources, hired labour and access to credit, factors that influence farmers' adoption decision. Shapiro and Brorsen (1988) reported that Indiana farmers' use of hedging was affected by experience, education, farm size, off farm income, expected income change from hedging and beliefs that hedging could stabilize income.

CIMMYT (1993) pointed out that adoption depends much on farmers' characteristics concerning education, age, gender, farm resources, the farming system, post harvest utilisation and market availability, plus information sources. Farmer characteristics concern the specific conditions that influence the farmers' acceptance to make technology generation more efficient and explain differences between adopters (CIMMYT, 1993). Colman and Young (1989) listed age, experience and education as farmers' characteristics that might determine awareness, interest and ability of the farmer to implement a new technology. According to CIMMYT (1993) education provides a foundation for adoption of new practices and therefore makes a farmer more receptive to advice and more able to understand and deal with technical recommendations. This assists people to make rational decisions (Rogers, 1983).

Formal education helps an individual to acquire knowledge and it is considered a prerequisite for economic and socio-change. Bisanda *et al*., (1998) observed that educational level increased the probability of adoption of recommended technologies since it increased farmers' ability to obtain, process and use information relevant to the adoption of a given technology. Consequently, Huffman (1977) concluded that farmers' allocative efficiencies in changing optimal fertiliser rates were significantly related to education. Rahm and Huffman (1984) also reported that the rate of adoption of reduced tillage production techniques rose with increased education and, Goodwin and Schroeder (1994) observed a 3.1% rise in adoption for each additional year of formal education. Farmers' age is reported to influence adoption of new technologies. Older farmers tend to have the ability to own more resources, experience or authority which allows them better chances for trying out new technologies and less afraid of taking a risk. It is also pointed out that young farmers may find it easier to adopt new technologies because they have had more education or may have been exposed to new ideas (Kayita, 1998)

Adoption is also influenced by gender in various ways (Ajwang, 1998). Beek *et al*., (1993) observed that women who contribute up to 68% of agricultural production in Uganda are often overlooked and have limited access to new technologies and are constrained in decision making. They also observed that women provide at least 50% labour in horticultural production in Uganda and 90% retail trade of fruits and vegetables is handled by women yet the illiteracy level for rural women was at 43% compared to 28% of rural men. They also make up to 20% of the total labour force and contribute about 60-80% of the country's agricultural production.

Farm resources make it easier or more profitable to a farmer to change practice (Nair, 1993; CIMMYT, 1993), they include farm size, which reflects a farmer's farm management ability, labour availability that may affect ease with which a technology can be accepted because it can affect labour input, plus division of labour. For a peasant small holder farmer, the family is the major source of labour (Collision, 1993). Hired labour usually supplements family labour particularly during critical labour demand times. However, Byerlee (1993) observed that it was the farmers' objective to increase the utilisation of family labour and maximize output with low cost inputs. As observed by Nair (1993), for ease of adoption, new technologies need not to be in competition with available labour or cause a rise in labour demands in an existing farming system. Labour requirements extending beyond available family labour may negate farmer technology adoption (Nair, 1993). Adams (1987) observed that in the major part of Africa where labour rather than land is in short supply, farmers are reluctant to adopt innovations which even if they produce more food involve more work. Lionbeger (1968) identified personal experience and exposure to reliable sources of information as predisposing individuals to the adoption of new practices. According to Arnon (1989) and Sabiiti (1989), farmers need to know about an innovation in order for them to accept to adopt it.

In addition, support by institutions responsible for providing inputs and technical advice such as offering extension visits and attendance at on-farm demonstration is reported to positively influence adoption of new technologies (CIMMYT, 1993). This is in agreement with Rahm and Huffman (1984) who found that participation in extension education programs increased the efficiency of reduced tillage adoption. Similarly, Huffman (1977) reported that extension education significantly increased adoption of optimal fertilizer application. Also, interpersonal channels were found to be more efficient in forming and changing attitudes towards a new idea

(Rogers, 1983; Lionberger and Gwin 1982). Byerlee (1993) noted the difference between knowledge and use of an innovation and advised that in adoption studies, the distribution of farmers who know and those who do not know could be examined.

Adoption of new technologies also depends on the farmers' economic conditions (Ntege-Nanyeenya, et al., 1997). For example, it was revealed that subsistence farmers in tropical agroecosystems are challenged with a wide array of insect pests and warm climatic conditions which support many pest generations per year and yet severe economic constraints limit the choice of options available for them to protect their crops. As a result, farmers place strategic importance on cultural practices such as the selection of varieties, planting dates and, to store unthreshed or unshelled grains as key elements to manage pest levels (Nahdy *et al*., 1993; Letourneau, 1994). In addition, Bisanda *et al*., (1998) found that access to credit relaxed farmers' financial constraints. Thus, access to credit would be expected to increase the probability of adoption. Similar observations were made in earlier studies carried out in Uganda showing that technologies needed to be economically attractive, realistic in input requirements, sustainable in terms of profitability and efficient for their adoption to be facilitated (Kasenge *et al*., 1999). The implication therefore is that innovations perceived to be economically compatible with values and resources are often readily adopted (Erbaugh *et al*., 2000).

The degree to which the technology is consistent with the farming system is also found to affect adoption. Rogers (1993) stated that the compatibility of an innovation with previous ideas can retard, reduce or promote the rate of adoption. Adams (1987) and CIMMYT (1993) argue that innovations, which are relatively simple and compatible with existing local farming systems previous experience, are usually more easily adopted. Adams (1987) explained that appropriate technology, which is defined as ''technical change that meets a specific need in a specific situation'', is within the ability of the local people to manage and is compatible with their financial incomes and capabilities. Also Rogers (1983) pointed out that old ideas are the main tools against which new ideas are assessed because old practices are familiar standards against which the new technologies can be interpreted to reduce uncertainty. The new technologies also need to be compatible with present and other management practices in the farming system.

A technology which is compatible with available post-harvest conditions, utilisation and input markets like local processing and cooking, marketing prospects and storage facilities is more acceptable to the people concerned. Input markets and farmer's ability to purchase the inputs enable access to the required inputs for the technology (Kayita, 1998). Colman *et al*., (1989) considered the availability of required inputs in the right amounts as a crucial aspect in the adoption process. Manyindo (1993) identified marketing as a thorny issue in Uganda in which storage and drying were bottlenecks.

2.4 Role of improved sweetpotato to household welfare

Sweetpotato plays a crucial role in the country's production system offering potential benefits to poor farm households and urban consumers. Sweetpotato is an important food security crop reducing hunger when other crops fail or in specific seasons before the main harvest (Kelly *et al., 2003)* It can be grown on soils of limited fertility and is relatively drought tolerant. Sweetpotato planting and harvest periods are more flexible than maize and other grains. In swampy areas it is planted throughout the year. Sweetpotato produces more edible energy per hectare per day than any other major food crop. It is prized as a fresh product, and the advent of orange-fleshed varieties also contributes to improved nutrition, through provision of vitamin A and other micronutrients and energy. It is consumed by all age-groups and is particularly liked by young children, the most vulnerable to the vitamin A deficiency.

Sweetpotato provides both on-farm and off-farm employment to youths and women. A large number of women do retailing this commodity across the country (Kelly *et al., 2003).* It is also a flexible source of income to poor households as production for the market is by small, diversified farmers. Sweetpotato cash proceeds are put to various uses including, paying school fees, purchase clothing of animals and of medicine. The market survey estimated the value of domestic trade to be about US $ 60 million (2002). Although at the moment processing is negligible, sweetpotato offers processing opportunities into products for human and industrial use. There is potential for new uses of sweetpotato flour as an ingredient of processed products including, *mandazi*, cakes, *kabalagala*, *chapatti*. Sweetpotato flour is also being tested in composite products such as Nutri porridge. Other products include juices, chips and for use in animal feed industry.

CHAPTER THREE

3.0 METHODOLOGY

3.1 Field Methods

3.1.1 Study Area

Having high priority in the research set-up, research on sweetpotato is conducted at national level with strong regional and international collaboration. The research focuses on the major sweetpotato growing areas in Uganda where the crop is grown in many different agro-ecological areas and socio-economic conditions. To address these agro-ecological and socio-economic diversities, studies were carried out in a number of carefully delimited areas representing important sweetpotato-based systems. The study was carried out in the central region of Uganda in the districts of Luwero, Kiboga and Mpigi, where the PPB and PVS approaches in sweetpotato research and dissemination efforts have been focused over the years.

3.1.2 Sampling Procedures

Before data collection, a preliminary survey was conducted in which a structured individual questionnaire and group questionnaire were pre-tested to randomly selected 20 households and one farmer group, respectively, who are outside the study area but who participated in PPB and PVS. The aim of this phase was to check the relevance and validity of the questions intended for respondents. In addition**,** participatory rural appraisal (PRA) was conducted because informal surveys are important in that they assist scientists to identify issues that may have not been considered in the formal questionnaire and these can be pursued in the formal study. Focus group discussion (FGD) using semi structured interview guide (SSI) was conducted in target areas in the three selected districts following Kristjanson *et al*., 2002. These communities were chosen according to representation of a spectrum of farmers who had participated and those who had not participated in participatory breeding/selection research, in order to capture possible differences in perceptions of the role of sweetpotato. The group discussions also elicited information as to the perceived benefits, the production constraints, the performance of different participatory methods engaged in testing and transfer of the improved sweetpotato varieties and factors that are likely to affect adoption of these improved sweetpotato varieties.

An adoption study of the participatory plant breeding/selection research approaches of multiplication and distribution of sweetpotato varieties in the locations/districts where the approaches have been used was conducted using a structured questionnaire. Combinations of qualitative and quantitative methods (explained in part 3.4) were used to assemble data from the studies fed into the ongoing research. Three farmers' groups (1 participatory plant breeding, 1 participatory varietal selection and non-participating) were purposively selected in each district. A sample frame available at project and local administration for participating and non-participating farmer groups and individual farmers, respectively, were used to sample the respondents randomly. A two-stage sampling technique was used for randomly sampling 20 and purposively 2, participating farmers and farmer groups, respectively, in each selected district. A further 20 and 1 non-participating farmers and farmer group, respectively, were selected. Hence, sampling sizes of 60 random individual farmers from 3 farmer groups (each 20 farmers) in each district were interviewed using semi-structured questionnaires. The study covered a total of 180 randomly selected individual respondents from 9 purposively selected farmer groups. However, in the district of Luwero farmers were selected from non-participating sub-county so as to capture the spill over effects of various developmental interventions in the district.

