THE ROLE OF IMPROVED SWEET POTATO VARIETIES TO FOOD SECURITY AND RURAL LIVELIHOODS IN ZANZIBAR, THE EASTERN AND LAKE ZONES OF TANZANIA

BY

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ABSTRACT

The study was conducted to analyse the role of improved sweet potato varieties (ISPV) and popular highly grown local cultivars to food security in Zanzibar, Eastern and Lake zones of Tanzania. Study objectives were, to assess the rate of adoption of improved sweet potato varieties at farm level; to assess the production trends of ISPV; to assess the role of ISPV to food security; to identify the production constraints of ISPV and finally identify highly preferred local cultivars in the community. Multistage sampling technique was employed, 186 sweet potato grower households were sampled by random sampling. Data were collected through interviews using the pre-tested questionnaire and checklists for informal surveys (PRA). Secondary data was obtained from projects reports and electronically through Internet. Data were statistically analysed using SPSS to obtain frequencies, percentages, Chi-square, SAS were used for multivariate analysis using logit/probit regression model. Adoption of ISPV was found to be influenced by socio-economic and institutional factors: extension service, participation and farming experience were statistically significant ($P<0.05$) between adopters and non-adopters. Majority (60.2%) of respondents reported high significant ($P<0.05$) increase in ISPV production compared to local cultivars, yet insignificant difference increase in acreage under ISPV was noted. Majority (70.4%) of respondents were growing ISPV and few (29.6%) were not growing. Majority of respondents (74.7%) were food secure and few (25.3%) were insecure. Sweet potato was found to be on transition from subsistence to commercial production. Major constraints identified were poor farming and post-harvest improved technology, drought, pests and diseases, poor access to improved sweet potato vines, and marketing. Popular and highly grown local cultivars for food and market are, *Pananzala/Mbutu, Matako mapana, Polista, Sekondari, Shangazi and Mkombozi.* Highly

adopted ISPV in the Eastern zone are *Ukerewe* and *Simama*, Lake zone are *Jitihada*, *Simama* and *Sinia* and Zanzibar *Kizimbani mayai*, *Sinia* and *Simama*. This study concludes that, ISPV play a greater role in household food security and generates income for their livelihoods. Its adoption was statistically significant though only few varieties were adopted. Thus research on potentials, opportunities, and constraints of the ISPV should be conducted. Plant breeders should develop improved varieties that have desirable traits for home consumption and for market.

DECLARATION

I, Mshaghuley Mcharo Ishika, do hereby declare to the Senate of Sokoine University of Agriculture that this dissertation is my own work and has never been submitted for a higher degree award at any other University.

Signature.....

Date.....28/10/2005.....

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LIST OF ABREVIATIONS AND ACRONYMS

AIDS	Acquired Immune Deficiency Syndrome
ARI	Agricultural Research Institute
CBO	Community Based Organisation
CIMMYT	Centro International de mejeromiento de maizy trigor
CIP	International Potato Centre
CMD	Cassava Mosaic Diseases
DSI	Development Studies Institute
FAO	Food and Agriculture Organization of the United Nations
FFS	Farmer Field School
FGD	Focused Group Discussion
FHHs	Female Headed Households
FS	Food Security
ha	Hectares
HHH	household Head
HIV	Human Immune Deficiency Virus
ISPV	Improved Sweet potato Variety
ITS	Indigenous Technology System
Kg	Kilograms
Km	Kilometre
L.	Lam
LZARDI	Lake Zone Agricultural and Development Institute
MAFS	Ministry of Agriculture and Food Security

MARD	Master of Arts in Rural Development
MHHs	Male Headed Households
n	Number of respondents
NGO	Non Governmental Organization
PRA	Participatory Rural Appraisal
SADC	Southern African Development Community
SADC	Southern African Development Community
SNAL	Sokoine National Agricultural Library
SPSS	Statistical Package for Social Science
SPV	Sweet potato variety
SPVD	Sweet potato Virus Disease
SSI	Semi-Structured Interview guide
SUA	Sokoine University of Agriculture
TAHEA	Tanzania Home Economics Association
TShs	Tanzania Shillings
URT	United Republic of Tanzania
USA	United States of America
VEOs	Village Extension Officers
WHO	World Health Organization

CHAPTER ONE

INTRODUCTION

1.1 Background information

Sweet potato, *Ipomea batatas* (L.), is an important crop in many parts of the world, being cultivated in more than 100 countries. As a world crop it ranks seventh from the viewpoint of total production. In monetary terms, it ranks thirteenth globally in the production value of agricultural commodities, and as the fifth in the list of developing countries' most valuable crops (Woolfe, 1992; Walker, 2004).

In Africa, sweet potato has been an important food crop especially in Uganda, Rwanda, Burundi, Tanzania, Angola, and Mozambique, and is a secondary food security crop elsewhere. Sweet potato is grown in all Southern African Development Community (SADC) countries; and is a commercial crop, partly for export, in South Africa, and Zimbabwe (Minde, *et al.*, 1999).

Sweet potato is widely grown in eastern, central and Southern Africa (less in West Africa), where it is reliable, low input, food security crop for resource poor farmers, with increasing commercial potential (Minde *et al.*, 1999). Sweet potato is one of the important household food security crops in Tanzania. The crop complements other food crops and serves to bridge periods of food shortage before the next harvest of maize or other staple crops (Kapinga *et al.*, 1995).

The crop is very important for food security and is the third most important root and tuber crop in the country, and is grown for home consumption and for sale (Kapinga *et al.*, 1995). Food security refers to the availability, accessibility of safe balanced and nutritious food through production, distribution, and purchase or exchange at the household level. This implies sufficient food for a normal healthy life for each and every member of the household (Kean *et al.*, 1999). Households get food through their own production by gathering wild foods, as a gift from the community, by spending income or assets and through migration (Kean *et al.*, 1999). Sweet potato is an important subsistence food crop grown in almost all agroecological zones of Tanzania. The major sweet potato production areas are the Lake Zone, Southern Highlands, Eastern, Western, Southern highland zones and Zanzibar (Shetto *et al.*, 2003 and Kapinga *et al.*, 1995).

The Tanzanian National Variety Release Committee of the Ministry of Agriculture and Food Security (MAFS) released several sweet potato varieties officially in the year 1999. These are: *Mavuno, Jitihada, Vumilia, Sinia, Simama* in the Lake zone (Chirimi *et al.*, 2000) and *Ukerewe* variety was released in 2002 in the Eastern zone. These varieties were tested widely in different agro-ecologies of Tanzania where sweet potato is important. Release of improved sweet potato varieties was done after on station, on-farm testing and assessment by researchers and farme rs (Chirimi *et al.*, 2000; Masumba *et al.*, 2002). Sweet potato is easy to produce at rural level with minimum input due to its tolerance to drought, low demands on soil nutrients, capacity to providing reasonable yields in different agroecologies and seasons where other crops would fail, low requirements for external inputs such as fertilizers, flexibility in planting and harvesting periods, convenient

in-ground storability and reduction in soil and wind erosion. Sweet potato takes about four months to mature and requires less moisture compared to maize (Minde, *et al.*, 1999).

1.2 Problem statement

In Tanzania sweet potato crop has been regarded by many people as a low value, low status, and highly perishable commodity with only minor supporting roles to play in the process of agriculture development. Relatively to cash crop and grains, sweet potato has received little research attention.

The National Root and Tuber Crop Research Programme was established in 1994 to address sweet potato problems. Even though, many problems still exist such as: pests and diseases, low yielding ability inherent to the genotypes, and poor adaptation to environmental conditions which needs more effort to solve them. Although some research efforts have been put into developing new sweet potato varieties, but establishing the role of different sweet potato varieties and the status of household food security has not been tackled. There is a knowledge gap as to whether the adoption or non-adoption of certain sweet potato varieties does in fact have any bearing on the household food security status, one of the major concerns both at household and national levels. Such a question as whether growing of improved or local varieties compromises on the food security status of smallholders remains unanswered. The core of this study was to seek the role of different sweet potato varieties to food security and income of farm households as well as the adoption rate of the improved sweet potato varieties.

1.3 Justification of the study

A number of studies on food security have been done in Tanzania (Mtunda *et al.*, 2003; Minde *et al.*, 1999; Kapinga *et al.*, 1995). Moreover, some research has been conducted on post harvest assessment by Rees *et al.*, (2003), improved market access for sweet potato by Ndunguru *et al.*, (2003). However, there is no documented information on comparison of contribution of improved and farmer sweet potato varieties to food security, diffusion and adoption.

Research findings are to be a useful feedback to research community on farmers variety preference, planners and policy makers, National and International organizations like the International Potato Centre (CIP) that have interest in the topic. Moreover, lessons learned can be used to improve the management and decision making process with respect to priority setting implementation and management of research activities as well as technology transfer. Also they may be useful for accountability purposes and to establish the credibility of the public sector research and to justify increased allocation of research resources. This study conforms to the National Strategy and objective for poverty eradication efforts through 2010 and the National vision of economic and social objectives to be attained by year 2025 (URT, 2000).

1.4 Objectives

1.4.1 General objective

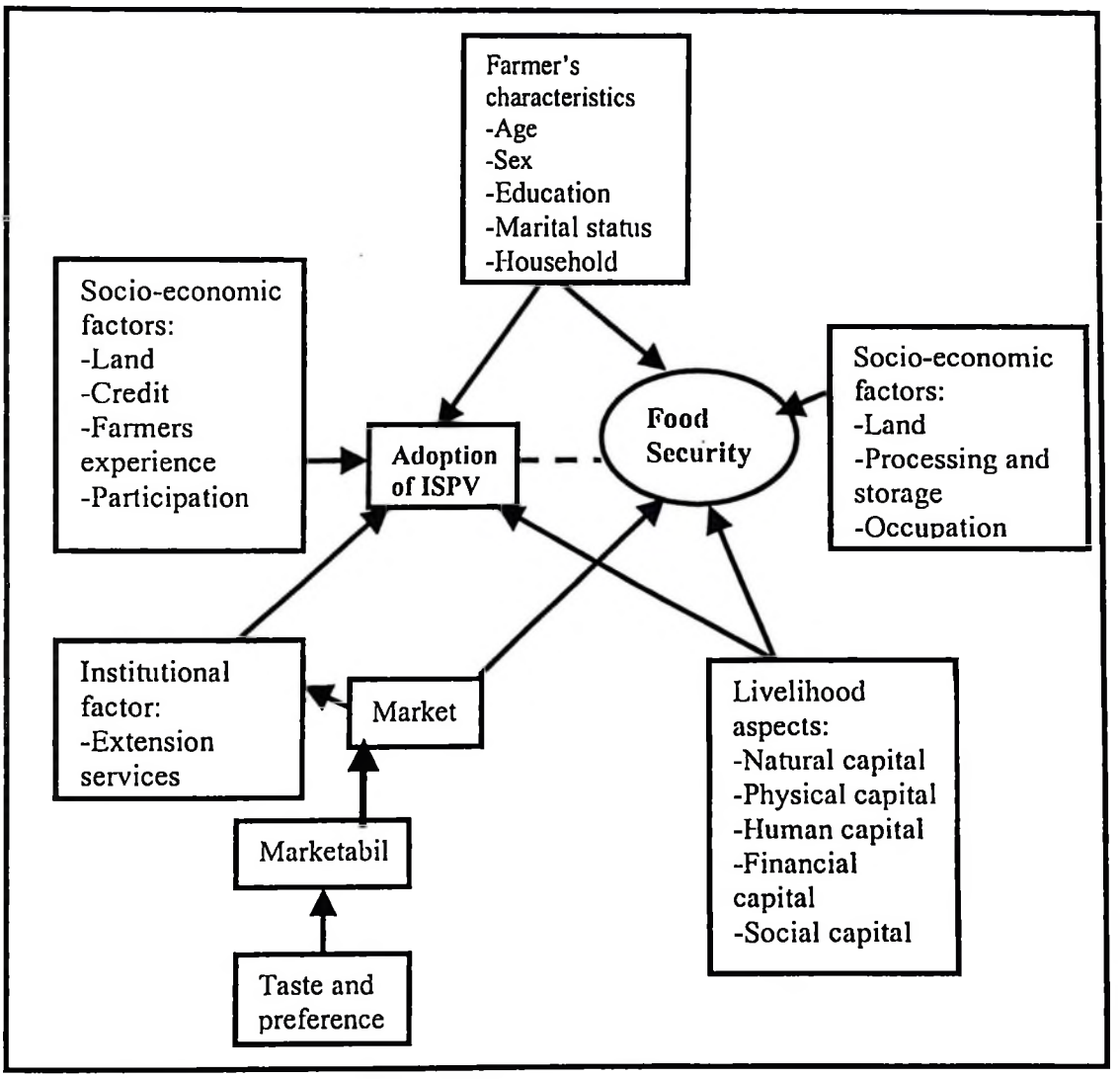
To assess the role of improved sweet potato varieties in the improvement of livelihoods of sweet potato farmers in Tanzania

1.4.2 Specific objectives

1. To assess the rate of adoption of improved sweet potato varieties at farm level
2. To assess the production trends of improved varieties against local cultivars
3. To assess the role of improved sweet potato varieties to food security of rural livelihoods in major growing area.
4. To identify the production constraints of improved varieties compared to the local cultivars
5. To identify local cultivars, highly preferred in the community and their characteristics.

1.5 Conceptual framework

Conceptual framework proposed in this study is presented in (Fig. 1). The framework groups the variables into four major blocks (farmer characteristics, socio economic factors, institutional factors and livelihood aspects) as independent factors. Their influence to adoption of ISPV and role played for food security was addressed. Farmers' characteristics may influence food security indirectly; this implies that there is an interaction between the various factors.



Key:

= Primary relationship

= Secondary relationship

ISPV = Improved sweet potato variety

Figure 1. Conceptual framework for the study

1.6 Research Hypotheses

1. Adoption of improved sweet potato varieties at household level is relatively low compared to local cultivars in the Eastern, Lake and Zanzibar zones of Tanzania.
2. There is no significant difference in production trends between improved varieties and local cultivars in the Eastern, Lake and Zanzibar zones of Tanzania.
3. The role of sweet potato to food security for the livelihoods of rural farmers is underestimated

Table 1: Definition of key variables used in the study

Variable	Description and Categories
Background	
Age	Age in years of the household head
Sex	Biological determinant sex of household head
Education	Highest level of formal education by household head
Marital status	Current status of marriage
Household size	Number of usual members of the household
Socio-economic factors	
Occupation	Economic activities carried out by the household
Processing	Households processing sweet potato to different products
Storage	Different methods storage of sweet potato used
Institutional factors	
Extension service	Frequency on contact to extension service
Market	Household access and reliability of sweet potato market
Dependent variables	
Adoption of ISPV	Farmers growing ISPV
Food security	Meals frequency: Taking more than three meals per day were considered secure and two meals insecure. Food quality: Household eating inferior foods more than thee days per week was considered unsecured.

Note: Other variables are defined in Chapter three under Probit/Logit regression model

1.7 Important ISPV and local cultivars in the study area

Improved Sweet potato varieties (ISPV), which were released officially in 1999 and 2002 were: *Sinia, Simama, Mavuno, Ukerewe, Jitihada,* and *Vumilia.* During the survey, some more varieties that are not yet released but under test were identified, particularly in the Lake zone and Zanzibar. The new varieties identified were, *Carrot Dar es Salaam, Resisto, Jewel, Japon, Zappalo, Kakamega, Ijumlo, Mafuta, Kala, TIB-4, Salyboro, Zapallo, Tainung, W-151* and *SPN/O*

Some of the important and popular local cultivars in the surveyed zones were also identified. In the Eastern zone, mentioned local varieties were, *Pananzala/Mbutu, Matako Mapana, Kanada, Gairo,Carrot, Shangazi, Mang'ondi* and *Binti machawa.* In the Lake zone important local varieties were, *Tonik, Polista, Bilagala, Ngoshaatenamtaji, Ruganza, Kajingo, Ogola, Rushuli, Kyantemle* and *Mwanarugend* and in Zanzibar were: *Shangazi, Mkombozi, Mdega, Bolibo, kiyungiyungi, Jani la tambuu Mdega* and *Mbega.*

CHAPTER TWO

LITERATURE REVIEW

2.1 Definitions of concepts

This section gives definitions of useful concepts used in this thesis

2.2.1 Food security

Food security concept has been given different definitions (Rukuni and Eicher, 1987). In the past, food security was mostly concerned with food supply, usually in the form of grain stocks and was being applied at regional or district level (Kavishe and Mushi, 1993). With the passage of time the concept has shifted to questions beyond supply to include access to food at the household and individual levels.