3.1.3 Data Collection

The data requirements for this study were largely contained within technology characteristics – users' context framework so as to test the hypotheses presented previously. The farm data required included socio-economic, biophysical and institutional variable associated with improved sweetpotato varietal testing and transfer. The data was categorized into discrete and continuous variables since the analytical methods which were used (described later in this chapter including logit) could handle both types of data. Table 3.0 below presents a summary of the data used in the study in the general context of socio-economic, natural and institutional environment of farmers.

Table 3.0: Summary of the data on the socio economic, natural and institutional factors**.**

Socio-economic factors	Bio-physical factors	Institutional factors
Land resource	Distribution systems	Participation in research
Household size	Variety attributes	Extension services
Labour		Marketing attributes
Sources of credit		
Household income		
Farmers' sources of information		
Family consumption		
Farming experience		
Age, sex, education		

3.1.4 Data Processing and Analysis

A range of analytical methods were applied to test the hypotheses described earlier. The model was run using STATA computer package. Following is an overview of these methods and the respective hypotheses they tested.

- Descriptive statistics were used to examine the frequency distributions, mean values, and standard deviations of the variables used in hypotheses.
- Univariate analysis was used to summarize the information relating to each variable
- The distributional properties were analysed using sub-programme frequencies and histograms.
- Cross tabs sub-program was used for bivariate analysis to study the relationship between pairs of variables.
- Correlation coefficient was used to summarise the associations.
- Frequency distribution was used to examine differences in the level of adoption of sweetpotato technologies under different methods testing and transfer as stated in hypothesis.
- Logit analysis.

Logit analysis was used to compare the relationship between variety, farm and/ or farmer characteristics and adoption under different testing and transfer methods as specified in hypotheses above.

3.2 Analytical Methods.

3.2.1 Characterization of a sample of sweetpotato farmers.

This objective was achieved through identifying and quantifying the various factors that influence adoption such as age, participation in research, family size, experience, gender, sex of household head, non-farm income, education level, training related to sweetpotato production and extension services. Information on these factors was obtained by running descriptive statistics by use of SPSS and Excel computer packages. Various descriptive statistics were used to examine the frequency distributions, mean values, and standard deviations of the variables mentioned above.

3.2.2 Establishing the role of ISPV on household food security and income.

Establishing the role of improved sweetpotato to household income, various descriptive statistics were run using STATA and SPSS computer packages. Various descriptive statistics were used to examine the frequency distributions, mean values, and standard deviations of use of proceeds from sale of sweetpotato, reasons for growing sweetpotato and most important food crop in a household.

3.2.3 Determining the major factors that affect the adoption of ISPV

3.1.3.1 Adoption theory

Adoption studies have considered adoption as a discrete phenomenon rather than a continum that reflects the intensity of use of various technologies. This makes the study of the adoption process complex and it requires consideration of a broad set of social, economic, natural and institutional determinants. Economic literature identified three possible directions, which adoption theory might take over time. These include: innovation-diffusion theory, the economic constraint theory and the technology characteristics- user's context theory (Rogers, 1962). The innovation-diffusion theory holds that technology is transferred from its source (research system) to users through agent-medium (extension systems), and its diffusion in potential users-communities depends mainly on the personal characteristics of the users. Therefore effective communication is required for technology transfer and inappropriate communication hinders technology diffusion (Negatu and Parihk, 1999). The innovation-diffusion theory assumes that a new technology has been already adopted, but those who have adopted have not yet used the best practice fully to achieve the full potential of the technology (Klirajan and Shand, 2001).

For the economic constraint theory, Adesina and Zinnah (1993) contended that economic constraints reflected in asymmetric distribution pattern of resource endowments are the major determinants of observed adoption behavior. However, the technology characteristics-users' context theory integrates approaches, which assume that characteristics of a technology, underlying users' agro ecological, socio-economic and institutional context, play the central role in the adoption of decision and diffusion process (Biggs, 1990). This theory further explains the perception of potential adopter regarding the characteristics of a technology as component, affecting adoption decisions, hence the diffusion of the technology (Gould *et al.*, 1989). This theory identifies the importance of farmers' involvement in technologies with appropriate and acceptable characteristics, and also implicitly recognizes the importance of institutionalisation of research policies and strategies that facilitate the participation of farmers and other relevant stake holders in the technology development process (Batz *et al.,* 1996, Negatu and Parikh, 1999.). This study therefore recognizes technology characteristics-users' context theory.

Farmers adoption decisions of improved technologies is built on the assumption of expected utility that would be maximized if the probability of adoption were 1 (Rahm and Huffman, 1984), therefore, the probability that a farmer adopts a new technology is a function of the expected utility (benefits) derivable from the decision to adopt. There is a functional relationship between expected utility (benefits) from participation in a technology and its characteristics and farmer characteristics expressed as

YN = 1 if E (UN) > E (UT)…………………......1

P (YN) = f {E (UN)/E (UT)}…………………………2

E (U) = F (TC, FC)…………………………………3

Where YN=1 is adoption of new technology

E (UN)= Expected utility of participating farmers

E (UT) = Expected utility of non participating farmers

TC = Technology specific characteristics

FC = Farmer specific characteristics

The adoption function is unobserved as in the case of utility function but specifically relates with vector of observable factors that can be grouped as varietal and farmer characteristics.

By assuming a non stochastic, but linear function we may have an adoption function implicitly represented as (Bua, 1998).

$$U_{ji} = \alpha_j F_i (M_i A_i) + e_{ji} \quad j = 1, 2; i = 1, 2 \ldots n \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad 4$$

Where M is farm and farmer-specific attributes

A is Technology- specific attributes

j= Participation, where j=1 for participation, j=2 non participation

i =Farmer number

α =Estimated coefficients of the independent variables

e = Disturbance term with zero mean

F= Cumulative standard normal distribution function

U = Utility function of farmer's adoption decision

Equation 4 holds for preference of the farmers for adoption. The perception of the farmers for a given new technology is measured on the ordinal scale being determined by various explanatory factors. These factors are the determinants of adoption.

3.1.3.2 Endogeneity

While participation in PPB and PVS programs have been hypothesized as influencing the adoption of improved crop production technologies, Green, (2000), past research rarely considered the potential simultaneity bias that arises from using the endogenous participation in PPB and PVS as a regressor in the adoption equation (Gulati and Narayanan (2003). The problem of endogeneity arises because unmeasured household-level variables affect program participation. The problem of endogeneity in econometrics occurs when an independent variable is correlated with the error term in a regression model. Endogeneity is tested using the Durbin –Wu-Hausman test. Endogeneity occurs when there is feedback between dependent and independent variable (two-way causality).For example PPB and PVS are potentially correlated to land, education level, location and gender. Scholars such as Green, (2003) have demonstrated that endogeneity is the same as model misspecification and ignoring it can be expected to lead to biased coefficient estimates and inferences.

Endogeneity arises when the covariance of two variables are not equal to zero. This implies that the presence of a covariate results in a significant variance of another. Different authors have recommended various remedies to deal with such a problem (ibid). One of the remedies includes the use Instrumental Variable (IV) or Generalized Method of Moments (GMM) estimation instead of Ordinary Least Square (OLS) estimation. In this study, therefore, the problem of endogeneity was addressed using the predicted values of the instruments of the endogenous variables. With the resulting endogeneity, least squares estimation procedure is likely to result in inconsistent estimates. Inconsistent estimates are those that do not converge towards the population mean as the sample size increases. To achieve consistent estimates, the predicted values of PVS and PPB was used to eliminate potential correlation of error terms with PVS and PPB. Factor analysis was used to combine instruments into single scores. This was useful where some of the instruments exhibited collinearity and factor analysis aided to prevent loss of crucial instruments.

3.1.3.3 Logit Model

The logit model addresses the 'adoption' issue and assesses the factors that enhance or reduce the probability of farmer adoption, for instance, of new sweetpotato varieties. The model provides for correction binary classification that is generally a consistent estimator of parameters and appears to be suitable to analyse the adoption decision (Feder *et a*l., 1985). Estimated coefficients of the logit model define the slope or rate of change of a function of the dependent variable per unit of change in the explanatory variable. Positive sign for the coefficient indicates that the log of the odds ratio of adoption of improved sweetpotato varieties increases as the value of the variable rises and a negative sign indicates that the ratio decreases as the value of the variable drops. As earlier mentioned, farmers adoption decisions of improved technologies is built on the assumption of expected utility/benefit that would be maximized if the probability of adoption were 1. The conceptual considerations of the analysis of technology adoption is based on the fact that the decision of an individual agent, i, to participate in an economic activity depends on a qualitative index, Z_i, that is determined by a set of explanatory variables in such a way that the larger the index, the greater is the probability of adoption. This index of participation/adoption is expressed as follows:

$$Z_i = \alpha + \beta_i X_i + \mu_i \quad \ldots\ldots (5)$$

Where

Z_i = Qualitative dependent variable (defined by adoption or non adoption of the ISPV)

ISPV = Improved sweetpotato varieties

Z_i = 1 if respondent adopted

= 0 if respondent is non adopter

X_i = a vector defining the independent variables

α = the value of the regression coefficient

β = the regression parameters

μ_i = Error term.

To operationalize the theory, a logistic regression analysis was conducted to identify the determinants of extent of adoption of improved sweetpotato varieties in Uganda. The probability of adoption was defined by the following expression:

$$P_i = \quad = \frac{1}{1 + \exp\left[-(Z_i)\right]} \quad \ldots\ldots (6)$$

Where Pi = is the probability that an event will occur

exp = is the natural logarithm

$Z_i = \beta_o + \beta_1 X_1 + \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \beta_n X_n + \mu_1$ ……………….(7)

This is the cumulative logistic distribution function. Where $\beta_o \ldots\ldots \beta_n$ are the coefficients to be estimated

$X_1 \ldots\ldots X_n$ are the explanatory variables describing the technology, farm and farmer characteristics. Equation (6) can be rewritten as;

$$P_i = \; = \frac{1}{1 + e^{-\beta_o + \beta_1 x_1 + \ldots\ldots + \beta_n x_n}} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(8)$$

If we multiply the numerator and denominator of equation (8) by

$$e^{\beta_o + \beta_1 X_1 + \ldots\ldots\ldots \ldots\ldots\ldots + \beta_n Xn}$$

We get

$$P_i = \; 1 - \frac{e^{\beta_o + \beta_1 X_1 + \ldots\ldots\ldots \ldots\ldots \beta_n X_n}}{1 + e^{-\beta_o + \beta_1 x_1 + \ldots\ldots + \beta_n x_n}} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \; (9)$$

Since P_i is the probability that an event will occur then, 1- P_i is the probability that an event will not occur.

$$1-P_i = 1- \frac{e^{\beta_o + \beta_1 X_1 + \ldots\ldots\ldots \ldots\ldots \beta_n X_n}}{1 + e^{-\beta_o + \beta_1 x_1 + \ldots\ldots + \beta_n x_n}}$$

$$= \frac{1}{1 + e^{-\beta_o + \beta_1 x_1 + \ldots\ldots + \beta_n x_n}} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(10)$$

Dividing equation 5 by 6, we get

$$\frac{P_i}{1 - P_i} = e^{\beta_o + \beta_1 X_1 + \ldots\ldots\ldots \ldots\ldots\ldots + \beta_n Xn}$$

$\frac{P_i}{1 - P_i}$ is the odds ratio, that is , it is a ratio of the probability of occurrence of an event to non-occurrence (Greene *et a*l ;1997)

By taking natural logarithms we get

$$\text{Ln} \frac{P_i}{1 - P_i} = \beta_o + \beta_1 X_1 + \ldots\ldots\ldots \ldots\ldots\ldots + \beta_n Xn \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots..(11)$$

A logistic regression was executed on equation (11) to determine the coefficients through the maximum likelihood technique.

3.1.3.4 The empirical model

On the basis of the theoretical model, the model for this study was specified as follows:

$$Y = \beta_i X_i + \mu_i \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 12$$

Where:

$\beta_i = \beta_1, \beta_2 \ldots\ldots \beta_n$ = a vector of parameter estimates

$X_i = X_1 \ldots\ldots Xn$ = a vector of the explanatory variables.

The explanatory variables included were variety attributes, institutional, farm and farmer characteristics. Variety attributes used were outer skin colour, taste, shelf life, yields, and resistance to sweetpotato virus (SPV), maturity period and in ground storage.

Farm and farmer characteristics: household income related to sweetpotato, size of arable land owned, education, contact with extension staff, age of household head and participation.

I.e.

Z = Binary (takes the value of 1 for adopter and 0 otherwise

X_1 = other activities/income (binary)

X_2 = Family size (continuous)

X_3 = Land size (continuous)

X_4 = Age of household head (continuous)

X_5 = Participation in PPB (dummy 1=yes, 0=No), Predicted.

X_6 = Extension services (Number of extension visits)

X_7 = Education level (No. of years for formal education)

X_8 = Farming experience in sweetpotato

X_9 = Training related to sweetpotato production attained

X_{10} = Participation in PVS (dummy 1=yes, 0=No), Predicted.

3.1 Measuring the impact of PPB and PVS

The impact of PPB and PVS on adoption was tested by use of a logistic regression model and the PPB and PVS was treated as dummies in the regression model taking a value of 1 for participation or 0 otherwise. Marginal effects were computed after running a logit model. This was done to establish the magnitude of change in the dependent variable with respect to change in the independent variable. The marginal effects were also generated using the STATA computer package.

3.2 Independent variables with their hypotheses

For the model to be useful, this study adopted the following assumptions:-

1) AGE: Young farmers were expected to search more than old farmers for technical information about improved sweetpotato varieties because they are looking for progress. Old heads of households tend to have a strong belief in traditional technologies hence very unlikely to accept changes readily in their way of farming.

2) EDUCATION: Farmers' education is generally associated with great understanding of new information and benefits of new technology. Therefore educated household heads were expected to more adopt ISPV than household heads with less or no education.

3) FAMILY SIZE: Family labour available determines adoption of new technology. Household with more labour can decide to adopt labour-intensive technologies than households with less labour or limited access to hired labour. It was hypothesized that availability of labour could influence the level of adoption of ISPV.

4) PARTICIPATION IN RESEARCH AND EXTENSION AVAILABILITY: Institutional support services were hypothesized to enhance adoption of new technology. Therefore extension services and farmers' participation in research were expected to increase exposure to awareness of households to adopt improved sweetpotato varieties.

5) EXPERIENCE: Farmers with a long experience in farming/sweetpotato production were expected to increase the level of adoption. Farmers with less experience are likely to be risk averse and may be early adopters, late adopters or laggards.

6) TRAINING IN SWEETPOTATO PRODUCTION: Training is an essential tool for any new technology to be adopted; it exposes the advantages of the new technology and hence increases the level of adoption. In this study, therefore, it was hypothesized that farmers who received training in sweetpotato production would adopt the improved varieties.

7) ROLE OF SWEETPOTATO IN HOUSEHOLD: If sweetpotato plays a great role in a household, there are high chances that family members will look for the varieties that will be of great help to them. It was therefore hypothesized that the greater the role sweetpotato plays in a household the higher the chances that a household will adopt improved sweetpotato varieties. The dependent variable for adoption (Adpt) was, have you grown improved sweetpotato varieties last season? The dependent variable was used as an indicator for ISPV adoption. The variable was coded '1' for yes indicating adoption and '0' for indicating no adoption.

CHAPTER FOUR

4.0 RESULTS AND DISCUSSION

This chapter presents findings of the farmers' survey conducted in Kiboga, Luweero and Mpigi districts to determine the impact of participatory approaches on the transfer and adoption of improved sweetpotato varieties. The participatory approaches considered include participatory plant breeding and participatory varietal selection on which the empirical analysis was based. For easy identification of sweetpotato farmers to work within the participating districts, the sweetpotato programme used sweetpotato farmer groups from which farmers were identified but participated in the research at household level. Each individual farmer was given planting material to evaluate at his/her home and therefore the impact of the participatory approaches employed was assessed at household level.

4.1 Characterization of sweetpotato producers

Before discussing the impact of participatory plant breeding and varietal selection on adoption of improved sweetpotato varieties and factors that affect the adoption of these improved varieties, it is important to understand the type and characteristic of sweetpotato growers.

4.1.1 Age

Respondents were grouped into four age groups. The minimum age of interviewed respondents was 18 years, maximum age was 74 years and average age was 43 years. The head of a household may have great influence in participation in research and subsequent adoption since he/she is the main decision maker in the household.

Table 4.1: Age distribution of respondents among sweetpotato farmers- a survey results.

PPB	Adopters (n=55)		Non Adopters (n=5)		Total (n=60)	
Age (years)	No.	%	No.	%	No.	%
18-30	7	12	0	0	7	11.7
31-50	38	68.8	3	60	41	68.3
51-70	10	18.2	2	40	12	20
71-80	0	0	0	0	0	0
PVS	Adopters (n=47)		Non-Adopters(n=13)		Total (n=60)	
Age (years)	No.	%	No.	%	No.	%
18-30	4	8.5	0	0	4	6.7
31-50	28	59.6	9	69.2	37	61.6
51-70	15	31.9	4	30.8	19	31.7
71-80	0	0	0	0	0	0
NON PPT Age (years)	Adopters (n=40)		Non-Adopters(n=20)		Total (n=60)	
	No.	%	No.	%	No.	%
18-30	9	22.5	5	25	14	23.3
31-50	24	60	12	60	36	60
51-70	6	15	3	15	9	15
71-80	1	2.5	0	0	1	1.7

From Table 4.1, we observe that, the majority in all the categories of respondents (68.3% for PPB, 61.6% for PVS and 60 % for non participants) of the house hold head were found in the middle-aged groups ranging from 31 to 50 years old. A small proportion (11.7% for PPB, 6.7% for PVS and 23% for non participants) household heads were below 30 years old whereas (20% for PPB, 31.7% for PVS and 1.7% for non participants) were above 70 years. The study also revealed that, adoption of ISPV as earlier mentioned in chapter two increases with age up to 50 years whilst further increase in age results in the number of adopters to go down in all categories of farmers. It was noted that, young people are more eager to learn and adopt new ideas than old people. CIMMYT (1993) reported similar results, that younger farmers are likely to adopt a technology, because they have attained higher levels of education than older generations or perhaps have been exposed as migrant labourers. At an age ranging from 51 to 70 years in all the categories of farmers, the adopters dropped from 68.8% to18.2% for PPB farmers, 59.6 to 31.9 and 60 to 15 for PVS farmers and non-participants, respectively. Further increase from 60 to above 70 years old showed that adopters drop to 0% for PPB farmers, to 0% and 2.5% for PVS and non-participants, respectively (Table 4.1).

The majority of adopters (56.7%) were farmers who had participated in sweetpotato research either in PPB or PVS. However, there were more adopters (91.7%) among respondents who had participated in PPB compared to those who had participated in PVS (78.3%) and the non-participants (66.7%), (Table 4.2).

4.1.2 Gender involvement in sweetpotato production

Gender involvement in sweetpotato production was evaluated comparing male and female adopters and non-adopters. Composition of the female and male adopter was 62.2 % and 37.8%, respectively (Fig. 4.1). Although sweetpotato is classified as a woman's crop,(Kapinga *et al*., 1995) a considerable change was revealed by this study, since there was no significant difference between male and female adopters ($p>0.05$).