Food security is defined as when all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life. Food security depends on the availability, accessibility, adequacy and acceptability (FAO, 2001). The most frequently used definition is probably the one by the World Bank (1986), "access by all people at all times for enough food for an active, healthy life." Other definitions include one by FAO/WHO (1992), which define food security as "the ability of the household to secure, either from own production or through purchases adequate food for meeting the dietary needs of its members". The World Bank perspective on time frame defines food security as either transitory, or chronic, where transitory food insecurity is a temporary decline in a

household's access to enough food resulting from instability in food production and or household incomes, lack of household ability either to buy or produce enough food (FAO/WHO, 1992). Chronic food insecurity is the persistent lack of household's access to enough food resulting from instability in food and prices or a household income.

Therefore, a household is said to be insecure when it fails to meet its dietary food intake in terms of quantity and quality. Evidence suggests that household food insecurity is widespread and chronic in some areas, since there seems to be evident in the periods in the year especially time prior to harvesting (FAO, 1998). In this study food security refers to access as indicated by number of days with inferior and luxury foods at the household level as well as the number of meals taken per day.

2.2.2 Livelihood

Livelihood comprises the assets (natural, physical, human, financial and social capital), the activities, and the access to assets together determines the living gained by the individual or household (Ellis, 2000). This study defines livelihood as access to income, health, social service, land use, credit, time allocation, labour and ability to utilize them for better living.

2.2.3 Household

Household is regarded as the social unit, which is the most appropriate for investigating livelihoods. It is a social group, which resides in the same place, shares the same meals, and makes joint or coordinated decisions over resources allocation and income pooling

(Ellis, 2000). This study defines household as total number of all members in the house as a unit

2.2.4 Farmer varieties

According to this study, farmer sweet potato varieties are local cultivars, which are popular largely grown by farmers but not officially released. Selection is done adhering to farmer's own criteria.

2.2.5 Research released sweet potato varieties

Researchers released sweet potato varieties are the improved sweet potato varieties (ISPV), which were, evaluated on-station and on-farm by farmers and researchers, and finally released by the Tanzania National Variety Release Committee of the MAFS.

2.2.6 Adoption of new technology

Adoption of a new technology involves a choice between two alternatives, the traditional technology and the new one and farmers are assumed to make decision by choosing the alternative that maximises their perceived utility (Senkondo *et al;* 1998). The farmer is likely to adopt new technology if the utility of that technology is higher than the utility derived from the traditional technology. Nkonya *et al.*, (1997) defines the rate of adoption as the percentage of farmers who have adopted a given technology. CIMMYT, (1983) indicated that adoption rate is an effective technique of measuring impact of introduced technology whilst intensity of adoption is a rate which measures actual adoption as

compared to recommended rate or level (Nkonya *et al.*, 1997). Feder *et al.*, (1985) distinguished types of adoption as: aggregate adoption as the process of spread or diffusion new technology within a region and incidence of adoption as the percentage of farmers using a specific technology at a specific point in time.

2.2.7 Participatory Rural Appraisal (PRA)

The term Participatory Rural Appraisal (PRA) is being used to describe a growing family of approaches and methods to enable local people to share, enhance and analyse their knowledge of life and conditions, to plan and to act. PRA is more owned and shared by local people (Chambers, 1994). Chambers, (1994) has listed some of the developed and tested methods of PRA are participatory mapping and modelling, transect walks, matrix scoring, well-being grouping and ranking, institutional diagramming, seasonal calendars, analytical diagramming all undertaken by local people. Model of investigation, sharing and analysis are open-ended, and often visual, by groups of people, through comparisons. PRA has been used in natural resources management, programs for women and the poor, agriculture, health and food security. The use of PRA methods is being increasingly explored by students and faculty in universities for research and by training institutes for fieldwork.

2.2.8 Coping strategies

Coping strategies are the mechanisms, which are used by people as measures to tackle some difficulties in the community or household. According to Maxwell and Frankenberg, (1992) copping strategies vary by region, community, social class, ethnic group,

household, gender, age and season. However, coping strategies employed by household vary depending on severity and duration of the potential disruptive condition.

2.3 Determinants of food security

Most people in Tanzania depend on agriculture for their livelihood (Ishengoma, 1998). Tanzania has about 36 million hectares of arable land (almost one hectare per person), out of which only six million hectares are calculated (Wagao, 1991). In most cases, all rural households grow food crops, accounting for the bulk of the area cultivated. Surveys indicate that under the existing farming system and technologies there exists an abundant cultivable land, which could productively used. Therefore, land availability in Tanzania does not seem to be a limitation to food production.

In Tanzania land is owned by the state and the majority of the communities have the right to own land for agricultural production. Nevertheless, in some parts of the country, productive land is becoming scarce due to increasing population. This is particularly so in areas where they practice permanent agriculture based on perennial crops like coffee (MoA, 1996). However, in most parts of the country there is simple land which could be used for expansion of both crops and livestock production. According to Ishengoma (1998), Tanzania as a whole, doesn't suffer from food shortages. However, some parts of the country are prone to drought, flooding, marketing, transportation and diseases that hinder food production, subsequent household suffer food insecurity.

The main reason for food insecurity in Tanzania include pests and diseases, low soil fertility, inadequate farming technologies for crop production, inadequate husbandry practices for livestock production, low yielding crop varieties and animal breeds, high work-load of women and limited access to markets (FAO, 2003). Lack of opportunities for commercialisation results in low incomes, which is needed to purchase the food they are unable to grow for themselves.

2.4 Food accessibility in the household

At the household level access to food may be understood as a process whereby food reaches people (Ishengoma, 1998). Lorri and Kavishe (1990) define access to food as the process and extent to which the available food can reach all members of the household during the whole year. Household food accessibility is also determined by factors such as storage, distribution and marketing, cultural behaviour, transport network, real income and pricing policies (Wagao, 1991). Other factors are demographic characteristics mainly household size and education of the spouse; these influence the consumption aspects of the household (Ishengoma, 1998).

However, purchasing power, which is largely dependant on income, determines the degree of access to food at the household level. The vast majority of those who are undernourished either cannot produce or afford to buy enough food (FAO, 1996)
Household income is an indicator of the potential access to food security. In other words access to food is dependant in income, whether in cash or kind. This includes food produced though agricultural production or hunting and gathering as well as through cash

income. Households will have stable access to food if they have viable means of procuring (produced or purchased) food that do not lead to environmental degradation (Maxwell and Frankenberg, 1992).

Kavishe and Mushi (1993) argues that among low income groups, food access apart from the problem of distribution depends mainly on the ability to buy or produce their own food in the household. In most households, food security is achieved through great expenses by using large proportion of their resources. In rural household, the main sources of income are sale of cash income and in part, food crops, including livestock. However, income earned through crop sales, off farm employment and other related activities do not suffice to obtain adequate family food especially when households' own production is affected by unfavourable conditions (MoA, 1996).

Frequency of meals per day is an indicator of food accessibility and nutritional status. For those who have access to food they can afford more than two meals per day and under severe shortages one meal per day may not be assured (URT/FAO, 1992). According to the food policy, eating frequencies for Tanzania are generally low on average twice or thrice times a day (URT, 1992). Diets of most people are characterised by single or a few components, example maize diet supplemented with a relish of vegetables, beans, or meat. Access to an adequate supply of food is the most basic requirement of human needs and rights.

2.5 Coping strategies used by households with regard to food security

In Tanzania, Wagao, (1991) pointed out that; residents in rural areas have diversified strategies to lessen the adverse effects of the crisis. Household members cope with food shortages by reducing the frequency of and changing the content of meals consumed daily. Undertaking more income earning activities and buying or borrowing from either relatives or friends was also a strategy.

According to Mgondo *et al.*, (1996) poor household have difficulties in meeting their food requirements from own production. To bridge the gap especially in the pre harvest period, they rely on off-farm enterprises, reduce their food consumption as well as frequency of meals per day, sell some assets, borrow food or cash from relatives and friends and migrate.

Mutangadura *et al,* (1999) reported that in Zambia and Uganda ru ral households couldn't meet their food requirements or obtain cash through agricultural production. Therefore, they undertake a range of income generating activities such as selling of fire wood, brewing millet beer, selling livestock, building fences, handcrafts, tailoring and petty trade to supplement their income. In Malawi, household cope by doing casual labour (Mutungadura, 1999).

2.6 Importance of sweet potato to food security and marketing in Tanzania

Sweet potato is grown throughout Tanzania and constitutes much of the main diet of the people; it ranks third most important root and tuber crop after cassava and round potato nationally (Kapinga, *et al.*, 1995). It also, ranks the fourth when compared to other food crops, after maize, cassava and beans it ranked higher than rice, which was the sixth (Table 2). Sweet potato serves as food crop as well as cash crop.

Researchers in the Eastern zone ranked sweet potato the fourth for income earning. Female farmer's ranks sweet potato the second for both food and income and male farmers ranked sweet potato the second for food and third for income earning (Shetto, *et al.*, 2003). Sweet potato ranks the second root crop in the Lake zone particularly in Kagera, Mwanza, Mara, Shinyanga, Kigoma and Tabora regions (Kapinga *et al.*, 1995; TAHEA, 2004). Sweet potato is major staple crop in north and west of Lake Victoria, it is important as secondary food during the hungry months before the main grain harvest (Navarro, 1994). The documented information shows the importance of sweet potato to income and food security by ranks. There is no information on adoption on ISPV in relation to food and income.

Kapinga *et al.*, (1995) found that cassava, maize and sweet potato were grown in all zones surveyed (Table 2). However, sweet potato play major role in household food security. This may be due to its short maturity period and flexible piecemeal harvest over extended period (Ewell and Mutuura, 1991). The role played by sweet potato crop was not specified, whether was contributed by improved, farmer varieties or both the information available is very general.

Table 2: Farmer's ranked food crops on their farms by zone

Crop	Ranking by zone						Mean score	Overal l rank
	Lake (n=186)	Southern (n=200)	Eastern (n=146)	Southern Highlands (n=101)	Central (n=109)	Northe rn -		
Maize	3	2	1	1	2	1	1.7	1
Cassava	1	1	3	4	5	5	3.3	2
Bean	6	-	-	2	4	2	3.5	3
Sweet-potato	4	5	4	3	3	3	3.8	4
Sorghum /Mill	2	3	-	7	1	7	4.0	5
Paddy (rice)	5	4	2	-	-	6	4.3	6
Upland-rice	-	6	5	-	-	-	6.0	7
Banana	7	-	-	6	6	-	6.3	8
Ground-nuts	8	-	-	5	6	-	6.7	9

Source: Kapinga *et al.*, 1995. Note: =Not mentioned; n=Number of participants

Generally, sweet potato production in Tanzania is not planned according to markets and demands. Sweet potato that are marketed are also of variable quality. In the Lake zone, few people sell sweet potato through formal market channels. They usually sell what they call surplus in order to earn some cash for household expenses. In other cases, sweet potato is exchanged for fish or given to hired casual labourers to cover labour costs. Sweet potato is marketed at the homestead, in small local markets, or to larger regional and urban markets through middlemen have been reported by Kapinga *et al.*, (1995). Who were reported to sale sweet potato were (76%), while 23% do not sell, they produce for home consumption (TAHEA, 2004).

2.7 Nutrition and consumption status of sweet potato in Tanzania

Sweet potato as a crop combines a number of advantages, which give it an exiting potential role in combating the food shortages, and malnutrition that may increasingly

occur as a result of population growth and pressure on land utilization. In many parts of the world, as population grows, fertile arable land available per head diminishes. This creates a shift to use of marginal land in those densely populated areas where low incomes allow only modest investment in land improvement and crop production. In, additional, the increasing flow of people away from the land from into already densely populated urban area puts a heavy burden on the diminishing number of rural food producers.

In the United States of America (USA), sweet potato roots are a festive food without which no table for the annual thanks giving meal would be complete. In other lands, sweet potatoes are sometime scorned as a 'poor man's food' fit only for those who can afford nothing better (Woolfe, 1992). Tuberous roots and leaves of sweet potato are eaten. The roots are used mainly as a source of carbohydrates. The leaves used as relish are a good source of minerals and protein. The roots and leaves have substantial amounts of vitamins, particularly, pro-vitamin A. Consumption of sweet potato tender shoots and leaves was found to be popular in areas like Meatu and Maswa districts (Lake Zone), only varieties with narrow leaves with deep lobes are preferred. Heart-shaped leaves are not preferred because they are bitter (Hart, 1991).

There are two types of prices from one place to another and from one market to another; these are the farm gate and market prices. The prices also differ with season; during high season (bumper harvest) prices are lower than low season supply (off season). Prices are negotiated between farmers and traders who either buy in bags or plot. Marketing of sweet potato is characterized by few numbers of small-scale traders, transporters, commission

agents and consumers. However, these consumers can be classified into whole sellers and retailers (Kapinga *et al.*, 1995; TAHEA, 2004).

2.8 Sweet potato production constraints in Tanzania

Sweet potato production in Tanzania has several limitations. In a study done by Msabaha (1979), it was reported that some factors such as: diseases, insect pests, lack of improved varieties with desired attributes by farmers, poor storage and inadequate utilization of the crop do hinder sweet potato production.

More sweet potato production constraints were identified by farmers growing root and tuber crops in a study conducted in the Eastern zone of Tanzania by Shetto, *et al.*, (2003). The constraints were, low yield of root and tubers estimated to be 2-5 tons per acre due to poor soils and low genetic potential, market unreliability, low knowledge on post-harvest processing technology, pests and diseases.

The study conducted in about six Zones of Tanzania (Central, Southern Highland, Southern, Lake, Eastern and Northern Zones) showed the major production and post-harvest constraints by farmer's percentage and their respective ranks (Kapinga *et al.*, 1995) (Table 3).

Table 3: Production and post-harvest constraints as mentioned by farmers

Constraint	CEN	SHL	SOU	LAK	EAS	NOR	Mean	Rank
Biotic								
Insect pest	52	57	50	77	58	80	62	1
Viral & fungal diseases	25	28	26	63	16	20	30	5
Vertebrate pests	20	56	6	21	11	60	30	5
Abiotic								
Low soil fertility	0	8	6	11	11	40	13	9
Drought	80	25	10	80	29	55	47	2
Shortage of planting materials	25	11	26	66	29	70	38	3
Low root yield	25	28	31	90	11	10	33	4
Lack of improved varieties	25	0	13	0	11	0	8	13
Socio-economic								
Limited consumption	25	20	0	9	0	9	11	11
Poor market accessibility	0	20	40	20	22	20	27	6
Storage problems	0	0	23	0	11	70	17	7
Lack of good processing techniques	15	11	0	24	11	9	12	10
Low market prices of produce	20	28	17	0	0	20	14	8
Labour shortage	0	0	12	24	0	20	9	12
Land shortage	0	0	12	0	11	40	11	11
Lack of capital	20	0	12	0	0	20	9	12

Key: CEN=Central Zone (n=109); SHL=Southern Highlands Zone (n=102); SOU=Southern Zone (n=200); LAK=Lake Zone (n=186); EAS=Eastern Zone (n=238); NOR=Northern Zone (Source: Kapinga *et al.*, 1995).

Ndunguru *et al.* (2003) revealed more constraints such as poor extension services, unstandardized system of packing of sweet potato. This means, traders prefer use of *rumbesa* bag weighing 300 kg but offer same price as for 100 kg. This exploitation discourages farmers increasing production. There no farmer union or groups, to assist in price setting and marketing. Also due to vagaries of weather and lack of good irrigation facilities, and its high perishability and poor post harvest technology, seasonal shortage of

sweet potato is common and the result is a varied marketing pattern. This consequently does not support marketing functions like grading and packing. Moreover, there is lack of enough implements, inputs and lack of market information. In the Lake zone more constraints were identified such as: labour intensive due to the use of hand hoes, planting materials not easily available, pests such as weevils and rats infest the crop, low yield due to low fertility of the soil and also, lack of market which demoralizes the farmers to grow more sweet potato.

2.9 Varietal qualities required by sweet potato farmers in Tanzania

In most cases, just like consumers of other commodities, farmers' tastes and preferences are vast and variable. Therefore, the subsection below presents a review of some of the qualities that seem to be preferred by farmers in relation to sweet potato production, consumption and marketing. According to Kapinga *et al.*, (2003) sweet potato varieties are ranked on the basis of characteristics related to farmer's preference.

2.9.1 Farmer varieties

There are many sweet potato varieties in Tanzania, just to mention a few in the Eastern zone, local varieties are: *Kula na bwana, Gairo, Mwananjemu, Furahisha, Kanada, Karoti, Mombasa, Bangi, Morogoro,* and researcher or improved varieties: *Simama, Jitihada, Ukerewe, Sinia, Vumilia, Jitihada* (Shetto, *et al.*, 2003). There are several names for sweet potato cultivars in the Lake zone. Bukoba district alone had

Table 4: Sweet potato varieties listed by farmers in five surveyed zones

Lake Zone	Northern Zone	Eastern Zone	Southern Highland Zone	Southern Zone
257	23	33	37	33

Source: Kapinga *et al.*, (1995).

over 57 varieties (Kapinga, *et al,* 1995). In Maswa district (Shinyanga region) over 100 varieties were collected (Hart, 1991). The survey carried out by Kapinga *et al.*, (1995), listed many local varieties grown in Tanzania mainland (Table 4). However, present study identified farmer varieties, which are popular and highly grown for research purposes, such germplasm collection and breeding work and testing farmer preference for official release.

2.9.2 Improved sweet potato varieties (ISPV)

Root and Tuber Crops Research Program, evaluates sweet potato varieties for characteristics including acceptability by farmers, resistance to pests and diseases, productivity and root characteristics. Varieties are tested on-station by researchers and also complemented by farmers' perception through participatory manner.

Researcher released varieties in 1999 in the Lake zone were, *Simama, Jitihada, Vumilia, Sinia,* and *Mavuno. Jitihada* is high yielding variety (between 10-30 tons/ha of fresh root tubers). This has a creamy storage root skin colour and tolerance to drought and Sweet potato Mosaic Disease (SPVD). *Vumilia* is moderately high yielding variety. It produces

between 10-20 tons/ha of root tubers. The variety has a white storage root with resistance to SPVD. *Mavuno* is also high yielding with great acceptability to farmers. Yields range from 10-25 tons/ha of root tubers. It is moderately resistant to weevils and SPVD. The storage root colour is white. The variety has some degree of tolerance to drought. *Simama* has high yielding quality, its yield is between 10-20 tons/ha, it is early maturity and wide adaptability. Has tolerance to sweet potato mosaic disease. *Sinia*: has high yielding quality. It produces about 10-20 tons/ha of roots. The storage root colour is purple with tolerance to weevils, SPVD and good in ground storability. It has good cooking qualities and consumer acceptability.

Ukerewe variety was released in 2000 in the Eastern zone out of seven tested varieties. Five varieties were introduced from Lake Zone to Eastern Zone for test (*Jitihada, Vumilia, Mavuno, Sinia* and *Simama*). Two varieties *Ukerewe* and *Carrot-C* (orange fleshed) were local improved varieties tested for farmer preference. *Ukerewe* and *Simama* are generally highly preferred as a result of farmer's assessment in all sites (Masumba *et al.,* 2002). *Ukerewe* had higher consumer acceptance in the coastal plains (lowland warm humid to sub humid areas of Tanzania). It is resistant/tolerance to Sweet potato weevil (*Cylas spp*) and SPVD, high yielding potential, good root characteristics and wider adaptability. A study done in Uganda by Hakiza *et al.,* (2000) revealed that many sweet potato varieties have been developed and released to farmers for utilisation. However, an immediate challenge is the improved sweet potato varieties, which have been generated, together with the improved production technologies available, have not spread much into the farming community.

2.10 Factors related to farmer's preference and choice in sweet potato production

The sweet potato, *Ipomoea batatas* (L.), is believed to have originated in the tropics. Primarily a crop of South America in the Andes Mountains of Peru and Colombia, this origin is undisputed. Sweet potato has been grown in Virginia since 1648 (Walker, 2004). The main hypothesis for the rapid spread of the Portuguese voyagers following the tuck of Vasco da Gama, carried the plant eastwards from the Caribbean, Brazil and Europe to Africa, India, Southeast Asia and Indonesia (Hakiza *et al.*, 2000).

A Study conducted in Uganda showed that sweet potato varieties are grown primarily on small farms where, several hundred landraces varying conspicuously in leaf shape, colour and size, floral morphology, vigour, maturity period, storage root shape, colour, size, yield, food value, taste, processing characteristics such as ease of slicing and drying, flour quality, resistance to insect pest and diseases, adaptation to different soils or agroecologies and consumer acceptance, (Aldrich, 1963 and Bashaasha *et al.*, 1995)

In Tanzania, many farmers choose to intercrop sweet potato with other crops. This may have varietal mixtures of sweet potato as a means of risk management and to fill a range of consumption and marketing needs. Farmers have been found to make deliberate decisions about sweet potato varietal combinations and planting arrangements based on their knowledge of the agronomic performance of the varieties available to them (Ndunguru *et al.*, 2003). Early maturing varieties are particularly important for farmers with small landholding diverse stock as a form of food security. They grow numerous sweet potato varieties because, if some failed during the growth season, other would

survive to feed their families. A study conducted in Lake zone of Tanzania by Chirimi *et al.*, (2000) reported that, the major attributes desired by farmers are: high yielding ability, early maturing and potential to produce leaves for relish and livestock feed. The major root characteristics preferred by farmers are high dry matter content and good taste.

However, Hakiza *et al.*, (2000) conducted a study in Uganda reported that, in any village the relative popularity of individual cultivars changes with time. Many cultivars which for example, were once popular and wide spread in Buganda have been replaced or their distribution is quite limited. Study conducted by Aldrich, (1963) in Uganda found that, popular cultivars might disappear from cultivation due to the so called "deterioration" attributed to a progressive increase in virus infection in stocks.

Declining of soil fertility is another possible cause for farmers changing varieties. Farmers tend to grow varieties adapted to the soil conditions in the area and drop the less adapted as evidenced from a study in Kabale district in Uganda (Hakiza *et al.*, 2000). The new varieties which replace the old ones may be introduced from neighbouring districts or countries, but occasionally new varieties may arise as chance seedlings in farmers' fields or by mutation (Aldrich, 1963). An old variety may be replaced by new one simply because the later is superior in root yield, taste, maturity, or other traits in addition to being virus resistance. A study done in Tanzania by Rees *et al.*, (2003) revealed that, most farmers grow sweet potato according to their characteristics which was highly preferred for home consumption or market. Therefore, sweet potato characteristics had an influence for new variety uptake.

a) Maturity

Farmers prefer early maturing varieties, which in the case of piecemeal harvesting, big roots can be obtained within 3-5 months while other roots are left to bulk. The varieties, which do not give mature roots within 4-5 months, are considered by farmers to be late maturing. In their study, Rees *et al.*, (2003) noted that, 55% of sweet potato varieties grown were referred to as late maturing while 45% of the sweet potato varieties were referred as early/medium maturing varieties.

b) Root sweetness

Rees *et al.*, (2003) explained root sweetness to be very subjective quality, being an indication of good taste rather than sweetness (sugar content) per se. In addition, a watery or fibrous root is never considered 'sweet', so that it is very difficult to distinguish completely between taste and texture. It was observed that most sweet potato varieties grown by farmers have medium 'sweet' or 'very sweet' taste. Analysis indicated that, 54% of the grown sweet potato was 'sweet' while 32% 'were very sweet' and lastly 14% were not/slightly sweet.

c) Root fibre content

Texture of root flesh in terms of fibre content is an important criterion used by farmers in the selection of sweet potato varieties. Farmer prefers sweet potato roots with no or low fibre content. It was noted that, the majority of sweet potato varieties currently grown has no fibre or low fibre. Among them, 55% had no fibres and only 15% were reported to have fibre (Rees *et al.*, 2003).

d) Root firmness/hardness

Firmness was an indicator of high dry matter content, which is a preferred attribute in sweet potato roots. However, farmers indicated that most sweet potato varieties grow into 'medium' or 'slightly' firm roots. Of the total varieties assessed, only 26% were reported to have firm roots (Rees *et al.*, 2003).

e) Outer skin of the roots

Rees *et al.*, (2003) reported that farmers have not mentioned outer skin of sweet potato root as major selection criteria however. skin colours are likely to be important for uptake of new varieties. Many of the varieties (45%) grown by farmers have a purple /red outer skin colour; next was white/yellow outer skin colour (33%) and a brown /cream colour (22%).

f) Flesh colour of the roots

Two main flesh colours were mentioned by farmers being white and yellow/orange. Farmer indicated that white roots are preferred for processing give good quality flour and is a good indicator of high starch/dry matter content. It is hypothesized that white-fleshed roots are preferred to yellow/orange ones, as 63% of the total varieties assessed have white root flesh (Rees *et al.*, 2003).

Woolfe, (1992) reported that, in many areas, the lack of cultivars with characteristics catering to consumer preferences for colour, texture, flour and low fibre levels, combined with the difficulties of handling and storage of a highly perishable commodity under

tropical conditions of elevated temperatures and humidity, has frequently resulted in the sale of inferior quality sweet potato.

2.11 Factors affecting sweet potato yield

Yield has always been the most important issue to a farmer. Despite the widespread cultivation of sweet potato varieties, the average yield under the farmer's field conditions in Tanzania has been on the low side. A rough estimate of the mean yield at farm level is 5.5 tons per hectare where, as yield reported from research stations average 15 tons/ha (Kapinga *et al.*, 1995).

The available yield data suggest that, yield can vary widely over seasons and farms. For example, low yields of sweet potato in Tanzania has been attributed to a number of factors including poor agronomic practices, drought, weeds, diseases, insect attack and socio-economic factors, poor soils, vermin (mole rats, monkeys, caterpillars) and unavailability of farm inputs (Shetto *et al.*, 2003). This emphasized the need of high yielding, insect, diseases and drought resistant varieties. Various constraints accounting for low sweet potato production in Tanzania are, unreliable rainfall which is often sporadic and poorly distributed, use of unimproved low yielding cultivars which are susceptible to pests and diseases, input unavailability, poor transportation, and poor marketing facilities. Soil fertility also plays an important role in influencing yield performance in some parts of Tanzania.

Diseases and pests are among the major factors limiting yield in most sweet potato growing areas. Alone or in combination these diseases and pests have been associated with large proportions of crop loses, either directly by reducing quantity, or indirectly by increasing cost of production (Kapinga *et al.*, 1995; Shetto *et al.*, 2003). Although yields are still disappointingly low in many countries, it has been shown that there is a tremendous potential for increasing yields by the introduction of improved clones and more efficient cultivation practice (Woolfe, 1992).

2.12 Factors affecting sweet potato for food security and marketing

Sweet potato is very perishable, hence low shelf life and reduced food security. The perishability of the fresh tubers is also a major constraint to the marketing of the commodity. The perishability and problems with in-ground storage mean that, the crop is seasonal with consequent peaks and trough in prices. Poor marketing system and facilities in the country also affect sweet potato production performance because farmers need to sale part of the harvests to obtain cash to cover both family demands as well as next season's production costs (Ndunguru *et al.*, 2003). Farmers are used to selling part of their crops in different markets for reasons (Kapinga *et al.*, 1995). However, a reason for choice for market is mostly based on price.

Lack of proper food storage methods also affects food security and marketing at household level. No modern ways of storing sweet potato. Most farmers rely on in-ground storage for fresh roots, kept in the field as a way of storage. About two thirds (60%) of the respondents in the surveyed area at the Lake zone reported the same (TAHEA, 2004).

Kapinga *et al.*, (1995), found that, sweet potato are commonly harvested in piecemeal. Mature storage roots on each plant are harvested individually leaving immature roots to continue bulking. In this way the plot is used as a store. However, attack by sweet potato weevils, rats and moles, as well as theft, was reported to cause serious losses for several months after the crop is mature. Early maturing sweet potato was found to have limitation to the in-ground storage method. In the Lake zone majority (89.5%) reported to have no storage of sweet potato (TAHEA, 2004).

Sweet potato roots can be stored for several weeks or even months after harvest if handled carefully, but deteriorate rapidly if bruised or handled roughly. It was also reported that, roots can be stored in underground pits during the cool, dry winter season between five and six months, commonly done in Usangu plains located in the Southern Highlands of Tanzania. The pit storage method was found mostly in cool, upland areas (Kapinga *et al.*, 1995). Also some farmers in Malawi store their sweet potato in pits. In Zambia the pits '*pfimbi*' are burned to sterilize the soil and the pit flour is smeared with ash. In Angola 20-30% farmers were reported to make '*tarrimb*' bags for storage of sweet potato (Minde *et al.*, 1999). These methods may be useful in food security since the shelf life is increased. However, Mbeza *et al.*, (1997) cited by Minde *et al.*, (1999) in a study conducted in Malawi on sweet potato storage and its economics, showed that although sweet potato can be stored in pits for up to 5 months, the market value obtained; thereafter is low and unattractive. Loss in weight due to shrinkage, attack by moulds, and the resulting unattractive tubers are some of the reasons for the loss in market value.

Sweet potato processing was reported in the lake zone, and was found to be useful for food security due to increased shelf life. Study conducted in Tanzania, reported that, sweet potato is processed to chips and dried under sun; locally known as *michembe* and *matoborwa* are normally stored in *vihenge* (big storage baskets), tins gunny bags, heaps and in other types of containers. Dried chips can be stored for two to eight months, depending on the type of product and climatic conditions (Kapinga *et al.*, 1995). In the surveyed districts Misungwi, Nyamagana and Ilemela (Lake Zone) majority were found to process sweet potato (71%) and few (29%) were not processing (TAHEA, 2004). Nevertheless, several storage pests particularly rats and the larger grain borers and lesser grain borers were found to attack the processed products and render them into unpalatable flour (Hart, 1991; Kapinga *et al.*, 1995).

The marketing system of the crop is poorly developed with very little information on the market characteristics of sweet potato. Also, sweet potato market in Tanzania is affected by poor transport and storage facilities. The main transportation constraint is the bulkiness of the crop produce, poor roads and storage facilities. Price in urban markets, particularly in Dar es Salaam, increases dramatically during the month of Ramadhan. It was noted that, the price of sweet potato in the retail markets of the city do not seem to follow the laws of supply and demand as one would expect. During the rest of the year there is often scarcity of sweet potato in the market, but the price remains constant (Kapinga *et al.*, 1995; Ndunguru *et al.*, 2003). Also, Minde *et al.*, (1999) conducted a study in the SADC countries and reported that, consumption of fresh sweet potato is concentrated in rural areas. High losses in transport and marketing have kept prices of fresh roots relatively high in urban markets. Nevertheless, urban consumption is increasing in many urban

areas, replacing bread as an accompaniment for tea. Sweet potato is consumed as snack (fresh, roasted, grilled and boiled) and also as main meal particularly during 'hunger period'.