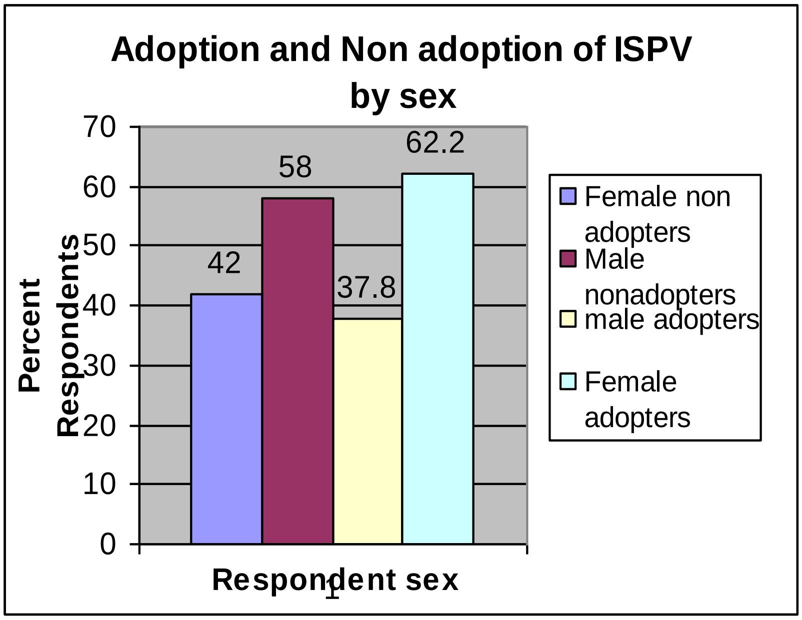

Figure 4.1: Adoption of improved sweetpotato varieties by sex-survey results

The study revealed that, males are effectively involved in sweetpotato production in all study areas in the three different categories of farmers (Tables: 4.2, 4.3, and 4.4).

Table 4.2: Family Labour distribution by gender in sweetpotato production and marketing in Luweero- survey results.

	PPB (n=60)		PVS (n=60)		NON ppts (n=60)		Overall mean	
Activity	M	F	M	F	M	F	M	F
Clearing	35	25	40	20	38	22	38	22
Ploughing	30	30	30	30	30	30	30	30
Planting	20	40	23	37	18	42	20	40
Heaping	35	25	30	30	32	28	32	28
Seed procurement	8	52	12	48	10	50	10	50
Weeding	28	32	30	30	25	35	24	36
Harvesting	32	28	23	37	28	32	28	32
Marketing	30	30	35	24	31	29	29	31

Table 4.3 : Family Labour distribution by gender in sweetpotato production and marketing in Mpigi.- survey results.

	PPB (n=60)		PVS (n=60)		NON ppts (n=60)		Overall mean	
Activity	M	F	M	F	M	F	M	F
Clearing	33	27	45	15	38	22	38	22
Ploughing	30	30	30	30	30	30	30	30
Planting	30	30	29	31	18	42	20	40
Heaping	35	25	30	30	32	28	32	28
Seed procurement	15	45	12	48	10	50	10	50
Weeding	28	32	30	30	20	40	24	36
Harvesting	32	28	23	37	28	32	28	32
Marketing	33	27	35	24	31	29	29	31

Table 4.4: Family Labour distribution by gender in sweetpotato production and marketing in Luweero - survey results

	PPB (n=60)		PVS (n=60)		NON ppts (n=60)		Overall mean	
Activity	M	F	M	F	M	F	M	F
Clearing	43	17	40	20	34	26	39	22
Ploughing	28	32	24	36	37	23	30	30
Planting	20	40	23	37	18	42	20	40
Heaping	30	30	30	30	32	28	31	29
Seed procurement	15	45	22	38	10	50	10	50
Weeding	28	32	30	30	25	35	24	36
Harvesting	32	28	23	37	28	32	28	32
Marketing	40	20	34	26	33	29	36	24

Men in all the three districts harvest the crop for marketing. However, for piecemeal harvest, it was predominantly a female activity. The change in gender roles may be attributed by men engaging in sweetpotato production for marketing. A change in roles was noted when comparison was made to that given by Kapinga *et al*. (1999). One may conclude that, gender roles in sweetpotato production has changed due to both male and female farmers participating fully in clearing, ploughing, heaping, planting, seed procurement, weeding, harvesting and marketing in most of the villages. Another fact is that sweetpotato is increasingly becoming a source of income generation.

4.1.3 Household headship

Household headship may have great influence on adoption in the household. Majority of the respondents (79.7 %) were found to be adopters and were male headed while their counterparts were few (34 %) and were female headed. The adopters had access to ISPV vines and most participated in research trials and received extension services compared to their counterparts (Table 4.5).

Table 4.5: Adoption of ISPV by head of household's sex - survey results

	Male (n= 137)		Female (n=47)		Total (n=180)	
Adoption of ISPV	No	%	No	%	No	%
Adopters	106	79.7	34	74.4	140	77.8
Non adopters	26	20.3	13	25.6	40	22.2

4.1.4 Household size and composition

Household size determines the possible supply of family labour for production, (Rauniyer and Goode, 1996). On average the household size for the three districts was 5.8 persons. The total population of the sample was classified into two groups according to their age. Respondents aged between 18-60 years were regarded as economically active and those below 18 and above 60 years were regarded as dependants.

4.1.5 Marital status

Marital status depicts the behaviour of the household in terms of social stability and responsibilities the household has, thus expected to influence the behaviour of the household on planting ISPV for food security. The marital status was described in four groups (Table 4.6).

Table 4.6: Response of planting improved sweetpotato by marital status - survey results

Marital Status	Adopters (n=142)		Non-adopters (n=38)		Total (n=180)	
	No.	%	No.	%	No.	%
Married	112	78.9	33	86.8	145	80.6
Single	10	7	4	10.5	14	8.8
Widow	16	11.3	0	0	16	8.8
Divorced	4	2.8	1	2.7	5	2.8

Results in Table 4.6 reveal that, the majority (80.6 %) of respondents were married, and a small fraction (19.4 %) were not married. Of the unmarried respondents, 8.8% were single, 8.8 % widows and 2.8 % separated or divorced. The majority of sweetpotato producers were found in the group of married, while the least adopters were those separated or divorced. The reason could be an increased demand for food security resulting from increased household size or increased labour force all of which may drive the married group to grow sweetpotato, which is early maturing before grains are harvested to meet their needs. Mtama (1997) argues that marriage has an effect on production activities as it affects labour availability in the household. The availability of labour in a household may increase the chances to engage in sweetpotato production and hence spread of improved sweetpotato varieties. On the other hand, respondents who were separated were the least adopters. The reason could be that, the separated household mostly were females having no access and ownership right over land and other resources.

4.1.6 Education in relation to adoption of ISPV

Education level of a respondent is considered as one of the factors influencing adoption rate of technology in a society (Bisanda *et* al., 1998). Education level is expected to influence spreading and adoption of improved and farmer released sweetpotato varieties. All respondents were requested to mention their levels of education.

Table 4.7: Response on planting ISPV by education level- survey results

Level of Education	Adopters (n=142)		Non adopters (n=38)		Total (n=180)	
	No.	%	No.	%	No.	%
Primary	96	67.6	23	60.5	119	66.2
Secondary	31	21.8	11	29.0	42	23.3
Tertiary	6	4.2	0	0	6	3.3
No education	9	6.4	4	10.5	13	7.2

This study revealed that, the majority of respondents had primary education (66.2%). A small proportion (23.3 %) had secondary education, or (3.3%) had tertiary education or had no formal education (7.2%). Adopters with secondary education were 21.8% while all those with tertiary education had adopted. A small proportion of respondents who had attained tertiary education had adopted ISPV. The small number could be due to educated people migrating to urban areas for business and government careers and hence reducing the number of post secondary education persons residing in the rural areas. Broadly the education level of the respondents is low. The low level of education among respondents is attributed to lack of self motivation towards education as well as poor incomes of some families as mentioned in the PRA. However, results show that education level has no effect up to secondary level but with tertiary education adoption was 100% even if the number of respondents was small (Table 4.7) For respondents with primary education who were participants in PPB, 36% adopted as compared to 31% who participated in PVS and 33% non-participant. Those with secondary education and were participants in PPB, 51.6% adopted ISPV while 32.3% of those participated in PVS and 16.1% non-participants had adopted. All respondents who had attained tertiary education and were participants in PVS and non-participants had adopted ISPV although there was none who had participated in PPB.

4.1.7 Production Constraints of improved sweetpotato varieties

4.1.7.1 Production constraints of ISPV and coping strategies.

When ISPV earlier mentioned in chapter one were compared to the local cultivars, their constraints did not differ much; they were more or less the same. Activities carried out in local fields are similar to those of improved ones. The constraints which were common to all districts were: pests and diseases, lack of post harvest technology, scarcity of labor, and drought; these constraints ranked high of all the listed constraints. Respondents were asked to give their own coping mechanisms on combating the constraints (Table 4.8).

Table 4.8: Production constraints and their coping strategies- survey results

Kiboga			
Constraint	**Frequency**	**Percent**	**Coping strategy**
Drought	52	38.2	-Plant in swamps/ banana plantations to preserve planting
Low yielding/pests (SPVD and Weevil)	34	25.0	materials, - Spray to kill pests,
Lack of planting material	13	9.6	Uproot infected vines - Buy from neighbours
Lack of market	19	14.0	
Low price	10	8.8	-Early harvesting
Labour	4	2.9	- none
Vermins	2	1.0	Hire labour --Scare/trap vermin
Luweero			
Constraint			
Drought	11	36.7	Plant in swamps/ banana plantations to preserve planting
Pests and diseases (SPVD and Weevil)	7	23.3	materials, - Uproot infected vines
	4	13.3	- Spray to kill pests
Inadquate land	5	16.7	-Hire land
Exploitation by traders	3	10.0	- Take to urban markets
Labour			-Hire labour
Mpigi			
Constraint			
Drought	7	23.3	-Plant in swamps/ banana plantations to preserve planting
Low yielding/pests (SPVD and Weevil)	5	16.7	materials, - Spray to kill pests,
Lack planting material	8	27.7	Uproot infected vines
Lack market	3	16.7	-Early harvesting
Land shortage	2	9.0	- Take to urban markets
Lack post harvest	1	4.2	-Hire land - Dispose off

The majority (36%) of respondents reported that, pests and diseases are the most prominent constraints in sweetpotato production and ranked first of all the listed production constraints. Kapinga *et al*., (995) reported that pests and related constraints in production were ranked first by 60% respondents. The higher the drought, the higher the infestation; ISPV was reported to be more susceptible to pest attack, compared to local cultivars. By their observation, most ISPV usually produce roots at the upper surface compared to local cultivars, which are deeper rooting. Due to exposure, the roots are easily attacked by sweetpotato weevils, mentioned to be the most destructive pest. The attacked roots are of poor quality for consumption and marketing. The coping strategy was early harvesting. Other pests such as vermins are scared away or trapped. All these were revealed during focus group discussions.