The market potential for dried sweet potato chips was not stated clearly in the past study. However, it was reported that, although processed sweet potato exist fresh tubers are highly preferred. Surveys conducted in the Lake and Eastern zones Tanzania, noted significant volumes of fresh sweet potato tubers sold in the markets of Mwanza, Morogoro and Dar es Salaam (Thomson *et al.*, 1997; Ndunguru *et al.*, 1998).

2.13 Sweet potato production trend

Minde *at al.*, (1999) reported that sweet potato is grown in all SADC countries as important food crop and commercial crop. Total area planted to sweet potato is ~ 325 000 ha, compared to ~ 2.2 million ha of cassava, but both of these figures are subject to widely margins of error. Tanzania has the largest area planted to sweet potato (250 000 ha) in the SADC countries which is ~ 50% that of cassava. Sweet potato is grown more widely than cassava, at least on a small scale, because of its broad agro-ecological adaptation. It also has a short growing cycle (3.5 months) that allows production during the rainy season, thus avoiding the region's long dry period. It was also revealed that sweet potato is a dynamic crop, farmers throughout the region were found to expand production, partly in response to the effects of drought on maize and other staple grains, and partly in response to new market opportunities. The rapidly changing situation presents a challenge to researchers, to provide the right varieties, as well as knowledge

about other technologies (Minde *at al.*, 1999). Woolfe, (1992) found that although yield are still disappointingly low in many countries, it has been shown that there is a tremendous potential for increasing yields by the introduction of improved clones and more efficient cultivation practices. Nevertheless, some nations have attained increases in countrywide yields under farm conditions.

Study conducted in Tanzania by Kapinga *et al.*, (1995) reported that, sweet potato production is increasing, especially in the Lake, Central and Eastern zones. Majority of farmers reported that, production was increasing compared to farmers who reported that, sweet potato production was decreasing (Table 5). Farmers were asked to give reason for sweet potato production decrease. These were; labour and land shortages, difficulties in getting material, drought, pests and diseases, and illness or old age of key members of the family. Also farmers, who reported an increasing trend in sweet potato production, reason were due to increase in the area under production, use of high yielding materials that are tolerant to drought, pests and diseases, and improved market opportunities.

Table 5: Farmer's perception on sweet potato production trend by zone

	Production trend (% of farmers)		
Zone	Increase	Decrease	Constant
Lake (n=186)	76	20	4
Central (n=109)	75	5	20
Eastern (n=226)	46	48	6
Southern Highlands (n=90)	46	37	17
Southern (n=149)	37	35	28
Sample Mean	58	26	16

Source: Kapinga *et al.*, (1995)

Study done in the Lake Zone by TAHEA, (2004) noted that, most farmers (55%) reported constant sweet potato production by acreage. However, about one third (36.5%) respondents reported to have increased sweet potato production by acreage and few (8.5%) reported decrease in production by acreage.

2.14 Adoption of technology

Rogers (1995) defined adoption of an innovation as a decision to make use of an innovation as the best course of action available. Innovation decision is a process from the time a farmer becomes aware of an innovation up to adoption stage. The author introduced the innovation decision model consists of five stages, these are: knowledge, persuasion, decision, implementation and confirmation. Awareness is the first and adoption the last stage. Lionberger and Gwin (1991) agreed that throughout adoption decision is the product of a sequence of influences operating through time rather than something happening instantaneously. The authors provided an agricultural research based model for describing what happens in the individual adoption process.

Similar with Rogers (1995), the model provides five stages that the adopter goes through, awareness being the first and adoption, the last stage. The model entails that at awareness stage people get general information about a new idea, product or practice for the first time but not its details. Since farmers are not satisfied with mere knowledge or general information, they need and actively seek additional and detailed information about the innovation (interest stage).

Having the detailed information the farmer decides whether the idea is good to him or not (elevation stage). After successful trial, usually on their farms and often after observing or consulting with other farmers may make up the innovation for full use (adoption stage). Depending on innovation type, some stages may be skipped and the most frequently skipped is the trial stage due to difficulties in trying little first and more later (Lionberger and Gwin, 1991).

In a social system, it is not possible for all individuals to adopt an innovation at the same time. Basing on the degree to which an individual or other unit of adoption is relatively earlier in adopting an innovation, Rogers (1995) classified members of the social system into adopter categories. Using normal frequency distribution the author presented the adopter categories and their approximate percentages of individuals as innovators (2.5%), early adopters (13.5%), early majority (34%), late majority (34%), and laggards (16%). In practice, the conventional methodology of studying adoption of innovation given by Rogers does not take into account the variability of the different communities and farmer's preferences, which are based on their livelihood strategies. Consideration of this aspect could likely alter Roger's adopter categorization. Therefore, Roger's adopter categorization cannot be generalized. It should be noted that, since farmers are rational in decision-making they balance between a wish to innovate and the expected worth of the innovation (Blum, 1989). This implies that the most desired innovation would likely be adopted by greater proportion of members in the first instance that the Roger's proportion (2.5%) and vice versa.

2.14.1 Innovators

Innovators are some individual in a social system, who are very eager to try new ideas, have substantial financial resources and the ability to understand and apply complex technical knowledge. They are also capable of coping with a high degree of uncertainty and playing an important role in important new ideas (Lionbeger and Gwin, 1991).

2.14.2 Early adopters

These are a more integrated part of the social system than the innovators. Members of this category are said to speed the diffusion process and are the ones to which potential adopters seek advice and information about the innovation since they find it necessary to make judicious innovation decisions (Lionberger and Gwin, 1991). According to Rogers (1995), this category decreases the uncertainty about a new idea by adopting it, and then conveying a subjective evaluation of the innovation to near peers by means of inter-personal networks.

2.14.3 Early majority

The category of the early majority comprises members who adopt new ideas just before the average member of the social system but after the early adopters. The innovation decision period of early majority is relatively longer than that of the innovators and early adopters (Van den Ban and Hawkins, 1996).

2.14. 4 Late majority

These are members of the social system, who adopt innovations relatively late. The members of this category adopt the innovation after the majority of people in the society have adopted. The adoption by this category has been described to rely on economic necessity and peer pressure (Rogers, 1995).

2.14. 5 Laggards

Laggards are the last group in a society to adopt innovations. According to Rogers (1995), the individuals often make decisions in terms of what has been done in previous generations and interact primarily with others who also have certain traditional values. It can therefore be argued that laggards tend to be suspicious of innovations and change agents (Van den Ban and Hawkins, 1996).

2.15 Factors influencing adoption of technology

Adoption of innovation has been found to depend on a variety of factors. This is because some innovations relate to the individual, some to the situation the individual is in, and some to the nature of the practice. Some innovations are also subject to the control and manipulation of change agents and of the farmer while some are not (Lionberger and Gwin, 1991). It is unhidden truth that several studies have identified various factors to be associated with adoption of innovation but there exist differences with geographical location. Adoption of technologies is affected by many factors these are, household head characteristics, farm characteristics, institutional factors, technological factors and gender

factors. Household head characteristics may have large influence on adoption of ISPV. It has been found that, older farmers have low rate of adoption but use improved technology intensively as compared to younger farmers (Kisusu, 2003). Gender, may influence adoption of technologies either positively, or negatively.

Farmer experience is a factor in adoption; a study conducted by Senkondo *et al.*, (1998) found that the number of years in farming influences adoption of new technologies. It is possible that number of years of working in the farm develops technical know how which is useful on adoption studies show that the way a farmer perceives a new technology influences positively and significantly the adoption rate of that particular technology in various development projects (Adesina and Forson, 1995; Senkondo *et al.*, 1998). However, it should be noted that farmers' perception on the new innovation is very subjective.

Farm characteristics, do influence the rate of adoption of technologies are farm size and farm implements. Available literature indicates that farm size influences adoption of new technologies (Mbata, 1994). Farmers with large farm sizes have high rate of adopting new technologies than farmers with small farm sizes because it plays to do so (Adipala *et al.*, 2000). Type of technology has been also reported to influence adoption because of the technology characteristics including, relative advantage compatibility and observability (Rogers, 1983). Most farmers behave rationally and therefore can adopt the introduced technology if yields will be increased and if the technology is easy to apply and is affordable. It has been found in several studies that higher yields influence positively and significantly the adoption of technology (Adesina and Forson, 1995). The new sweet

potato varieties that replace the old ones may be introduced from the neighbouring districts.

Despite efforts of introducing technologies, which aimed at boosting production, various studies have indicated that a large number of farmers reject introduced technologies (Fujisaka, 1993). Proportions of farmers who reject technologies are large and this depends on the type of that technology. Technologies are rejected due to several reasons. Among reasons reported for not adopting technologies included tendency of innovation addressing the wrong problem, farmer practice is equal to better than the innovation, innovation does not work, extension fails, the innovation is too costly and social factors (Fujisaka, 1993). Due to the above reasons farmers continue using their traditional practices on the assumption that they can live comfortably. In some cases, it has been found that farmers are right on rejecting the technology. For example, it has been reported that economic impact on adopters and non-adopters of nitrogen fertilizers was not significantly different (Fujisaka, 1993). This means the practice used by farmers is as suitable as those recommended by scientists.

Institutions affect the rate of adoption of technology through supporting services offered to farmers. For instance, Kuzilwa and Mushi, (1997). Have reported that well-established credit system, research and marketing stimulate small business, which later enables adoption of new technology in the community. Several studies also indicate that farmers contact with extension staff increase the probability of adopting the introduced technology Rutatora and Matee, (2001).

However, some studies show that extension service influences negativity adoption of technology (Dimara and Skuras, 1998). The negative relationship between extension service and adoption of new technology could be attributed to inappropriateness of technology brought to the target group. Mbata (1994) found that transport cost has significant negative influence on adoption of technologies. This is based on the experience that high transport cost increases cost of production reduces market access and therefore discourages farmers to purchase the technology in question. The available literature is deficient in factors affecting the adoption of improved sweet potato varieties in Tanzania. Researchers have been concentrating their efforts more on cash crops and cereal crops.

2.16 Indicators for food security, livelihood, and adoption of new technologies

There are many indicators used to measure levels of food security example: meals /day, number of months of self-provisioning, change in diet, percentage total income on food, migration and changes in adult anthropometry (Food Security, 2002).

Livelihood according to Ellis (2000), comprises the capabilities, assets and activities required for means of living. There are five main categories of capital identified that contributes to assets in the livelihood definition. These are; natural capital, physical capital, human capital, financial capital, and social capital their definitions:

a) **Natural capital**: refers to the natural resource base (land, water, trees) that yields products utilised by human population for their survival.

b) **Physical capital:** refer to the assets brought into existence by economic production processes for example tools, machines and land improvements like terraces or irrigation canals, transport, shelter, water energy and communication.

c) **Human capital:** refer to the educational level, work place skills, knowledge, ability to labour and health status of individual and population.

d) **Financial capital:** refers to stocks of cash that can be accessed in order to purchase either production or consumption goods, savings, regular remittances or access to credit.

e) **Social capital:** refers to the social networks and associations in which people participate, relationship of trust, and from which they can derive support that contributes to their livelihood.

Adoption of new innovation has to do with farmer perception. Nkonoki, (1994) reported that, alternative explanations of characteristics of individual farmer could be used as explanatory variables in understanding adoption patterns and included factors such as education, gender, and age. These may predispose a farmer to take interest in a new technology, and resources such as a size of land, income or access to credit may make it easier or more profitable for a farmer to change practices.

CHAPTER THREE

METHODOLOGY

3.1 Location of the study area

The study was conducted in six villages, namely: Matimbwa village in Bagamoyo district, Coast region, which lies between 6°-9 ° latitude and 38°-39° longitude. Chanika village in Ilala district which is in Dar es Salaam region, lying between latitude 6°-7° and longitude 39°-40° both are in the Eastern zone. Kiilima village in Bukoba district (Kagera), lies between latitude 1°-4° and longitude 30°-32° and Mwasonge village in Misungwi district (Mwanza) is situated between 2°-4° latitude and longitude 32°-34° in the Lake zone, Mitakawani in Kati district (Kusini Zanzibar) and Donge-kipange village in Kaskazini B district (Kaskazini Zanzibar) lies in 4°-7° latitude and longitude 38°-40° . These three zones were selected among the seven zones of Tanzania (main land and Island), these areas were selected/considered due to their potentiality in sweet potato production in Tanzania. The country map (Fig. 2) shows the location of the study and major growing areas in Tanzania. Sweet potato is grown at all altitudes, on all kinds of soils, and in areas where rainfall varies between 800 and 1,400 mm per year and altitude 1200-1900 m above sea level (Kapinga, *et al.*, 1995).

Table 6: Study locations

Zone	Region	District	Village/area
Eastern	Coast	Bagamoyo	Matimbwa
	Dar es Salaam	Ilala	Chanika
Lake	Kagera	Bukoba	Kiilima
	Mwanza	Misungwi	Mwasonge
Zanzibar	Kusini	Kati	Mitakawani
	Kaskazini	Kaskazini B	Donge-kipange

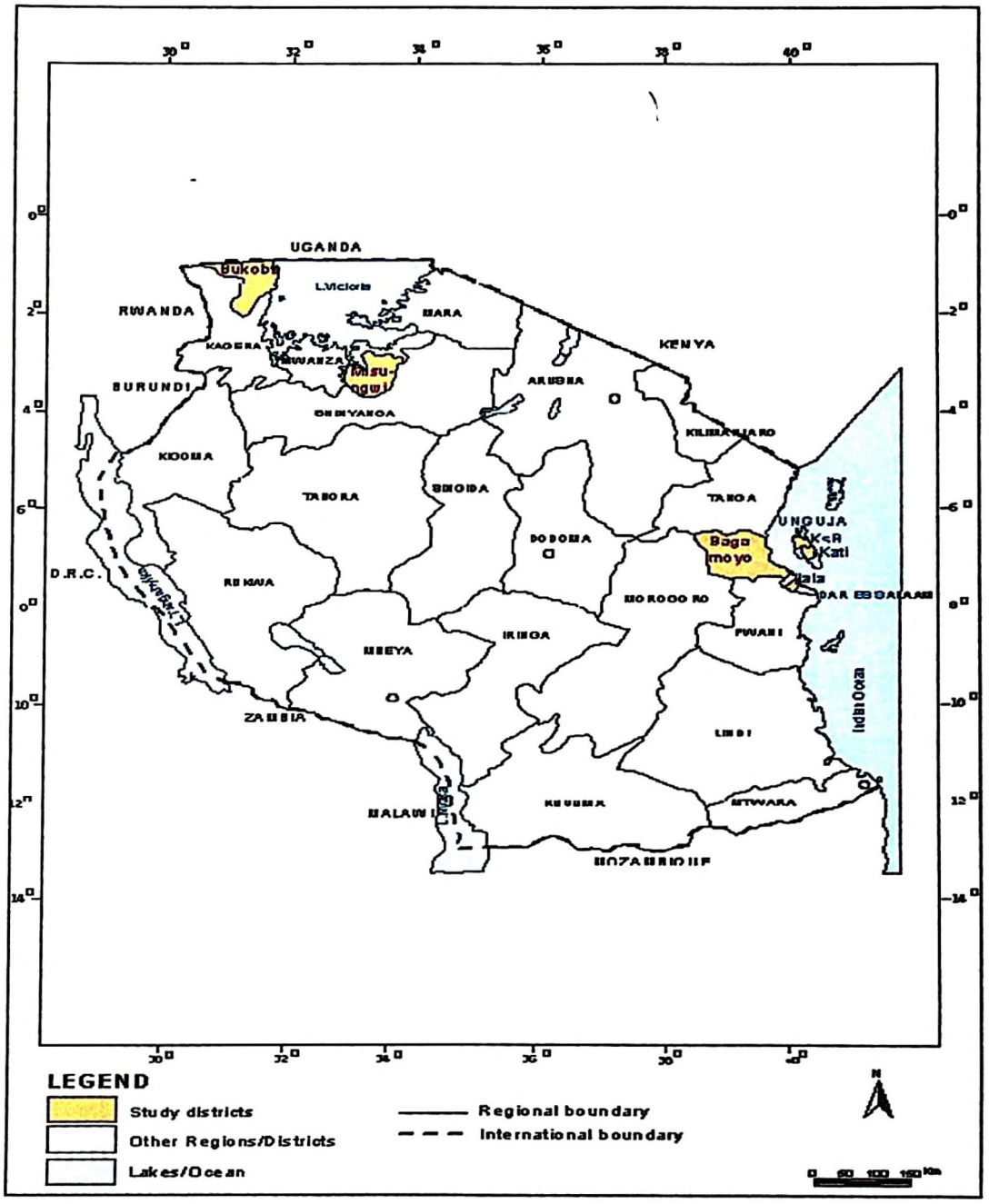


Figure 2. Location of the study area and major growing areas

3.2 Research design

Non-experimental design was employed whereby a cross-sectional research design was used. This design was adopted because it is a one-time affair and is designed to obtain a snapshot of a representative group of households at a given moment in time. The design has greater degree of accuracy and precision in social science studies (Deaton, 1997). According to Bailey (1994) this design allows for a descriptive analysis as well as for determination of relationships between variables.