Also the most destructive disease mentioned by respondents was sweetpotato virus disease, which reduces ISPV adoption. Uprooting of the infected vines was mentioned as a control measure to prevent the spread of the disease. Drought was mentioned to be the second most serious constraint in sweetpotato production. Prolonged dry spells were reported by respondents during the PRA session. This has caused many sweetpotato farmers to loose planting material and yields. For preservation of the planting material, most farmers either plant them in banana plantations or in swamps as a way of overcoming the constraint. Majority (10%) of participants in the PRA mentioned scarcity of labour for cultivation of fields to be due to lack of funds.

4.1.8 Contacts and frequency of contact of farmers and extension staff

Table 4.9 indicates that 56% of the respondents had contact with their extension worker. Of these, about 43 % of the respondents were visited a few times, a smaller proportion (38%) of them were visited regularly and 16% had no contact at all with extension workers. Thirty eight percent of the respondents reported that the subcounty extension staff- farmer ratio was high (Table 4.9).

Table 4.9: Contacts and frequency of contact of farmers and extension staff- survey results

	Adopters (n=148)		Non adopters (n=32)		Total (n=180)	
Extension service	No	%	No	%	No	%
Had contact	82	56	9	28	110	84
Had no contact	66	44	23	56	89	16

However, non-adopters who reported to have contact with extension workers were 28% compared to their counterparts who were 56%. The results show that contact with extension staff may influence adoption. Chitere (1998) reported that farmers' contact with extension staff increases the probability of adopting the introduced technology. The reason is that extension services create awareness of the availability and importance of new innovation to economic development of small holder farmers.

4.1.9 Main source of farm labour

The majority (86 %) of respondents reported that most of sweetpotato production activities were carried out by family members. In all three districts, male farmers participate fully in sweetpotato production such as land preparation up to marketing.

4.1.10 Adoption of improved sweetpotato varieties

Estimating the proportion of farmers using a particular technology over a period of time is an essential step in assessing the impact of the technology. The condition is whether or not the technology meets farmers' objectives, expectations, management practices and circumstances. For this study an adopter was defined as a farmer who had grown at least one of the introduced varieties more than twice and was still growing the varieties at the time of the survey. All respondents grew some sweetpotato in the last two seasons with varying yields due to non-uniformity of the rains. Approximately 78.8% of the respondents adopted at least one of the improved varieties. Table 4.10 shows the characteristics of farm house holds' adoption of improved varieties.

Table 4.10: Characteristics of farm households' adoption of improved sweetpotato varieties-survey results

Description of Characteristics	Farmers (%)
Sample of farmers (N=180) that have heard about ISPV	85
Source of planting material by adopting farmers	
Neighbour	23
Researcher	70
Saved seed	53
Distribution of farmers by adoption of ISPV	
Adopting farmers who are participants in PPB	91.7
Adopting farmers who are participants in PVS	78.3
Adopting farmers who are non-participants	66.7
Non -adopting farmers who are participants in PPB	8.3
Non-adopting farmers who are participants in PVS	21.7
Non-adopting farmers who are non-participants	33.3
Commonly grown ISPV	
Naspot1	41.5
Naspot2	6.7
SPK004	9.5
New Kawogo	14
PPB varieties	6.5
Ejumula	13.3
Tanzania	6.5
ISPV preference by rank	
Naspot1	45
Naspot2	7
SPK004	32
New kawogo	13

4.2 The role of sweetpotato to household welfare

4.2.1 The role of sweetpotato to household food security

As earlier mentioned in section 1.4.1.1, the second objective of the study was to establish the roles of improved sweetpotao to household welfare. It was hypothesised that the roles of improved sweetpotato were under estimated hence the need to ascertain them. During the PRA farmers were asked to rank the major food crops grown in their area. Cassava, maize, banana and sweetpotato were important food crops grown in the surveyed districts. Sweetpotato ranked second after cassava. Sweetpotato has proved to be a second staple food and very important for food security.

Table 4.11: Food crops ranked for food security by district in the survey.

Food crop	Luweero	Kiboga	Mpigi	Overall Rank
Cassava	2	1	2	2
Maize	3	2	4	3
Banana	4	4	3	4
Sweetpotato	1	3	1	1

1= most important, 2= important, 3=less important, 4= least important

When food crops were compared by district, sweetpotato ranked first in Mpigi and Luweero districts, while it ranked second after cassava in Kiboga district. Sweetpotato has gained importance as a substitute to banana and cassava due to various reasons given by farmers in Table 4.11

4.2.2 The roles of sweetpotato in income generation at household level

Sweetpotato was found to be important for income generating at the house hold level. When districts were compared, sweetpotato ranked first in Mpigi and Luweero (Table 4.11). Sweetpotato played a great role in the household for food and a moderate role for income generation . It ranked first for both food security and income generation by farmers during the PRA in Mpigi and Luweero, and ranked second during PRA in Kiboga. Sweetpotato is among the important cash crops in the major growing areas. The study revealed that there is a move to change from subsistence to commercial farming in sweetpotato production in all the three districts especially in

Mpigi and Luweero. Notable was that more male farmers are involved in sweetpotato production; the crop is no longer a women's crop.

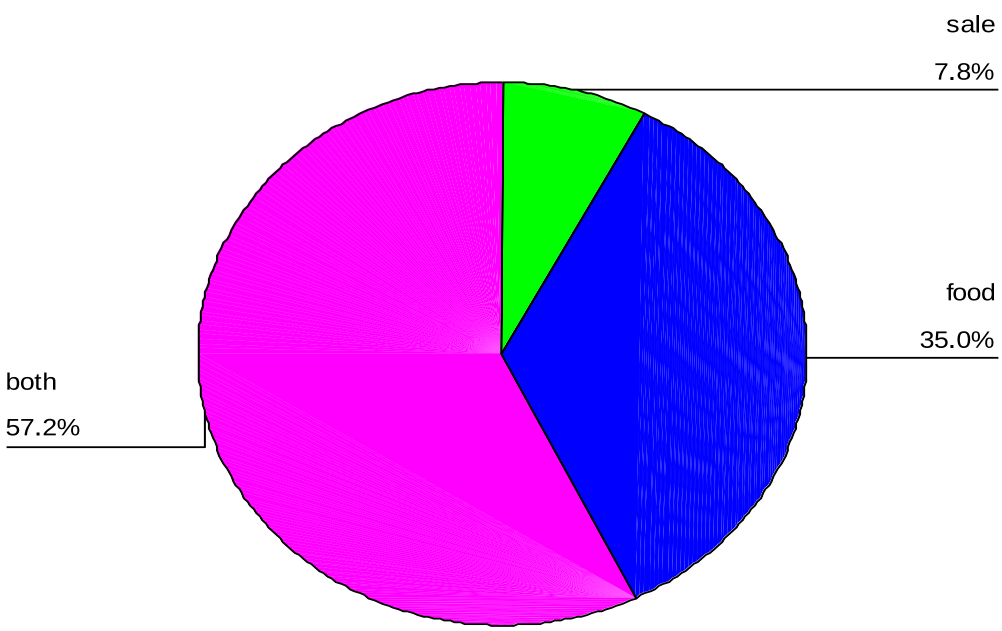

Fig 4.2: The role of sweetpotato in household income

Sweetpotato was found to play various roles for both household income and food security. During PRA meetings and interviews, 57.2% of the farmers mentioned that they grew sweetpotato for both sale and for food. Thirty five percent of the respondents produced sweetpotato for food only while a small percentage (7.8) produced for sale primarily. Majority in the later category were farmers from Mpigi district.

Table 4.12: Use of proceeds from sale of sweetpotato to households in the survey.

Usage	Farmers (%)
Expenditure on education	32.0
Medicine	22.0
Clothing	19.4
Purchase of animals	8.3
Purchase of land	6.9
Improve housing	4.0
Invest in income generating activities	2.8
Save	2.8
Purchase of food (including beverages, soap, salt etc)	1.6
Give to spouse	0.2

To obtain insights of impacts of improved sweetpotato varieties on the livelihoods of farming households, during focus group discussions as well as individual interviews, farmers were asked to identify and estimate changes they had experienced as a result of introduction of new varieties on their farm. On the analysis of the role that sweetpotato plays, Table 4.12 summarizes the main common uses of proceeds from sweetpotato. The results show clearly that expenditure on education, purchase of medicine and clothing were the most common uses of the proceeds from sweetpotato. The results in Table 4.12 show that 32% of the respondents use the proceeds for paying of school fees and one specific example is Mrs Musoke Federesi from Mpigi who had educated three children who were attending university (Makerere University) education and one completed by 2007. This also came out during the questionnaire administering. The second and third use of proceeds from sweetpotato was purchase of medicine and clothing with 22% and 19.4 %, respectively. Another notable contribution of sweetpotato proceeds was improvement of housing whereby some farmers managed to build better structures. One farmer in Luweero went a head to name his house ‘‘NASPOT HOUSE’’ which he said was built from sale of improved sweetpotato.

4.3 Factors affecting the adoption of improved sweetpotato varieties.

Table 4.13 presents the results of running a logit model relating adoption of improved sweetpotato varieties to farm and farmer specific characteristics. This relationship is highly significant (p=0.0000). The model also correctly predicted the adoption status of 89.4 % of the 180 farmers in the effective sample from which the model was developed. Farm and farmer attributes taken together, significantly influence the adoption of new improved sweetpotato varieties in Uganda as shown in Table 4.13. This supports the hypothesis that access to information that depends on socio-economic environment of the farm and farmer attributes may influence farmers' adoption decision. This is in congruence with earlier adoption studies that attributed adoption of new innovations to socio-economic factors (Adesina and Zinnah, 1993).