3.3 Sampling procedures

The target population for this study was sweet potato producers/sweet potato-farming households in six selected villages. The sample involved farmers (male and females, in villages, which grow many crops including sweet potato. However, Kilima village (Bukoba district) was an exceptional with women respondents; sweet potato is considered as women crop. The sample was selected by simple random selection using village register provided by the village authority.

The study had two phases:

a) Phase one constituted a preliminary survey in which questionnaire and checklist for Focused Group Discussion (FGD) were pre-tested to randomly selected 20 households in Kahororo village (Bukoba district), which is one of the village with sweet potato growers. The aim of this phase was to check the relevance and

validity of the questions to the intended respondents, as argued by Metrick (1993) that, pre-testing is essential before beginning any survey.

b) The second phase based mainly on informal and formal survey. The informal survey involved of Participatory Rural Appraisal (PRA) and formal one included questionnaire administering to respondents.

3.3.1 Identification of populations

Before sampling design was adopted, a target group (i.e. the sweet potato-farming households) was identified through secondary data information, where major growing areas were identified (Kapinga *et, al.,* 1995). Not only major growing areas but also where improved sweet potato varieties were distributed.

3.3.2 Sampling technique

The study employed a multistage sampling technique, which is convenient for studying large and diverse population with no particular records of the actual individuals to be studied (Fowler, 1993). Additionally, the technique reduces the amount of travelling for interview and hence the corresponding costs (Casley and Kumar, 1998).

Purposely selection was employed in the first stage, where three zones which are major sweet potato growers were selected. In the second, third and fourth stages the simple random sampling technique was used. Therefore, two districts were selected from each zone identified. In stage three, one village was selected from each district and hence, total

of six villages were selected. Lastly, farming households for questionnaire administering and PRA were selected; random numbers were used in picking names of household heads from the list of the villagers. Every (N/n) th household were picked from the village register as a sample household; where "N" represents total households in the village and "n" represent household interval between sampling unit in the population. The sample household were then traced out in the field with the guidance of the village government leader who accompanied the researcher throughout the survey period in the village. During survey not all head of households were respondents due to the nature of the crop, in households where the head was not involved at all in production of sweet potato; he/she had to identify the right respondent among the members of the household.

3.3.3 Sampling unit

A farming household was used as a sampling unit because it is most appropriate unit of measurement when assessing the level of poverty and standard of living in a society (Blackwood and Lynch, 1994).

3.3.4 Sample size

According to Boyd *et al.*, (1981) a random sample should at least constitute 5% of the total population to be representative of the population. The sample comprised 186 households. Of these, 106 were females and 80 were males giving a ratio approximately of one to one. This study also, adhered to Bailey, (1994) who argues that regardless of the population size, a sample or sub-sample of 30 is the bare minimum.

3.4 Data collection process

3.4.1 Primary data collection

(a) Questionnaire

The main instrument used in collecting primary data in this study was structured questionnaire containing both open and closed ended questions. The questionnaires were formulated in English and translated into Swahili to facilitate easy communication during data collection (Appendix 1). The focus was to examine the adoption rate and role of improved sweet potato to food security in relation to the study's objectives. To ensure validity and reliability, the first draft of the questionnaire and the semi-structured interview guide for PRA was tested in 20 households (sec.3.3) and necessary changes were made. This included restructuring of and omission of some irrelevant questions. The information collected from the pre-tested households was not included in data collected during the main survey.

(b) Participatory Rural Appraisal (PRA)

Twenty households, including both males and females of different age group, were involved in Focus Group Discussion (FGD) using Semi Structured Interview guide (SSI) to get in-depth understanding on the role of sweet potato to food security and cash income. Main aspects considered were; type of crops grown, available ISPV and popular local cultivars with their important attribute, household food supply and consumption pattern, sweet potato production constraints and their coping strategies, market information and opportunities, pair wise ranking on contribution of food crops to income and food security.

Direct observations were also made especially on the identification of pests and diseases on the crop, estimation of farm size and converting the local material used in packing to kilograms and dwelling characteristics. Identification of the consumer preferences, Venn diagrams on their income and expenditures. PRA was very useful, because it allowed more probing and high interaction in a participatory manner. Also participants were involved in analysing the results directly in the field.

3.4.2 Secondary data collection

Additional information, wase sought from relevant documents/reports and other documentary materials. These were mainly from different institutions such as Sokoine National Agricultural Library (SNAL) in Morogoro, Lake Zone Agricultural Research and Development Institute (LZARDI) Ukiriguru and Maruku and Kibaha Research Institutes in Tanzania and International Potato Centre (CIP) based in Kampala-Uganda. Other useful literatures were searched electronically through Internet service. These were used to supplement the information obtained from the field.

3.5 Data processing and analysis

Data collected by PRA techniques were analysed by a researcher in the presence of villagers who assisted to verify the authority and the correctiveness of the PRA results. Collected data from the primary sources were verified, coded and summarized prior to analysis using the Statistical Package for Social Sciences (SPSS) computer programme in conformity with the objective of the study.

a) Univariate and bivariate analysis

Univariate analysis was used to summarize the information relating to each variable. Summary statistics were calculated using a sub-programme descriptive. The distributional properties were analysed using sub-programmes frequencies and histograms. A cross-tabs sub-programme was used for bivariate analysis to study the relationship between pairs of variables. Chi-square (χ^2) test was used to assess the significance of bivariate relationships for nominal and ordinal variables. Hypotheses were tested using chi-square. For comparing means of interval variables, t-test statistics were calculated. Correlation coefficient was used to summarize these associations.

b) Multivariate analysis

Multivariate analysis was used to study the combined effect of explanatory variables (background, socioeconomic and institutional) on adoption. Logistic regression model was used to examine the response of binary adoption indicators to the background, socio-economic and institutional variables. A logistic regression model was used to analyze the postulated factors affecting farmer's decision to adopt improved sweet potato varieties. Household characteristics were sex, age, marital status, education, labour (family size and/or family labour); socioeconomic factors were land, credit and farmers experience on farming. The institutional factors included extension contact, market and participation in research trials or NGO/CBOs' activities.

However, the decision to use the model was influenced by the fact that logit/probit model is based on the cumulative logistic probability function and hence computationally easier

to use. The probability scale for the logistic model ranged from (0, 1) to $(-\alpha, +\alpha)$, via a logistic transformation of success probabilities, P_i (Gujarati, 1995), that is:

1) Probit $(Y_i) = \text{Ln}\ \{P_i/1-P_i)\}$ ..... (1)

Where P_i = is the probability that a household to adopt ISPV

$1-P_i$ = the probability of a household not to adopt ISPV

Probit $Y_i = b_0 + b_1X_{i1} + \ldots + b_{10}X_{i10} + E_i$ .....(2)

Where: Y_i = a dependant variable,

b_o = a constant or intercept,

$b_1 \ldots b_n$ = regression coefficients,

i = I, 2, 3,....., 186 households,

$X_{i1} \ldots X_{i10}$ = independent Household variables;

E_i = error/residual term.

2) $\text{In}\ (P/(1-p)) = b_0 + b_1X_1 + \ldots + b_{10}X_{10} + E$ ..... (3)

Where: X_1 = AGE (Age of head of household)

X_2 = EDUC (Education of household head)

X_3 = HHS (Household Size)

X_4 = CREDIT (Farmers access to credit)

X_5 = EXTEN (Farmers access to extension)

X_6 = PART (farmers part. in on-farm research trials)

X_7 = TLOA (Total land owned)

X_8 = SEX (Sex of household head)

X_9 = MARK (Farmers access to market)

X_{10} = EXPE (Farmers experience in sweet potato farming)

In = Natural logarithm

b_0, b_1-b_{10} = Are Coefficients of independent variables

E_i = Error term

The dependent variable for adoption was: have you grown improved sweet potato varieties last season? (HGISPV). Dependent variable was used as an indicator for ISPV adoption. The variable was coded '1' for Yes indicating adoption and '0' for No indicating no adoption.

c) Independent variables with their hypothesis

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

1) AGE: Young farmers were expected to search for technical information about improved sweet potato varieties because they are looking for progress than old farmers. 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) EDUC: Farmers' education is generally associated with great understanding of new information and benefits of new technology. Therefore educated household heads were expected to adopt ISPV than household with less or no education.

Table 7: Definition of variables for adoption

Variable	Units	Variable description
Y	Binary	Dependent variable takes the value of 1 for adopter and 0 otherwise (not adopted)
X_1	Continuous	Age of head of household in years
X_2	Binary	Formal education 1, 0 otherwise (no education)
X_3	Continuous	Total number of members in the household
X_4	Binary	1 if farmer has access to credit, 0 otherwise
X_5	Binary	1 if farmer had contact with extension service, 0 otherwise
X_6	Binary	1 if the farmer participated on research trials, 0 otherwise
X_7	Continuous	Total land owned by farmer (in acreage)
X_8	Binary	1 if Male headed household, 0 otherwise
X_9	Binary	1 if farmer has access to market, 0 otherwise
X_{10}	Continuous	Number of years of farming

3) **HHS/HILA:** Family labour available determines adoption of new technology. Household with more labour can decide to adopt labour-intensive technologies than household 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) **CREDIT:** Cash availability eases adoption constraint for high cost input technologies. It was therefore considered that farmers' access to credit would increase the level of farmers' adoption of improved varieties.

5) **EXTEN/PART:** Institutional support services were hypothesized to enhance adoption of new technology. Therefore, extension services and farmers participation in on-farm research trials were expected to increase exposure to awareness of households to adopt new sweet potato varieties.

6) **TLOA:** Land availability and ownership was also considered influential in the adoption of improved varieties. Household with less land therefore are likely to be risk-averse and will tale more precaution in allocating land for ISPV production.

7) **SEX:** Gender of household determines access to new information. Social behavior makes male informants to address male-headed households leaving female-headed household uninformed. This attitude deprives women's access to new information and limits their perception of new varieties.

8) **MARK:** Households with access to market were expected to increase the level of farmers' adoption on of farm produce. Therefore, it was hypothesized that availability of sweet potato market could influence the level of adoption of ISPV.

9) **EXPE:** Farmers with high experience on farming/sweet potato production were expected to increase the level of adoption. Farmers' with low experience are likely to be risk-averse and may be early majority/late majority or laggards.

3.6 Limitations

The study had the following limitations, which must be taken into account when interpreting the results:

a) Responses of the interviews and the questionnaire are based on respondent's memory since most farmers keep no written record of their activities.

b) Some farmers had problems of memory recall and some could not estimate some of the research parameters like farm size, age, output harvested per area, amount sold, amount consumed, and conversion of local measurements like gunny bags, *besen, tenga fungu* to metric measures (kilogram or tons). In some cases the researcher had to rely on their rough estimates.

c) The source of secondary data for this study was highly diverse; the researcher had to travel for those materials.

d) Finally, some respondents were not willing to give information because they had never received feedback from previous research conducted. They argue "benefit nothing in answering question".

e) Insipite of the above limitations, the researcher is confident that the data which has been collected, is reliable. And has adequately addressed the objectives set for the study as elaborated in the next chapter of the thesis.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Household characteristics of sweet potato producers

Before discussing on the role of sweet potato to food security and cash income in the household, it is important to understand the type and characteristic of the sweet potato grower. Household head/respondent's characteristics are discussed in sub-section below. However, sweet potato is considered as women crop in most areas, in this case; not all head were respondents; the matter was taken care of.

4.2 Age

Information on the age was obtained from the question on the date of birth of head of household/respondent. In situation where, the respondents failed to recall the date, month or year of birth, a best estimate was recorded based on related information such as the age of first born. To make it easy the respondents were grouped into five age groups. The minimum age of interviewed respondents was 20 years, maximum age was 79 years and the average age was 39.5 years old.

Head of household may have great influence in adoption since he/she is the main decision maker in the household. Their characteristics were highly considered. The minimum age for the head of the household was 23 years while the maximum age was 84 years and average age was 44.7 years old (Table 8).

Table 8: Distribution of the respondent and food availability by age

Age grouping (Years)	Adopters (n=131)		Non-adopters (n=55)		Total (n=186)	
	No.	%	No.	%	No.	%
20-30	13	10.0	8	14.5	21	11.3
31-40	44	33.6	18	32.7	62	33.3
41-50	32	24.4	10	18.2	42	22.6
51-60	27	20.6	11	20.0	38	20.4
> 61	15	11.4	15	14.5	23	12.4
	Food availability status					
	Food secured (n=47)		Food unsecured (n=139)		Total (n=186)	
20-30	14	10.1	7	14.9	21	11.3
31-40	48	34.8	14	29.8	62	33.3
41-50	34	24.5	8	17.0	42	22.6
50-60	27	19.4	11	23.4	38	20.4
> 61	16	11.5	7	14.9	23	12.4

It was revealed that, the majority (76.3%) of household head were found in the middle-aged groups ranging from 31 to 60 years old. Few (11.3%) head of the households were below 30 years old where as 12.4% were above 61 years old. However, it was observed that, the adoption of ISPV increases with age up to 40 years whilst further increase in age results in the number of adopters to go down. It was noted that, young people are eager to learn and adopt new ideas than old people as hypothesized before. CIMMYT (1993) reported similar results, that younger farmers are likely to adopt a technology, because they have had more schooling than the older generation or perhaps have been exposed as migrant labours. At an age ranging from 41 to 50 years the adopters dropped from 33.6% to 24.4% while further increase from 50 to above 61 years old showed adopters drop to 11.4%.

Majority of adopters (78.7%) were food secure and fall between ages of 31-60, whilst, their counterparts (70.2%) were food insecure (Table 8). The adopters were likely to harvest sweet potato even in bad weather condition because they are drought tolerance

may also sale and buy other types of foods. Their counterparts in high drought may depend on buying some root crops. However, results given by chi-square test revealed that, statistically there were no significant different (P>0.05) across the age groups when adopters and non-adopters were compared on food security (Table 8). Majority of the respondents were at middle age (31-60 years) this may imply that, the selected sample was within the Tanzania's economically productive class which ranges between the ages of 15 to 64 years Makauki, (2000). The availability of an active force has a positive influence on food availability in the household through productive activities.