Table 4.13: Factors affecting adoption of improved sweetpotato varieties in the survey

Variable	Estimate	Odds Ratio	Std. Err.	z	P
Training	2.173***	7.766	0.507	4.29	0.000
Extension	0 .87*	2.623	0.476	1.85	0.064
Other income	1.764***	5.835	0.516	3.41	0.001
Experience	0.047**	1.048	0.019	2.45	0.014
Land	- 0.080	0.927	0.064	-1.25	0.212
Pred.PPB	3.616**	6.941	1.424	2.54	0.011
Family size	-0.591	1.066	0.085	-0.69	0.490
Pred.PVS	1.897*	3.219	1.113	1.7	0.088
Const	-6.264	0.903	-1.419	0.000	

***, **,* = significant at 1%, 5% and 10% respectively

Total observations	=	161
Log likelihood function of the model	=	-56.229
Prob > chi^2	=	0.0000
Pseudo R^2	=	0.4488

In Table 4.13, of the several farm and farmer attributes included in the model, extension services, training, experience, other incomes and participation in either PPB or PVS were statistically significant at 10%, 5% and 1% levels of significance. In the pooled model, the odds ratio shows that farmers who were trained in sweetpotato production specifically were 7.8 times more likely to be adopters. The regression coefficient for training is 2.173; this implies that an increase by one unit in farmer's training is associated with an average 2.1 increase in the log-odds ratio of adopting ISPV. The most important factors in the model are PPB and PVS, which captures the effect of participation. This increases the odds of adoption by a factor of 6.9 and 3.2, respectively.

Essentially, the probability of adoption of improved sweetpotato varieties is most increased by farmer participation in technology development and transfer. This reinforces and signifies the principle of participation by the resource poor farmers adopted by Uganda sweetpotato program in the implementation of sweetpotato project at grass-root levels in Uganda. This, in part, explains the impact on adoption pattern achieved by the Uganda sweetpotato program using the two approaches. Since participation in on-farm trials and multiplication can be regarded as an exposure variable and, thus may serve as proxy to contacts with extension and distance to source of new planting material, it can be argued that this result considerably signifies that adoption of improved sweetpotato varieties is influenced by access to information, methods used for testing and multiplication and farm and farmer attributes.

Increasingly, through participation, farmers are stimulated to evaluate, adapt and adopt innovations that fit within the goals and socio-economic complexity. To this end, farmers can serve as a viable resource in adapting new technology to specific farming conditions and thereby providing input to basic research needs. This requires targeting farmers based on critical farm and farmer attributes when involving farmers in technology testing and transfer. It is, however, noted from the model results that PPB significantly influenced the likelihood of adoption more than PVS as can be revealed by the magnitudes of the p-values (1%, and 5%, respectively). The odds ratio in Table 4.13 also shows that farmers who used PPB approach were 6.9 times more likely to be adopters compared to 3.2 times for farmers who participated in PVS, respectively. The regression coefficients indicate that increasing the PPB approach by one unit is likely to increase the adoption rate by 3.6 times compared to 1.9 times in the case of PVS.

Similarly, access to extension services had a positive and significant (10%) effect on adoption of ISPV. The probability that one would adopt at least one of the ISPV increased by 1.6 times if a farmer had access to extension services. This is probably because extension enables the farmers to get information about new or improved technologies through the interaction and consequently extension workers encourage farmers to use proven technologies. Extension officers during extension visits and attendance to on farm demonstrations provide technical advice on the use of different inputs, thus encouraging the farmers to take up proven technologies (CIMMYT, 1993). Further more, Bisanda *et al*., (1998) and Beyene *et al*., (1998) observed that agricultural information gets to the farmers through extension. In Uganda, the public extension service system, NGOs, National Agricultural Advisory Services (NAADS) are quite instrumental in providing extension services to farmers. However, these extension delivery systems were lacking in many aspects (Oleru, 2004).

One striking feature is that other income had a positive effect on adoption of ISPV and is significant at 1% level. This captures the effect of an increase in off farm activities by one unit which is associated with an average 1.8 times increase in the log-dds ratio of adopting improved sweetpotato varieties (relative to not adopting the ISPV). This is in line with the observation made by Savadogo *et al*., (1998) that non-farm incomes can influence technology adoption decisions. This can be explained by the fact that non-farm income enables the farmer to raise the level of his/her disposable income and thus being able to spare some of the disposable income for input purchases. As expected, sweetpotato farming experience had a positive and significant (5%) effect on adoption of ISPV. The probability that farmers adopt ISPV increases by 1.04 times if farmers gained one additional year in sweetpotato farming. With more experience, a farmer gains confidence in new technologies (Ogwal, 2003). The regression coefficient for experience is 0.047; this implies that an increase by one unit in farmer's training is associated with an average 0.05 increase in the log-odds ratio of adopting ISPV.

The findings on household size are similar to those of Phiri *et al.*, (2000) who found that household size was negatively associated with the probability to apply soil fertility management options. This outcome could be attributed to the effect of household size on household disposable income and resource allocation behaviour. The larger the house holds the more subsistence requirements they have, leaving proportionately fewer resources to finance the adoption of improved technologies. Nanyeenya *et al*., (1997) and Bisanda *et al*., (1998), however, found that household size increased the likelihood of adoption of improved agricultural technologies. Feder *et al*., 1985; Makhoka *et al*., (2001) also found households size influencing adoption. Similarly, Ogwal (2003) found that household size had a negative effect on adoption of groundnut IPM technologies but was not significant.

Land had an inverse effect as shown by the negative sign of the coefficient; the interpretation might be that farmers with limited land are likely to be risk-averse. They tend to take up improved sweetpotato varieties which they are sure will provide them with household food security in SPVD epidemic situations. Farmers with bigger chunks of land are less risk- averse in that they have the capacity to offer a piece of land for trials of other technologies while they go on with their usual varieties. In fact Rauniyer and Goode (1996) hypothesized that small farms usually employ less new practices than do large farms in order to meet their subsistence requirement. Moreover, most of the rural people in Uganda who derive their livelihood mainly from agriculture generally have small land areas for crop production with relatively small family size. This forms a great proportion of farmers sampled and interviewed such that their responses may influence the outcome of farmers' adoption behaviour observed in the analysis reported here in. The foregoing arguments are in conformity with Bua (1995) hypotheses that farm and family sizes usually have inverse association with technology adoption.

Table 4.14: Impact of PPB on adoption of ISPV-survey results

Variable	Estimate	Odds Ratio	Std. Err.	z	P
Training	2.469***	11.806	0.484	5.10	0.000
Extension	0 .851***	2.342	0.474	1.80	0.072
Other income	1.654***	5.227	0.483	3.43	0.001
Experience	0 .048**	1.050	0.019	2.48	0.013
Land	- 0.090	0.914	0.064	-1.42	0.156
Pred.PPB	1.829**	6.228	0.765	2.390	0.017
Family size	-0.068	1.071	0.083	-0.82	0.411
Const	-3.623	0.903	-4.02	0.000	

*****, **,*** = significant at 1%, 5% and 10% respectively

Total observations	=	161
Log likelihood function of the model	=	-57.439
Prob > chi^2	=	0.0000
Pseudo R^2	=	0.4369

The study also reveals that farmers who participate in PPB have a likelihood of adoption by 6.2 times compared to 2.72 times by farmers who participate in participatory varietal selection (Tables 4.14 and 4.15), respectively. This is in congruence with Witcombe *et a*l., (1996) who in their study on farmer participatory crop improvement, varietal selection and breeding and their impact on biodiversity cited that farmer participatory approaches for the identification or breeding of improved crop cultivars can be usefully categorized into participatory varietal selection (PVS) and participatory plant breeding (PPB). They cited that PVS is a more rapid and cost-effective way of identifying farmer-preferred cultivars if a suitable choice of cultivars exists. If this is impossible, then the more resource-consuming PPB is required. PPB can use, as parents, cultivars that were identified in successful PVS programmes. Compared with conventional plant breeding, PPB is more likely to produce farmer-acceptable products hence uptake, particularly for marginal environments. The long-term effect of PVS is to increase biodiversity, but where indigenous variability is high, it can also reduce it. PPB was found to have greater effect on increasing biodiversity although its impact may be limited to smaller areas. This on the other hand could be explained by the differences between the stages of involvement of the farmers in variety development. Farmers in participatory plant breeding are involved in early stages of variety development when materials are still segregating compared to their counterparts who get involved at a later stage after release of the developed varieties.

Table 4.15: Impact of PVS on adoption of ISPV in the survey.

Variable	Estimate	Odds Ratio	Std. Err.	z	P
Training	2.735***	15.413	0.484	5.65	0.000
Extension	0 .964**	2.624	0.460	2.10	0.036
Other income	1.712***	5.540	0.498	3.44	0.001
Experience	0 .044**	1.045	0.019	2.33	0.020
Land	-0.068	0.935	0.059	-1.14	0.254
Pred_PVS	0.999*	2.715	0.540	1.85	0.064
Family size	-0.073	7.766	0.083	-0.87	0.384
Const	-3.623	0.903	-4.02	0.000	

*****, **,*** = significant at 1%, 5% and 10% respectively

Total observations	=	161
Log likelihood function of the model	=	-59.554
Prob > chi^2	=	0.0000
Pseudo R^2	=	0.4162

Results from the above reveal that PPB and PVS influence adoption of ISPV significantly although at different levels. PPB has a significant effect at 5% level while PVS is significant at 10% (Table 4.15). As earlier mentioned in chapter 2, farmers who participated in varietal selection were involved in the research at an advanced stage. They were given finished/near finished materials by researchers for evaluation compared to farmers who participated in PPB who were involved at a much earlier stage when materials were still segregating. The difference in the level of adoption is a result of farmers in PVS being given materials that do not suit their interest such as colour, taste, maturity period among others, hence low or no adoption. Whereas farmers in PPB feel they own the varieties since they are involved right from seedling and choose clones they feel meet their demands/interests as they discard those that are not popular.

CHAPTER FIVE

5.0 SUMMARY, CONCLUSIONS AND RECOMMENDATIONS.

5.1 Summary and conclusion

A study was done on the impact of participatory plant breeding (PPB) and participatory varietal selection (PVS) on adoption of improved sweetpotato varieties (ISPV) in central Uganda. The study assessed how the two approaches influence farmers' uptake of the introduced sweetpotato varieties and determined socio-economic, bio-physical and institutional factors that influence the adoption of these improved sweetpotato varieties and their role in households. The study showed that a wide range of socio-economic and institutional characteristics affect adoption of improved sweetpotato varieties. Overall 91.7% of farmers who participated in PPB had adopted ISPV while 78.3 who participated in PVS had adopted. However, several factors, including extension services, age, training, level of education, other income and experience influenced adoption of ISPV differently in the two approaches.