4.3 Sex

During the survey both male and female respondents were involved. However, Kiilima village (Bukoba) had no male respondents. Sweet potato in this area is considered as a women crop and it is shame for men to cultivate sweet potato. Out of 186 total numbers of respondents 43% were males and 57% were females.

4.3.1 Gender involvement in sweet potato production

Gender involvement in sweet potato production was evaluated comparing male and female adopters. Composition of the male and female adopters was 41.2% and 58.8% respectively (Fig. 3). Although, the crop is classified as women crop Kapinga *et al.*, (1995) a big change was revealed by this study, since there was no significance difference between male and female adopters (P>0.05). This result confirmed that, male and female farmers have adopted ISPV equally.

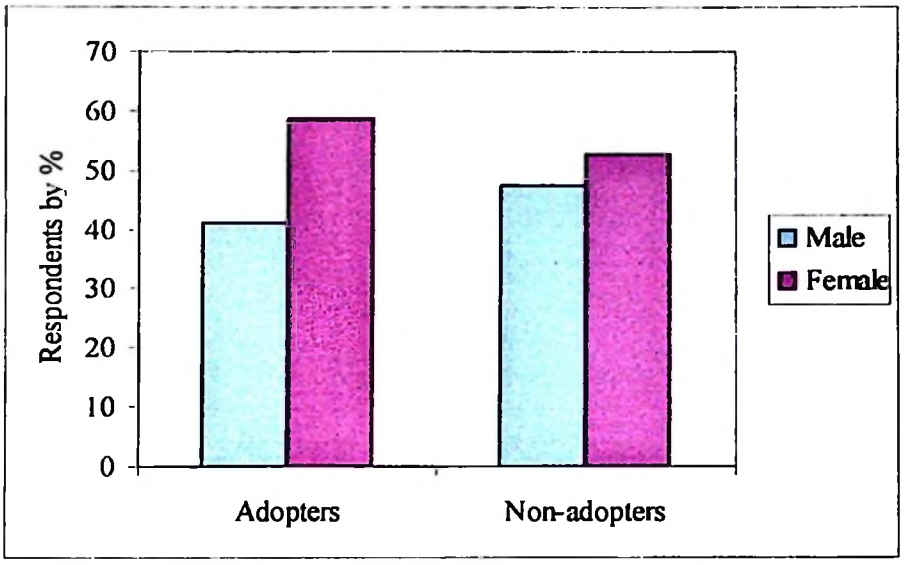


Figure 3. Adoption of improved sweet potato varieties by sex

This study agrees with the findings given by Kapinga *et al.*, (1995) who reported that in Kagera region sweet potato is a women crop and it is a big shame for men to grow sweet potato. This study has noted that for more than ten years ago no change has occurred on the gender roles in Bukoba district on sweet potato production. However, this may be due to the poor marketability of sweet potato in the study area, which do not motivate farmers to grow sweet potato as commercial crop thus, men finds it less important. The crop specification in Kagera region was found to be very high, for example men's crops are cash crops and food crops which have high market potential, and these are: coffee, brewing banana, maize, cassava, fruits and vegetables. All respondents interviewed were females in Kiilima village. Some women crops were identified: sweet potato, cooking banana, bambara nuts, yams, cocoyam and beans. These crops are highly used for food security and little income from crop sales Kapinga *et al.*, (1995) reported the same. PRA conducted in this study also, revealed that, male farmers were biased to crops, which

generate income, but women were found to own crops, which are for food security with low income however females labour is very important in male's crop production. High demand of sweet potato roots may be due to increasing of urbanisation in Dar es Salaam, Mwanza and Zanzibar.

In other places like, the Eastern Zone and part of the Lake Zone-Mwanza a great change was noted in sweet potato production, from being subsistence crop to a market oriented commodity both by females and males. This statement implies that, sweet potato market is increasing particularly the villages close to the cities. These areas, were found to grow sweet potato for commercial purposely adhering to consumer preference. Study carried out by Minde *et al.*, (1999) in the SADC countries reported that, sweet potato serves as an alternative to bread to most people in the urban areas.

Table 9: Labour distribution by gender in sweet potato production (%)

	Eastern zone (n=60)		**Lake zone (n=66)**		**Zanzibar (n=60)**		**Overall mean**	
Activity	F	M	F	M	F	M	F	M
Field preparation	50	50	50	50†	55	45	52	48
Planting	60	40	100	0	60	40	73	27
Weeding	45	55	70	30†	50	50	55	45
Harvesting	30	70	75	25†	50	50	65	35
Processing	Na	Na	60	40†	Na	Na	60	40
Storage	Na	Na	100	0	Na	Na	100	0
Marketing	30	90	20	80	50	50	33	67

Note: Na= Not applicable F= Female M=Male

† = Not applicable to Kagera region (only applicable in Mwanza)

This study revealed that males are effectively involved in sweet potato production (Table 9). Men in the Eastern Zone and some parts of the surveyed areas of the Lake Zone

(Mwasonge village) harvest the crop for sale and marketing. Particularly, when customer comes or when the farmer intends to transport sweet potato roots to village centre men are highly involved.

Nevertheless, piecemeal harvesting was no more practised in the Eastern zone, harvesting was found to be done by completely removal of roots from the ridge. The change in gender roles may be attributed by men engaging in sweet potato production for marketing. A change on gender roles was noted when comparison was made to that given by Kapinga *et al.*, (1995) (Appendix 3k). Sharing of gender roles has also been reported by Ndunguru *et al.*, (2003) in study conducted in the Eastern zone where men and women were reported to cultivate and plant sweet potato in their field.

One may conclude that, gender roles on sweet potato production has changed due to importance of sweet potato as an income earning crop for both male and female farmers participate fully in land preparation, planting, weeding, harvesting, and marketing in most of the surveyed villages.

4.3.2 Household headship

Household headship may have great influence on adoption and food intake in the household. Majority of the respondents (70.4%) were found to be adopters while their counterparts were few (29.6%) (Table 10). The adopters had access to ISPV vines and most participated in research trials, non-governmental organization, community based organizations and/or extension service compared to their counterparts. Most of the

interviewed respondents (74.7%0 were found to be food secured while few (25.3%) were unsecured. Majority had access to food; only few had no food reliability.

Results (Table 10) show that female and male headed household adopters were 81.5% and 68.6% respectively, on October-December (32.6%) female-headed households (77.8%) were more secured compared to their counterparts who were (74.2%). Men are more likely to adopt the technologies, which generate income whilst women are interested on food security crops. Female-headed households showed high adoption rate and food secured though their difference was insignificant (P>0.05).

Table 10: Adoption of ISPV and food status by head of household's sex

Adoption of ISPV	Male (n=159)		Female (n=27)		Total (n=186)		
	No.	%	No.	%	No.	%	χ^2
Adopters	109	68.6	22	81.5	131	70.4	1.85ns
Non-adopters	50	31.4	5	18.5	55	29.6	
Food security							
Food secured	118	74.2	21	77.8	139	74.7	0.16ns
Food unsecured	41	25.8	6	22.2	47	25.3	
Food shortage (Months)							
January-March	14	20.9	4	21.1	18	20.9	
April-June	11	16.4	-	-	11	12.8	
July-September	6	9.0	3	15.8	9	10.5	
October-December	23	34.3	5	26.3	28	32.6	
Whole year	13	19.4	7	36.8	20	23.3	

Note: ns = Not significant

- = Not Mentioned

It is possible that, without sweet potato their status could be very poor compared to their counterparts who have more resources. Both male and female-headed households have

adopted ISPV, and almost all had experienced food shortage in some months of the year particularly in October-December (32.6%), January and March (20.9%), these months sweet potato are not available or are in short supply. Most farmers reported to sale food crops including sweet potato particularly in harvesting period. However, most of them run food shortage during land preparation. Majority (85.5%) of households were likely to be male headed households than female-headed households who were very few (14.5%) (Fig. 4). However, in both Zones there was dominance of male-headed households (in the Eastern, Lake and Zanzibar Zones, male headed accounts for about one quarter of all respondents (95%), (75.8%), (86.7%) respectively and female headed were very few (5%), (24.2%) and (13.3%) respectively (Appendix 31). Male dominance did not affect planting of ISPV in all villages; this may be due to its role in the household as food and income generating crop.

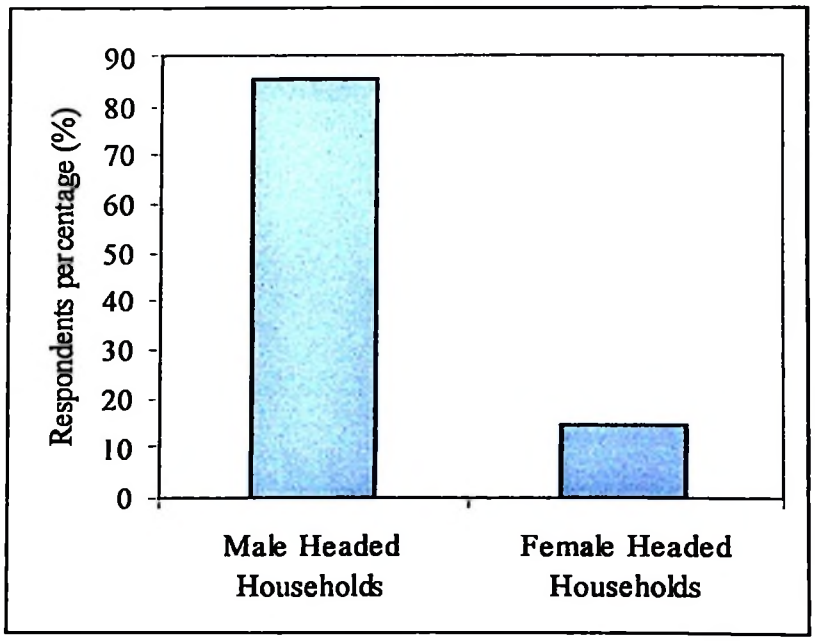


Figure 4. Household headship

4.4 Household size and composition

A household size is an important variable determining the possible supply of family labour for the crop as far as sweet potato is concerned. On average, the household size for the six villages was found to be 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 dependant population.

4.5 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 household on planting ISPV for food security. The marital status was described in four groups.

Table 11: Response of planting improved sweet potato by marital status

Marital status	Adopters (n=131)		Non-adopters (n=55)		Total (n=186)	
	No.	%	No.	%	No.	%
Married	101	54.3	50	26.9	151	81.2
Single	17	9.1	3	1.6	20	10.7
Widow	7	3.7	1	0.5	8	4.3
Separated/ Divorced	6	3.2	1	0.5	7	3.8

Results in Table 11 revealed that, majority (81.2%) of respondents were married, and the rest few (18.8%) were unmarried. Of the unmarried respondents, 10.7% were single, 4.3% widows, and 3.8% separated or divorced. The majority of sweet potato producers were

found in the group of married, while the least adopters were those separated or divorced. The reason could be an increased demand of food security resulted from increased household size or increased labour force all of which may drive the married group to grow sweet potato, which are 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 at the household may increase the chances to engage in sweet potato production and hence spreading of improved sweet potato vines. On the other hand, respondents who were separated were the least adopters. The reason is that, the separated household mostly were females having no access and ownership right over land and other resources. Men have more secure rights to land and other resources than women members in the household. Female spouses are normally granted secondary rights to resources from their husbands although as heads of household women's rights are greater. They can "own" land through purchase in areas where sales occur, however their ability to purchase land is highly limited due to lack of financial means, similarly Mwaipopo-Ako, (1994) reported that, women can own land by purchase, and only few manage due to their low economic status.

4.6 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. Education level is expected to influence spreading and adoption of improved and farmer released sweet potato varieties in Tanzania for food security. All respondents were requested to state their levels of education.

Table 12: Response on planting ISPV by education level

Level of education	Adopters (n=131)		Non-adopters (n=55)		Total (n=186)	
	No.	%	No.	%	No.	%
Primary	89	47.8	29	15.6	118	63.4
Secondary	18	9.7	10	5.4	28	15.1
Tertiary	0	0.0	1	0.5	1	0.5
Adult education	0	0.0	2	1.1	2	1.1
No education	24	12.9	13	7.0	37	19.9

This study revealed that, majority of the respondents had primary education (63.4%). Few (15.1%) had secondary education, very few (0.5%) had post-secondary education and 1.1% of respondents had adult education. About 19.9% of the interviewed farmers had no formal education (Table 12). Illiteracy could be due to ignorance that is attributed to cultural reasons, which has made people fail to recognize the importance of education.

Adopters with secondary education were very few (9.7%); and there were no adopters with post-secondary education. This may be, due to the phenomena of educated people migrating to urban areas for business or government careers and hence reduce the number of post to education persons residing in the rural areas. Broadly, the education level of the respondent is low. The low level of education is attributed to lack of self-motivation towards education as well as poor economy of some families. However, results (Table12) show that education has no effect on adopting ISPV. It was observed that out of 37 respondents having no formal education the adopters were 64.8%. For respondents with primary education out of 118 persons the sweet potato adopters were 75.4% whilst, for secondary school adopters were 64.3% out of 28 respondents.

4.7 Socio-economic factors

4.7.1 The role of sweet potato to food security

During PRA farmers were asked to rank the major food crops grown in their area. Cassava, maize, and sweet potato were found to be important food crops grown in all surveyed Zones. Sweet potato ranked the second after cassava as an important food crop when overall rank was made (Table 13). Sweet potato has proved to be a second staple food and very important for food security.

Table 13: Food crops ranked for food security by zones

Food crop	Eastern Zone	Lake Zone	Zanzibar Zone	Mean Score	Overall rank
Cassava	1	1	1	1.0	1
Sweet potato	2	2	3	2.3	2
Banana	-	3[b]	2	2.5	3
Paddy	3[a]	4[a]	4	3.7	4
Maize	4	2	5	3.7	4
Yams	-	5	3	4.0	5
Coco yams	5	6	6	5.7	6
Cowpea	6	6	-	6.0	7

Note: - Not mentioned.

[a] Paddy: grown in Coast and Mwanza region in the Eastern and Lake zones

[b] Banana: grown in Kagera region in the Lake zone.

When food crops were compared by zones, sweet potato ranked the second in the Eastern and Lake Zones, after cassava and the third in Zanzibar after cassava and bananas/plantains. It was also noted that, in cities with a significant Moslem population, demands have traditionally gone up during the fasting month of Ramadhan. This was noted in Dar es Salaam, Mwanza and Zanzibar where, sweet potato plays a great role as a

special menu known as "futari" soft dish for Moslems during fasting period. Also, in the Lake Zone sweet potato has grown popularity as alternative to bananas, which have been attacked by panama, bacteria wilt and banana weevils and cassava by Cassava Mosaic Diseases (CMD). However, cassava was the leading food crop in all surveyed Zones.

4.7.2 The role of sweet potato to income at the household level

Sweet potato was found to be important for income generating at the household level. When Zones made comparison, sweet potato ranked the second after coconut with equal rank with cashew nuts in the Eastern Zone. It also, ranked third after coconut and cooking banana in Zanzibar and ranked second after cooking and brewing bananas in the Lake Zone (Table 14).

Table 14: Farmers ranked food crops for income earning at household level by zones

Food crops for cash	Eastern	Lake	Zanzibar	Mean score	Overall rank
Coconut	1.0	-	1.0	1.0	1.0
Banana	-	1.0[b]	2.0	1.5	2.0
Cashew nuts	2.0	-	-	2.0	3.0
Sweet potato	2.0	2.0	3.0	2.3	4.0
Fruits	1.0[a]	4.0	-	2.5	5.0
Cassava	4.0	3.0	4.0	3.7	6.0
Paddy	6.0	5.0[c]	5.0	5.3	7.0
Maize	5.0	6.0	6.0	5.7	8.0

Note: - Not mentioned.

[a] Fruits (watermelon and cucumber) highly grown in Chanika (Dar es Salaam).

[b] Cooking and brewing bananas grown in Kagera region in the Lake zone.

[c] Paddy grown in Coast region in the Eastern zone.

Sweet potato was found to play a great role in the household for food and a moderate role in marketing. It ranked second for food security and fourth for income generation as the

overall rank by farmers during PRA (Tables 13 and 14). Sweet potato is among the important cash crops in the major growing areas. It was noted that there is a move to change from subsistence to commercial farming in sweet potato production in villages close to the cities where market opportunity is increasing. It was also noted that, more male farmers are involved in sweet potato production; the crop is no longer women crop with few exceptional of Kagera region where it is a shame for men to cultivate sweet potato. More emphasis on production will improve household food security and income.

4.7.3 The role of sweet potato to food security and income is underestimated

Sweet potato plays a great role in food security, as reported by the majority (97.8%) of respondents during the survey. Of these, about two third (59%) of sweet potato growers reported to consume most of their sweet potato at home, about one third (38.8%) of respondents reported to consume at home and sale surplus, very few households (2.2%) produced for income earning only. Nevertheless, more than one third of the respondents (41%) sold their sweet potato produce in a fresh form during the season 2004 (Fig. 5).

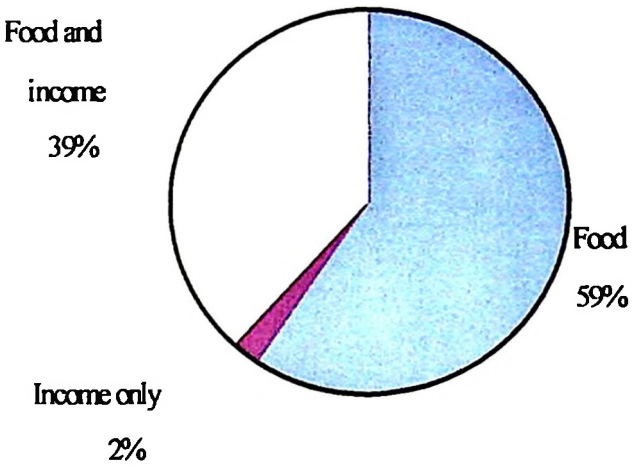


Figure 5. Role of sweet potato to food and income at household level

In case of unreliable weather (drought), sweet potato acts as a buffer and saves as staple food since other crops may be destroyed completely. Sweet potato is dependable. Once the plant forms edible root, a hungry family can start eating. An established patch keeps producing despite drought, for months. Kapinga *et al.*, (1995) reported that, sweet potato complements other food crops and serves to bridge "hunger periods" of food shortage before the next harvest of maize or other staple crop. However, the chi-square test proofed to have statistically significant difference ($P<0.05$) in contribution to food security between household types. Therefore the hypothesis which state that; the role of sweet potato to food security for the livelihoods of rural farmers is under estimated was accepted.

Table 15: Adopters response to ISPV against local sweet potato cultivars production

	Sweet potato adopters (n=131)		Adopters who rejected some varieties (n=45)	
Type of variety	No.	%	No.	%
Improved and local	90	68.7	7	5.3
Local only	-	-	1	0.8
Improved only	41	31.3	37	28.2

Note: - not mentioned

Majority of adopters (68.7%) were identified to plant both improved and local varieties. This result implies that, most of adopters, still plant their local cultivars. Reason given for continue planting local cultivars was, the easy availability of sweet potato vines, also most of local cultivars has almost all desired attributes as farmers had been carrying out selection in several years. Most are drought resistance, pest and disease tolerance, good storability and marketability.

Farmers take time to test the new innovation released in a small portion in their plots to evaluate varieties performance while continuing with their local cultivars production to avoid risk of losing their local cultivars. Due to this reason, adoption takes place in slow rate. Slow adoption was partly attributed to shortcoming of new varieties in terms of eating quality, storability and adaptability to marginal environment, limited access of farmers to planting material of new varieties, no stable market for increased production and the demand for varieties with high dry matter, good eating quality and high yield has not been met.

However, few adopters (31.3%) had planted ISPV only in their fields, they no longer plant local cultivars, have shifted to ISPV completely. The results obtained by chi-square

proved to be statistically significant difference ($P<0.05$) between local cultivars and ISPV adoption. Thus the hypothesis which states that; adoption of improved sweet potato varieties at household level is relatively low compared to local cultivars in Tanzania was rejected and the alternative hypothesis accepted which states that: adoption of improved sweet potato varieties at household level is not low when compared to local cultivars in Tanzania. Adoption was highly limited to very few sweet potato varieties officially released. In the Eastern zone *Ukerewe* was highly adopted followed by *Simama* and *Jitihada*, in the Lake zone *Jitihada, Simama* and *Sinia* have being adopted and in Zanzibar *Kizimbani mayai, Sinia* and *Simama* have being adopted and the adoption is statistically significant ($P<0.05$). However the adoption of *Vumilia* and *Mavuno* was not statistically significant ($P>0.05$) in the Eastern and Lake zones and Zanzibar, most farmers have rejected them because did not defeat the local cultivars (Appendix 3n). A study on adoption of nitrogen fertilizers done by Fujisaka, (1994) reported the same that, farmers are right in rejecting the technology when the practice used by farmers are better off compared to recommended by scientists.

On further analysis, sweet potato was found to contribute in household income (Fig.6). Majority, (83%) of interviewed respondent reported that, sweet potato contributes to household income; however few, about (17%) of respondents reported not to earn income from sweet potato at all. Reason given by not selling sweet potato roots was; little quantity of roots obtained from field was consumed at home, some respondents with surplus distributed to relatives and friends as gift.

4.7.3 The role of sweet potato for marketing at household level

Respondents who sold sweet potato had their own reasons for doing so. About 72.5% of respondents reported to have need of cash for household expenditure, items like food, clothes, school requirements, medical bills, home items like sugar, salt, and cooking oil etc

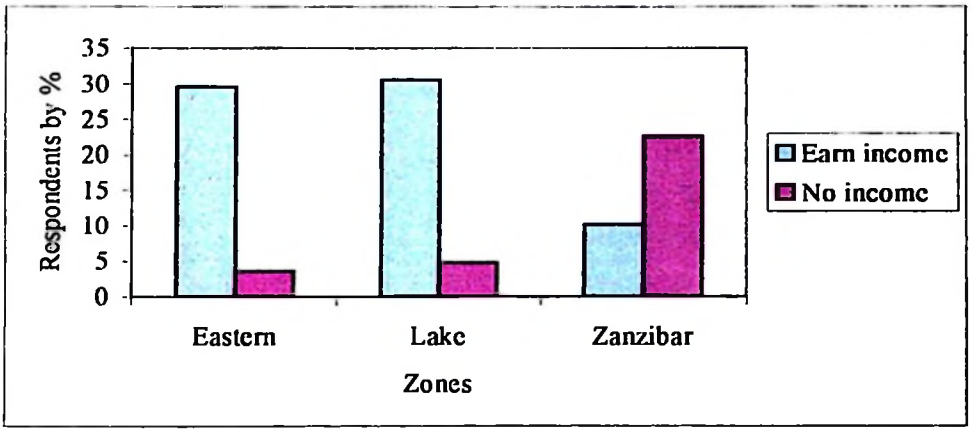


Figure 6. Contribution of sweet potato to household income by zone

However, "food was sold to buy food" this was proved by the data given in Appendix 3m type of foods which were bought after selling sweet potato roots were; *sembe,* maize and rice which are non-perishables, can be stored for future use and not only that, but are also used as staple food and were listed as the preferred food crops.

Table 16: The reasons given for sweet potato sales

	Adopters (n=131)		Non adopters (n=55)		Total (n=186)	
Reasons for sale	No.	%	No.	%	No.	%
Household expenditure	79	73.1	29	70.7	108	72.5
Earn income	19	17.6	6	14.6	25	16.8
Avoid crop loss	10	9.3	6	14.6	16	10.7

During PRA in Kiilima village (Kagera region), one of farmers reported that, "We consume sweet potato more than other food types, because sweet potato has low price in the market. Instead, of selling sweet potato we sale *Mtwishe* a multipurpose type of banana (cooking, roasting or as dessert banana) has high demand and fetch more money due to its high price compared to sweet potato" (Personal communication, Ma-Emeliana, 2004).

4.7.4 Important economic activities in the surveyed area

During the survey respondents were asked to list their economic activities in the household. Results (Table 17) pointed out that, all zones depend on crop produce for income at household level. The majority, more than 90% respondents, reported to sale crop produce in year 2004. Of these, (68.8%) of respondents sold crop produce only, (21%) of respondents sold crop produce but also were traders and (1.1%) sold crops and livestock. Very few (2.7%) of respondents were petty traders and 23.7% were petty traders and sold crops produce. Lake Zone was found to be the highly crop seller dependant followed by Eastern zone and lastly Zanzibar. These results conform to the PRA results (PRA data, 2004), which revealed that, crop sales accounts for high percentage, more than 77% of total income generated in the household.

Similar observation was also reported by Ndunguru *et al.*, (2003) in study carried out in Lake and Eastern zone, where crop sales ranked the first on income generation in the household. When link was made on results in Tables 14 and 17; sweet potato raked the third as overall income generating crop, of these it ranked the second in the Eastern and

Lake Zones while in Zanzibar it was the third of all food crops for income. One may conclude that most farmers are employed in agriculture sector. This study conforms to other studies, which insist that Tanzania depends on agriculture for its economic growth.

Table 17: Important economic activities for household's income by zone

	Eastern (n=60)		Zanzibar (n=60)		Lake (n=66)		Total (n=186)	
Source of income	No.	%	No.	%	No.	%	No.	%
Crop sales†	39	66.1	38	62.3	51	77.3	128	68.8
Crop sales and petty trade	17	28.8	11	18.0	11	16.7	39	21.0
Petty business	0	0.0	5	8.2	0	0.0	5	2.7
Livestock and crop sales	1	1.7	0	0.0	1	1.5	2	1.1
Labour selling	1	1.7	0	0.0	1	1.5	2	1.1
Employment	1	1.7	7	11.5	2	3.0	10	5.3

Note: Some of respondents mentioned more than one economic activity

†Sweet potato included

4.7.5 Main sources of daily meals in the household

Households have different sources for their daily meals. These are; own food producers with surplus, food production with no surplus, own production but insufficient, supplemented by purchasing foods from the market and some respondents depend on purchased foods from markets and/or shops throughout the year. Majority (82.3%) of respondents produced their own food and purchased in market. Few (15.6%) of respondents were self-sufficient; means produced their own food and did not purchase food. Particularly, respondents from Kiilima village in Kagera region, whose staple food was reported to be bananas, to them banana was more than enough, only supplemented with other root crops (yams and cocoyam).

Table 18: Source and status of food at household level

Source of food	Adopters (n=131)		Non adopters (n=55)		Total (n=186)		
	No.	%	No.	%	No.	%	χ^2
Own produce and purchase	105	80.2	48	87.3	153	82.3	1.35ns
Own produce	23	17.6	6	10.9	29	15.6	1.30ns
Purchase from market	3	2.3	1	1.8	4	2.2	0.41ns
Level of food security							
High	113	86.3	41	74.5	154	82.8	3.73*
Low	18	13.7	14	15.5	32	17.2	2.73ns

Note: ns not significant

* Statistically significant at 0.05

However, very few (2.2%) of respondents purchased food from the market and shops throughout the year. These are petty traders who had no time to produce on their own, use money from the business to buy food. Others are the dependants of labour selling, during season were busy selling labour, come to their own field when season is about to end, and therefore get low yield or nothing from their field. They are hand to mouth depending on buying food after labour sales (Table 18). However, results of the chi-square test proved to have non-significant difference (P>0.05) between the adopters and non-adopters on food purchase. This was due to the fact that, the adopters sold some of their crops to purchase other type of food they prefer. It was observed that about (18.3%) adopters and (18.2%) non-adopters sold sweet potato to buy other food items (Appendix 3m). One can conclude that, non-adopters are likely to purchase food from the market compared to adopter households. As the result shows that, adopters are likely to earn more money from sweet potato sales to purchase other food items.

Where researcher had to ask the respondent's perception on the level of food security whether high or low in the household level. Majority (82.8%) of the respondents reported

that, sweet potato has high contribution to food security at household level. During harvesting almost all households consumed sweet potato. Nevertheless, few (17.2%) respondents reported that, sweet potato has low contribution to food security at household level, main reason for low or no contribution was, very low sweet potato yield due to poor soils, shortage of labour or unreliable rainfall, the amount harvested was not enough for the household itself (Table 18).

Sweet potato consumption at household level was also considered. Majority (71%) of respondents reported to eat sweet potato on breakfast and as main dish, followed by (20.4%) respondents reported to consume sweet potato at break-fast (accompaniment with tea), very few (8.6%) respondents eat sweet potato as main dish (Table 19).

Table 19: Sweet potato consumption in a household

	Adopters (n=131)		Non-adopters (n=55)		Total (n=186)	
Meal type	No.	%	No.	%	No.	%
Break-fast	27	20.6	11	20	38	20.4
Main dish	12	9.2	4	7.3	16	8.6
Break-fast and main dish	92	70.2	40	72.7	132	71

Crops produce were found to be sold to earn money and buy other type of food so as to change diet in the household, observed in Chanika and Donge kipange villages of Eastern and Zanzibar respectively. The results (Appendix 3m) showed difference by percentage between adopters (18.3%) and non-adopters (18.2%) on selling sweet potato and buying other food items. This result proves the importance of sweet potato for food and income for the rural livelihoods.

4.7.6 Meal frequency

In order to get information about the household status, numbers of meals taken per day in the household were asked. Results in Table 16, show the daily meal frequency in the household. In this study, taking two meals per day and below was considered to be food insecure and taking three meals per day and above was considered as food secure.

Table 20: Meals eaten per week in the sampled households

Variables		Adopters (n=131)		Non adopters (n=55)		Total (n=186)		χ^2
Number of meals per day		No.	%	No.	%	No.	%	
	2	31	23.7	16	29.1	47	25.3	0.604ns
	3	100	76.3	39	70.9	139	74.7	
Inferior foods per week (Legumes, roots and vegetables)								
	1	19	14.5	7	12.7	26	14	
	2	31	23.7	10	18.2	41	22	
	3	29	22.1	13	23.6	42	22.6	2.573ns
	4	33	25.2	13	23.6	46	24.7	
	5	6	4.6	5	9.1	11	5.9	
	6	1	0.8	1	1.8	2	1.1	
	7	5	3.8	2	3.6	7	3.8	
Superior food: Meat per week								
	0	61	46.6	33	60	94	50.5	
	1	24	18.3	11	20	35	18.8	
	2	26	21.4	8	14.5	36	19.4	5.215ns
	3	14	10.7	3	5.5	17	9.1	
	4	4	3.1	0	0	4	2.2	
Fish per week								
	0	3	2.3	1	1.8	4	2.2	
	1	3	2.3	0	0	3	1.6	
	2	5	3.8	1	1.8	6	3.2	
	3	3	2.3	6	10.9	9	4.8	8.696ns
	4	16	12.2	7	12.7	23	12.4	
	5	21	16	8	14.5	29	15.6	
	6	16	12.2	9	16.4	25	13.4	
	7	64	48.9	23	41.8	87	46.8	

Note: ns not significant

*Statistical significantly at 0.05.