From survey analyses, improved sweetpotato varieties selection criteria explicitly emerged as having the greatest potential for sweetpotato adoption that meet the overall goal of increasing sweetpotato production, hence, favouring even small farmers in Uganda. Such factors will enrich the set of factors conventionally used in adoption studies as illustrated under individual attributes and in combination. This shows that acceptability and subsequent adoption of improved sweetpotato varieties is influenced by farmer, farm and variety specific characteristics and access to information. This has direct implications on the development and transfer of improved sweetpotato varieties in the country. Gender concerns revealed that women have a higher rate of adoption than men when involved in research. The reason being that sweetpotato is considered a women's crop.

During the focus group discussions, farmers revealed that, the breeding research priorities, for instance should embrace the variety attributes particularly taste, skin colour, yield, maturity period and in-ground storage so as to generate sweetpotato varieties which have significant probability of being adopted by farmers. As revealed in PRA meetings, of interest are, taste, mealiness and shelf-life qualities that are considered important in marketing of sweetpotato. Another factor that came out clearly during PRA was the issue of constraints which included drought, vermin, land shortage, SPVD and sweetpotato weevil. Importantly, research should therefore consider yield and resistance to SPVD and sweetpotato weevil which respond to natural and socio-economic variations that can influence adoption decision of the farmers on new sweetpotato varieties as supported by their significant contribution to the probability of adoption. All these factors that are variety linked and influence adoption tally with the hypothesis that adoption of sweetpotato variety depends on the variety characteristics. This also requires the development and other technology transfer efforts focused on sweetpotato varieties that possess these attributes of significant influence so as to propel adoption and diffusion of sweetpotato varieties in the country.

As revealed by the logit model, the characteristics that significantly affected adoption of ISPV, include extension services, training related to sweetpotato production, non-farm income, experience and participation in either PPB or PVS significantly influenced adoption of ISPV at 1%, 5% and 10% level of significance. Nevertheless there were variations in adoption between farmers who participated in PPB and PVS research. Results also showed that PPB approach significantly influenced adoption of ISPV at 1% level while PVS influenced at 5% level. Most importantly, it was noted that farmer's adoption of new sweetpotato varieties came during and after the implementation of sweetpotato PPB and PVS as revealed by the fact that collaborating farmers in PPB and PVS had higher adoption rates than non-participating farmers. This implies that there is a related link between research and development effort and adoption. This may be because collaborating farmers receive more information from research and development agents that facilitate their appreciation of the value of new sweetpotato varieties. Thus, the results affirm the importance of adopting participatory approach in the transfer of technology in Uganda. Consequently, farmer participation can be seen to play a role in the Uganda sweetpotato program in the identification of research priorities and evaluation of technology performance.

This study also recognised the importance of extension in adoption of improved sweetpotato varieties. This reinforces the hypothesis that adoption is affected by farmers' access to information about varieties. Possibly, this suggests reorientation of extension service that may provide a mechanism for extension-research-farmer interactions. This momentum needs to be maintained and translated into future sweetpotato and development efforts. Related to extension, is the need to invest in rural education in order to facilitate technological change in agriculture. This follows the observation in this study that, at some point, level of education of a farmer influenced adoption behaviour of the farmer especially in being innovative. This implies that education has a positive impact on the adoption of new technology. Therefore research and development programmes should encourage rural farmer awareness campaigns so as to facilitate the adoption of new sweetpotato technologies. Farmer training should form a component of sweetpotato technology transfer as was emphasised in PPB and PVS approaches. From these results, it is clear that PPB approach yields more effects than PVS in that, interventions such as training, when PPB is used are likely to have a greater impact on adoption and transfer of improved sweetpotato varieties than PVS or non-participation.

Rural financing is a major factor in adoption of improved sweetpotato varieties as revealed by this study. Farmers who had additional income generating activity were more likely to adopt compared to their counter parts since the later had capacity to finance the required inputs such as vines.

Farmers use proceeds from sweetpotato for different needs among which include expenditure on education, clothing, purchase of animals, medicine, food, land and other requirements, save, invest in income generating activities, improve housing and others give to spouse. The PPB trials demonstrate the potential for significant rapid progress in sweetpotato breeding in specific environments but at the same time demonstrate the high risks involved in loosing valuable genetic material due to such factors as drought, destruction by wild and domestic animals, thefts by neighbours, farmers abandoning PPB trials due to fatigue because of long periods involved to be committed to conducting the trials, inadequate budget support, and the type of starting (base) breeding populations.

5.2 Recommendations

Although PPB and PVS approaches require more resources for their implementation, research efforts should employ these approaches for transferring of technologies to farmers as evidenced by the study results. Participatory approaches such as PVS and PPB are a vital means in adoption of improved technologies. Training related to sweetpotato production should be emphasized either through traditional extension services or researchers and other development partners. Formal education should be geared up for rural farming communities since the study revealed that the number of years of formal education played a great role in influencing uptake of improved agricultural technologies. Farmers should be encouraged to have other income generating activities other than farming. This could be a form of small low interest loans for financing these activities. Labour for cultivation of fields was cited as one of the biting constraints in sweetpotato production, provision of labour saving technologies such as ox ploughs and tractor hire services would help alleviate this limiting factors.

Gender is a factor to look at critically in that, if women are involved in technology development, the likelihood of adoption is higher than that of men. It is therefore recommended that women be fully involved in development programmes. Of the constraints mentioned during PRA, drought came out strongly as a hindrance in increased sweetpotato production. It would therefore be prudent if development and research efforts on top of breeding for drought tolerant varieties, would promote water harvesting techniques such as small scale irrigation. The roles of sweetpotato in household incomes and food security should not be underestimated since the results showed that the crop plays a vital role in farmers' welfare. This implies that more development effort should be geared towards supporting sweetpotato research for development and dissemination of improved sweetpotato varieties

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APPENDIX I

THE IMPACT OF PARTICIPATORY PLANT BREEDING AND SELECTION ON ADOPTION OF IMPROVED SWEETPOTATO VARIETIES IN UGANDA

Questionnaire for Household members

Respondent ……………… Date of interview………….. Name of interviewer…………

District…………….. Sub county……………Village………………….

Status of respondent: Participant in PPB…………Participant in PVS……………

Non-Participant………………………………..

SECTION 1. SOCIAL DEMOGRAPHIC INFORMATION

1.0 Farmers Characteristics

1.1 Sex of respondent

1. Male ……………… 2 Female …………….

1.3 Age (years) ……………

1.4 Marital status? Single ………1 Married ……… 2 Divorced ……3 Widowed …..4

1.5 What level of formal education have you attained? Primary………1 Sec……2 Tertiary…….3

Non…………4

1.6 Have you received any training on sweetpotato production? Yes….1 No…….2

1.7 House hold type: Male headed…………Female headed………………

1.8 Type of farmer

Small scale subsistence…………………1

Medium semi commercial………………2

Large commercial……………………….3

1.9 Household composition

Age in years	No. of males	Working on farm		No. of females	Working on farm		Total
		Full time	Part time		Full time	P/time	
10 or < 10							
11-17							
18 and above							
Total							

1.10 Gender division of labour for sweet potato production

Activity	Source of labour Male adult=1, Female adult=2, Both=3 Male child family=4, female child family=5, hired=6
Land clearing	
Ploughing	
Heaping	
Seed procurement	
Planting	
Weeding	
Harvesting	
Sorting	
Sale	

1.11 For how long have you been growing sweetpotato…………………

1.12 Type of housing: Temporary………………1, Semi permanent………….2,

Permanent………………...3

1.13 Year of construction…………………

SECTION 11 PARTICIPARION IN SWEETPOTATO RESEARCH

2.0 Have you received any training in sweetpotato production? Yes/No

2.1 Are you a member in any groups, if yes please name them

2.3 Do you participate in sweetpotato research? Yes/No

If yes, what kind of participation, Seed trial……….1, Vine trial……..2 others……3

2.4 Did you receive any planting materials? Yes/No

If yes what planting materials did you receive? Seeds….1 Vines…….2

2.5 Of the materials you received, how much did you get?

SECTION 111 SWEET POTATO PRODUCTION AT FARM LEVEL

3.0 Total Amount of land owned in acres………………………

3.1 Is the land consolidated……………1, Fragmented…………….2

3.2 How was land acquired; Inherited……………….1, Rented……….2, Borrowed……..3, Given…………….4 Bought…………5

3.3 How much land is allocated to sweet potato production…………… (%)

How much land is allocated to ISPV…………………….. (%)

What sweet potato varieties did you grow in the last 3 years

Variety	Season 1	Season 2	Acreage	Purpose Sale = 1 Food = 2 Both = 3
New Kawoogo				
SPK004				
EJUMULA				
NASPOT 1				
NASPOT2				
NASPOT3				
NASPOT4				
NASPOT 5				
NASPOT 6				
Sowola				
Bwanjule				
Tanzania				
Wagabolige				

Of the varieties mentioned in 2.6 select the most preferred 4 varieties giving reasons for their preferences.

Variety	1 = 1st Preferred, 2= 2nd Preferred, 3=3rd Preferred 4= 4th Preferred	Reason for selection

Reasons for dropping variety that is not preferred.

Variety dropped	Reason for dropping

How do you plant sweet potato:

Pure variety……………………….1

Mixed variety………………………2

What is the common intercrop with sweet potatoes in this area?……………………………………………………………………………………

What are the best alternative crops to sweet potatoes………………………………………………………………………………………

………………………………………………………………………………..

In the last 5-10 years has production/productivity under sweet potato increased or decreases or remained constant?

Changed=1, Decreased=2, No change=3	Score
Reason for increase High returns/Main cash crop=1 Early maturing=2.Easy to grow=3, Improved extension=4, High market demands=5, High yields=6,others=7.	
Reasons for Decrease Drought = 1, Low yielding = 2 Lack of planting material =3 Lack of market =4	

2.9 Did you drop any crops to grow improved sweet potato varieties?

Yes……………………………….1

No…………………………………2

If yes mention the crops dropped

………………………………………………………………………………………………………

………………………………………………………………………………………………………

…………………………………………………………………………………

What is the source of your seed?

NGO……………………………….1

Extension…………………………..2

Research station……………………3

Neighbour…………………….……4

Saved seed………………………….5

Market………………………………6

Other (specify)……………………...7

Production constraints of sweetpotato

Constraint	Cause	Possible intervention

3.0 Post harvest Handling- Storage

3.1 How do you store sweetpotato?

Storage method	Seed/planting material	Period of storage in days	Sweet potato roots	Period of storage in days
Store=1				
In ground=2				
Under shade=3				
Granary				
In main house; in bags, baskets, floor				

3.2 Ranking of varieties to store for long by farmers

Variety	Score: 1=highest in that order	Days	Months

4.0 MARKETING SYSTEM

4.1 In what form do you sell your sweetpotato?

Root …………………………………1

Vines…………………………………..2

Processed………………………………3

4.2 Where do you sell your sweetpotato roots/processed products?

Local market…………………………..1

Urban market…………………………..2

By the road side………………………..3

Farm gate………………………………4

Export……………… (Country)……….5

4.3 Where do you sell sweetpotato vines?

Local market…………………………..1

Urban market…………………………..2

By the road side………………………..3

Farm gate………………………………4

4.3 Distance to the nearest local market………………………Kms

4.4 Do you sell as an individual or as a group?

Individual………………………………1

Group…………………………………...2

4.5 What variety did you sell and when?

Variety	When sold Immediately after harvest=1 Wait for a better price=2	Amount sold (bags/tins/baskets)	Price per unit sold	Reason for option 1

4.6 Who buys your sweetpotato?

Consumers……………………………………….1

Retailers…………………………………………..2

Institutions (e.g. schools, hospitals………………….3

Wholesalers………………………………………4

4.7 What marketing constraints do you face?

Problem	Cause	Possible intervention

5.0 CONSUMPTION AND UTILISATION

5.1 Consumer preferences and why

Variety	Rank: 1=highest………………….lowest			
	Home consumption on farm		Urban consumption(middle class consumers)	
	Rank	Reason for consumption Good taste=1 Good for boiling=2 Good for steaming=3 Attractive skin colour=4 Farm fresh textures=5	Rank	Reason for consumption Good taste=1 Good for boiling =2 Good for steaming=3 Attractive skin colour=4 Farm fresh textures=5
New kawogo				
Naspot1				
SPK004				
EJUMULA				
Naspot2				
Naspot3				
Naspot4				
Naspot5				
Naspot6				
Sowola				
Bwanjule				
Tanzania				
Wagabolige				

5.2 Reasons for dislike of sweetpotato

Variety	Reason
New kawoogo	
Naspot1	
SPK004	
EJUMULA	
Naspot2	
Naspot6	
Naspot5	
Sowola	
Naspot4	
Naspot3	
Bwanjule	
Tanzania	
Wagabolige	

5.3 Utilisation

Method of utilisation	Farmers	Urban consumers
Roasted		
Boiled		
Chips		
Mashed		

6.0 The Role of sweetpotatoes on farmers' livelihood

6.1 State 4 most important crops to you in their rank

Crop	Rank according to importance 1= highest……..lowest	Reasons
Sweet potato		
Cassava		
Banana		
Maize		

7.0 PROBLEMS ASSOCIATED WITH SWEET POTATO PRODUCTION

8.1 List pests and diseases of sweet potatoes

Pest/Disease	Damage caused	Control measure	Source of information

8.0 SOURCE OF INFORMATION

8.1 Where do you get assistance/advice on sweetpotato production?

Source **Rank**

Agric Extension staff

Relatives

Political leaders

Neighbors

Other farmers

Researchers

News papers Resistance councils

Radio

Non

Others specify

8.2 (a) How often do you meet with the extension staff?

8.3 Has an extension worker visited your farm in the last one year?

Yes……………………….1

No………………………..2

If yes how often does she/he visit your farm ?……………..

8.4 What do you usually discuss?…………………………………

9.0 OTHER INFORMATION

9.1 Do you access credit for acquiring improved varieties?

Yes…………………………….1

No……………………………..2

9.2 Do you keep livestock?

Yes…………………………….1

No………………………….….2

9.3 If yes state the types, numbers and source of funding

Type of livestock	Number owned	Source of fund
Cattle		
Goats		
Sheep		
Pigs		
Chicken		
Other		

9.3 Apart from farming what other activities are you engaged in?

……………………………………………………………………………………………………

………………………………………………………………………………………

9.4 List in order of importance your source of money

1…………………………………………………………..

2…………………………………………………………..

3……………………………………………………………

4……………………………………………………………

5……………………………………………………………

9.5 What did you use money from sweetpotato for?

Purpose of income from sweetpotato	Season 1	Season 2	Sweet potato (Rank)
Purchase of animals			
Save			
Child education			
Purchase f food			
Purchase of medicine			
Purchase of clothing			
Invest in income generating activities			
Improve housing			
Give to spouse			
Purchase of land			

APPENDIX II

THE IMPACT OF PARTICIPATORY PLANT BREEDING AND SELECTION 0N ADOPTION OF IMPROVED SWEETPOTATO VARIETIES IN UGANDA

Group questions on Sweetpotato technology transfer and adoption.

District …………………………………… Date …………………………..

Sub county ……………………..Parish ………………………

Name of the group ………………………….Initiation date ………………..

Group leader ……………………………….No. of members …….men…..women………

Record the number of men and women present: men …….women……

History of the group

1. For what purpose was the group formed?
2. Who decided on the number of members?
3. How were the group members chosen?
4. Who owns the land the group uses?
5. How do you manage your group multiplication block?

Sweetpotato and other enterprises in the Village

6. What have been the main crops grown in the village in the past three years

Year 2005

Crops Trend (+ve, -ve,=) Cost/acre Yield/acre, Price/kg

Year 2004

Crops Trend (+ve,-ve,=) Cost/acre, Yield/ acre , Price/kg

Year 2003

Crops Trend (+ve,-ve,=) Cost/acre, Yield/acre , Price/kg

7. What is the main food crop in the village?
8. What is the main cash crop in the village?
9. What do you use money from sweet potato for?
10. What other role does sweet potato play?

Participation in research

- Do you participate in sweet potato research?

- If yes, what kind of participation?
- What planting materials did you receive? Seed/Vines?
- Of the materials you received, how much did you receive?
- Outline the process you went through to choose the most preferred varieties from seed/vines. What level are you?
- What are the benefits associated with sweet potato seed?(building houses, purchase of cows, Paying school fees, Marrying, others specify)
- What are the benefits associated with sweetpotato vines? (?(building houses, purchase of cows, Paying school fees, Marrying, others specify)

Sweet Potato Production

11. What sweetpotato varieties have you been growing in the past 3 Years? What was the general yields/acre and give reasons for increased, decreased or stable yields.

Year	Variety	Trend (+ve,-ve,=) Yields/acre	Reasons.
2005			
2004			
2003			

12. From where do you get your sweetpotato planting materials?

i) Multiplication blocks ii) Dept. of Agriculture

iii) NGO (name) iv) Uganda sweetpotato program v) others, specify.

13. Have you bought sweet potato vines in the last 3 years for your group?

Year	Where	cost/measure	Transport cost/measure
2005			
2004			
2003			

14. Has the group been selling sweet potato vines in the last three Years? At what price?

Year	Where	Price/measure	Transport cost/measure
2005			
2004			
2003			

15. Has the group bought the following and from where?

Item	From where	When	Quantity	Costs	Transport cost

Fertilizer

Herbicide

Other chemicals

Hoes

Ox-ploughs

Others, specify

1.6 What criteria do you use for choosing a particular variety? (Farmer criteria for variety choice)

Marketing

16. How are the planting materials transported to your blocks? What are the transport costs to plant the whole block?
17. Since the group started growing improved sweetpotato varieties (ISPV), how many farmers have you given the vines?

Year	No. of people/group	Quantity	Approx. Acreage
2005			
2004			
2003			

18. Do you sell the sweetpotato planting materials? Yes/No
19. If so price/unit in 2005, 2004, 2003, Cost of transport, if any to the market place.
20. What do members do with the sweet potato roots from the block?
21. Home consumption …………………parts out 10

    Sale …………………..parts out 10

    Total 10
22. How do you distribute the tubers/vines among members?

Method of Transportation:

23. Are the sweetpotato Vines/roots/products transported as a group/individually to market places? If as a group how do you transport the tubers and processed products?

Method	Cost/measure	Distance to marketplace
i).Headload		
ii).Bicycle		
iii).Motorcycle		

iv). Wheel barrow/ox-cart

v). Pick-ups

vi). Tractor trailer

vii). Trucks/Lorries

viii) Others (specify)

Source of information

24. Where do you get assistance/advice on sweet potato production, disease and pest problems?

Source Rank

i). None

ii). Relatives

iii) Other groups/farmers

iv). Newspapers

v). Agricultural extension staff

vi). Local chiefs

vii). Political leaders

viii). Schools

ix). Agricultural research staff

x). NGOs

Who of the above do you think is the most useful in increasing knowledge about sweet potato production?

25. Have you ever had any contact with any agricultural extension staff? If yes, when? On what matter? If no, why not?

26. Are you aware of any control measures of SPW/V? Name them.

27. Which of the above control measures are you using? Why?

28. How did you learn about these control measures?

Recommended control and production methods

29. Which of the following control measures and production methods have you ever heard of?

Practice Year first heard of practice Reason for still using

i). Resistant varieties

ii). Clean planting materials

iii). Spacing of 1m x 1m

What do you say about these recommended practices?

i) Resistant varieties

Advantages

Disadvantages

ii) Clean planting materials

Advantages

Disadvantages

31. What multiplication approaches would you want to institute in order to increase the availability of resistant sweet potato varieties in this area?

i). Individual multiplication approaches

Advantages

Disadvantages

ii). Group multiplication approach

Advantages

Disadvantages

33. What other approaches would you have instituted?

34. Which other farmer organisation exist in the village?

35. Do you think they are useful? Why?

36. What sort of things do you think Research and other development partners could do to increase sweetpotato production in the area?

Thank you very much.