Findings indicated that, the majority (76.3%) of adopters had three meals per day, and about a quarter of the respondents (23.7%) were taking two meals per day. However, no household were reported to take one meal per day. Table 20 shows that, majority (70.9%) of the non adopters had three meals per day and about a quarter (29.1%) of non-adopters had two meals per day. Taking three meals per day is common in Tanzania where food is adequate and activities do not limit this food-feeding regime. Results of the chi-square showed insignificant difference (P>0.05) between adopters and non-adopters on meal frequency per day. However, a household that uses almost all of its resources to achieve food security is highly vulnerable to risk of becoming food insecure compared to a household that uses a small proportion of its resources to achieve the same goal.

4.7.7 Inferior foods

Inferior foods were defined as foods that cannot provide the recommended daily intake. Types of food reported by the respondents to be inferior included stiff porridge (*ugali*), boiled bananas without cooking oils and spices, boiled sweet potato, yams, coco yams and boiled cassava or cassava *ugali* taken with legumes and/or boiled vegetables.

In this study taking inferior type of food three times per week was considered to be food secure and taking inferior type of food more than three times per week was considered food insecure. Results (Table 20) show that, 56.6% of the households were considered food secured as they consumed inferior foods not more than three times in a week. Of these, (36%) of the households consumed inferior foods less than three times in a week and about a quarter (22.6%) of household consumed inferior foods three times in a week.

However, (35.5%) of the households were considered food insecure as they consumed inferior foods in more than three times in a week. Of these (24.7%) of the households consumed inferior foods four days in a week. Very few (1.1%) had consumed inferior foods about six days in a week and (3.8%) had consumed inferior foods throughout the week.

The research results revealed that, the proportion of the household adopters (34.4%) that consumed more than three times in a week did not differ much compared to their counterparts (38.1%) on consumption of inferior types of food. Hence, adopters are more or less likely to survive on inferior type of food than their counterparts during food shortage and famine.

4.7.8 Superior foods

In this study, meat and fish were considered to be superior foods because they are regarded as food of high quality. Experience shows that food consumption changes according to changes in income. The findings of this study show that, less than two third (50.5%) of the households reported not to eat meat in a week. About nineteen percent reported to have eaten meat once or two days in a week and very few (9.1%) respondents reported to eat meat on three days in a week.

Non-adopters (60%) did not eat meat in a week, the percentage was high compared to adopters (46.6%), this may be explained that adopters (53.5%) are likely to eat meat than non adopters (39.5%) once to four times in a week. The reason may be due to the sale of

sweet potato, money earned may be used to purchase meat for the household as it was shown that high percentage was for household purchase (Table.16). However, the chi square result show insignificant differences (P>0.05) in the number of days a household ate meat between the household types, that is, adopters and non-adopters.

However, majority (93%) of respondents reported to have eaten fish three to seven days in a week before this survey. Of these (46:8%) ate fish in the whole week. Very few (2.2%) households did not eat fish in a whole week. The chi-square result does not show any statistical relationship (P>0.05) between the reported days of eating fish as superior food and the type of the household. One can conclude that fish was highly consumed superior food in the surveyed area compared to meat; this may be attributed by the price difference when compared to meat. Meat was mentioned to be very expensive in all surveyed zones, Zanzibar was even more serious because had to import meat from the mainland.

4.7.9 Classification of food types eaten in the household

Within a household, not all kinds of food were regarded the same, despite of their nutritive value. During the survey, respondents were requested to give their perception on food crops grown in their households. Based on the criteria of preference, foods that were highly preferred by the household members were classified as superior foods and those less preferred were classified as inferior foods in the surveyed household (Table 19). The researcher had to probe more on the criteria used by respondents for their classification. It was noted that the most preferred food type classified superior was the type which when cooked everybody was happy in the household, normally it was expensive compared to

sweet potato and thus, not consumed all the time. The less preferred type of food was that type cooked several time at home, to others in the household has become too monotonous, cheaper even if one want to buy can afford.

Table 21: Highly preferred food items in surveyed Zones

	Eastern zone (n=60)		Lake zone (n=66)		Zanzibar (n=60)		Total (n=186)	
Food item	No.	%	No.	%	No.	%	No.	%
Rice[a] (boiled/fried)	37	45.0	21	31.8	48	80.0	96	51.6
Maize ugali[a]	33	55.0	19	28.8	3	5.0	55	29.6
Cooking banana/plantains[ab]	-	-	21	31.8	9	15.0	30	16.1
Sorghum ugali[c]	-	-	1	1.5	-	-	1	0.5
Sweet potato[c] (boiled/fried)	-	-	1	1.5	-	-	1	0.5
Cassava[c] (ugali/boiled)	-	-	1	1.5	-	-	1	0.5
Others[c]	-	-	2	3.0	-	-	2	1.1

Note: - = Not mentioned

[a] = More preferred foods

[c] = Less preferred foods

[b] = Bananas are highly consumed in Kagera region as staple food.

Results revealed that majority (51.6%) of household members prefer rice in all zones, about quarter of respondents (29.6%) also prefer *ugali* particularly in Mwanza and Eastern zone and few respondents (16.1%) in Kagera and Unguja-Zanzibar prefer bananas/plantains. Less preferred foods identified were, sorghum, sweet potato, cassava and others (yams and coco yams). In spite of the combination of desirable traits, which

the sweet potato possesses, its use has declined in many countries. Similarly, Woolfe, (1992) reported that, the low status accorded both roots and vines are due to their image as a subsistence crop, 'a poor man's food' or something to be eaten only in times of dire need such as famine or war may have been a limiting factor in their exploitation as foods of high quality.

Table 22: Comparison of most preferred food items

	Adopters		Non adopters		Total		χ^2
Food item	No.	%	No.	%	No.	%	
Rice (boiled/fried)	67	51.1	28	50.9	95	51.1	0.00ns
Maize ugali	40	30.5	15	27.3	55	29.6	0.15ns
Cooking banana/plantains	20	15.3	8	14.5	28	15.1	0.02ns
Sorghum ugali	3	2.3	4	7.3	7	3.8	0.82ns
Sweet potato (boiled/fried)	0	0	1	1.8	1	0.5	2.40ns
Cassava (ugali/boiled)	1	0.8	0	0	1	0.5	0.42ns
Others	2	1.5	3	5.5	5	2.7	0.40ns

Note: ns not significant

When the most preferred food (cereals and roots) were compared in terms of adopters and non-adopters in percentages slightly differences were shown, the adopters consumed more of preferred food compared to the non-adopters. Statistically there were no significant difference ($P>0.05$) in consumption of more preferred and less preferred foods between adopters and non-adopters (Table 22). This may be due to the fact that all households would like to consume the most desired food thus fight to fulfil the goal, however the adopters may be poor than the non adopters but have improved their livelihood due to adoption of ISPV of which they sale to buy desired food type. The mentioned alternative foods to superior food types were the consumption of sweet potato and cassava were less

preferred hence, classified as inferior food. However, the later were the most consumed root crops in most households because could not afford to buy the most preferred food in their households.

4.7.10 Sweet potato processing, storage and utilization

All zones were found to produce sweet potato for food and for income. Fresh sweet potato roots are more preferred by both producers and consumers Kapinga *et al.*, (1995) and Ndunguru, (2003) reported that processing is highly carried out in the Lake Zone particularly in Mwanza and Shinyanga. This study observed that, processing is done when there is surplus to avoid food loss because sweet potatoes are very perishable. When the dry season sets in, weevils start to proliferate. To keep the sweet potato roots from being destroyed farmers' harvest whatever is left in their fields. This surplus can tide them over during the long dry season if it can be kept from spoiling. Processing was very useful in off-season especially during land preparation when food shortage is high, sometimes used as a staple food.

Table 23: Sweet potato processing and sweet potato products by respondents

	Adopters		Non adopters		Total		
Processing sweet potato	No.	%	No.	%	No.	%	χ^2
Yes	30	22.9	1	1.8	31	16.7	12.40*
No	101	77.1	54	98.2	155	83.3	
Sweet potato products							
Yes	24	18.3	Na	Na	24	12.9	11.60*
No	107	81.7	55	100	162	87.1	

Note: * Statistical significant at 0.05 probability level

During the survey, majority (83.3%) of the respondents reported not to process sweet potato mainly in Eastern zone, Zanzibar and part of Lake Zone (Kagera region). It was also revealed that processing is only done in Mwanza in the Lake zone. A few (16.7%) of respondents were found to process sweet potato into chips, which are normally dried under direct sun, locally called *michembe* or *matobolwa*. Processed sweet potato chips are very important for food security during land preparation when there is food shortage. Sweet potato chips can be stored for more than six months when well dried and kept in the storing sacks called "sandarus" or "vege". These packing materials are soaked in salt solution and dried well prior to storage. Nevertheless, very few (1.8%) non-adopters were found to process sweet potato roots to dried chips. There are several studies conducted in the Lake Zone, which has also reported on sweet potato processing (Hart, 1991; Kapinga *et al.*, 1995; Ndunguru *et al.*, 2003 and TAHEA 2004). However, sweet potato processing in the other surveyed Zones were not mentioned and when the respondents were asked reason of not processing they reported to have lack of post-harvest and diversified utilization technologies.

For Mwasonge village, out of 35 respondents 31 (88%) were processing *michembe* or *matobolwa* out of these 24 (68.6%) make sweet potato products. Farmers in the Lake zone revealed that the white-fleshed roots are more appreciated in processing. Of these respondents, (12.9%) were found to diversify sweet potato utilization. Results in (Table 23) showed that, sweet potato processing to various products such as *maandazi*, cakes, chapatti, doughnuts; mixing wheat and sweet potato flour makes breads.

Common utilization of sweet potato was reported to be boiling, mixed with other roots (yams and coco yam) and accompanied with tea or vegetables in Kiilima-Bukoba. Boiling of fresh or dried chips accompanied with yoghurt and roasted groundnuts was common in Mwasonge-Mwanza. In the Eastern zone the roots are boiled in water or coconut milk. Sweet potato chips were found to be common in Dar es Salaam city known as "chips dume". In Zanzibar utilization was more diversified, where sweet potato was boiled in coconut milk, or mixed with unripe pawpaw, spices, sugar/salt or with ripe bananas in coconut milk, also as fried chips and porridge.

Storage of fresh sweet potato was reported to be mainly in-ground storage. Mitakawani village (Zanzibar) carry out harvesting in piecemeal and practice in-ground storage. In Donge kipange village (Zanzibar) harvesting is done at once if there is a customer. In the Lake zone piecemeal harvest is highly carried out in Kiilima village and in-ground storage was used. This is possible may be due to enough moist in soils according to the nature of the place however, in dry spell they complain of weevil infestation. In Mwanza harvesting has been reported be done at once for sale or processing into sweet potato dried chips, leaves the field open for other crops. Weevil infestation has been reported to be very high, probably, because of dried soils.

4.7.11 Production trend of ISPV

Farmers in the surveyed zones were asked to give their views on the general trend of improved sweet potato to the local varieties over the past four years. Majority (60.2%) of respondents revealed that ISPV production is increasing as compared to local cultivars.

Few (17.7%) of respondents (Table 24) reported that, production of ISPV was more less the same when compared to local cultivars.

Table 24: Farmer's perception on ISPV production in surveyed zones

	Adopters (n=131)		Non-adopters (n=55)		Total (n=186)		
Level of production	No.	%	No.	%	No.	%	χ^2
Increasing	85	64.9	27	49.1	112	60.2	4.03*
Decreasing	25	19.1	7	12.7	32	17.2	1.10ns
No change	20	15.3	13	23.6	33	17.7	1.90ns
Uncertain	1	0.8	8	14.5	9	4.8	15.97*

Note: ns= Non-significant

* =Statistically significant at 0.05 probability level

Whilst, few (17.2%) respondents stated that production was decreasing. Nevertheless, very few (4.8%) respondents were uncertain, had nothing to say on production trend. Production of ISPV was found to increase in Zanzibar (63.3%), followed by Eastern zone (53.3%) and lastly Lake Zone (37.5%) (Appendix 3i). The reason may be due to commercial production at Donge kipange village (Unguja) where farmers also make timing of the holy Month of Ramadhan to earn income from sweet potato production. Eastern zone and part of Lake Zone particularly in Mwanza, was noted to be on transition from subsistence farming to commercial production.

The study conducted by Kapinga *et al.*, (1995) in Tanzania reported that, sweet potato production is increasing (58%) of respondents reported in Eastern, Lake, Central, Southern and Southern Highlands Zones. Some (16%) of the respondents reported constant trend of production and 26% of respondents reported decreasing sweet potato production. When compared to the present study the same trend was noted however constant production was

high with minimised decreasing production trend. Chi-square result showed to have high statistically significant difference ($P<0.05$) in ISPV production trend when compared to local cultivars. The null hypothesis, which states that, there is no significant difference in production trends between improved and local cultivars in Tanzania, was rejected however, the alternative hypothesis was accepted. Which states that: there is significant difference in production trend between ISPV and local cultivars in Eastern, Lake and Zanzibar Zones of Tanzania.

4.7.12 Livelihoods factors linked to sweet potato production

4.7.12.1 Natural capital

a) Land availability and farm size

In this study, respondents were requested to report on the amount of land owned (Table 25). Frequency and percentage distribution of the household's land ownership by hectares was given. Results showed that, majority (40.9%) of the households owned between 1.1-2.0 hectares.

These were followed by those who owned less than one hectare and a few (12.4%) owned 2.1-3 hectares and very few (7.5%) above five hectares. This study revealed that, adopters (62.6%) own more land between 1.1- 3 hectares and above compared to non adopters (56.4%). More of non-adopters (43.6%) own less than one hectares compared to their counterparts who were few (37.4%). Such an observation implies that size of land is an important factors that influences adoption or diffusion of improved sweet potato variety.

Table 25: Household land ownership

Land ownership (ha)	Adopters (n=131)		Non-adopters (n=55)		Total (n=186)		χ^2
	No.	%	No.	%	No.	%	
< 1	49	37.4	24	43.6	73	39.2	-0.07ns
1.1-2	54	41.2	22	40	76	40.9	
2.1-3	17	13	6	10.9	23	12.4	
> 3	11	8.4	3	5.5	14	7.5	

It can therefore be argued that small size of land per household could have been one among the factors, which hindered the adoption of improved sweet potato in Tanzania. A study carried out in Uganda by Hakiza *et al.*, (2000) reported that small size of land per household was one of the factors, which hindered adoption of improved sweet potato in Uganda.

b) Importance of water and trees on sweet potato production

Sweet potato crop is mainly rain fed crop. In the surveyed zones water was found to be useful for domestic matters. Farmers in Mwasonge village (Mwanza) reported to carry out irrigation in very small scale. Sweet potato in Mwasonge village was found to be grown on upland during rain season and in lowlands on dry spell. Lowland cultivation was found along the river Nyanholongo and on the Lake Victoria shore. Other surveyed villages did not report on irrigation as far as sweet potato production is concerned.

However, the lowlands were found to be very useful for vines production in most of villages surveyed. Areas such as: swampy areas, areas along rivers and lakes used to keep vines as planting materials (nurseries of sweet potato). Similarly, Kapinga *et al.*, (1995) found that, planting materials are obtained from seed nurseries maintained during the dry season along riverbeds or wet spots. Other source of planting material was reported as

neighbours, neighbouring villages and some vines were purchased (especially in Mwanza). Lack of access to ISPV vines may influence adoption negatively and hence food insecurity. In places where swampy areas, and other wet areas were scarce trees were found to be very important livelihood asset for sweet potato vine multiplication and preservation until planting time arrives. Most nurseries were found to be made under coconut, mango and cashew nut trees in Eastern zone, under coconut and clove trees in Zanzibar and in the Lake Zone at low-lands as explained before and in banana fields particularly in Kagera region. Kapinga *et al.*, (1995) found that sweet potato is grown under shade of young perennials such as coconut, pawpaw, and plantain/banana and tree crops such as mango trees this findings conforms to this study.

4.7.12.2 Physical capital

Physical capital refers to the assets bought into the existence of economic production processes.

a) Farm implements

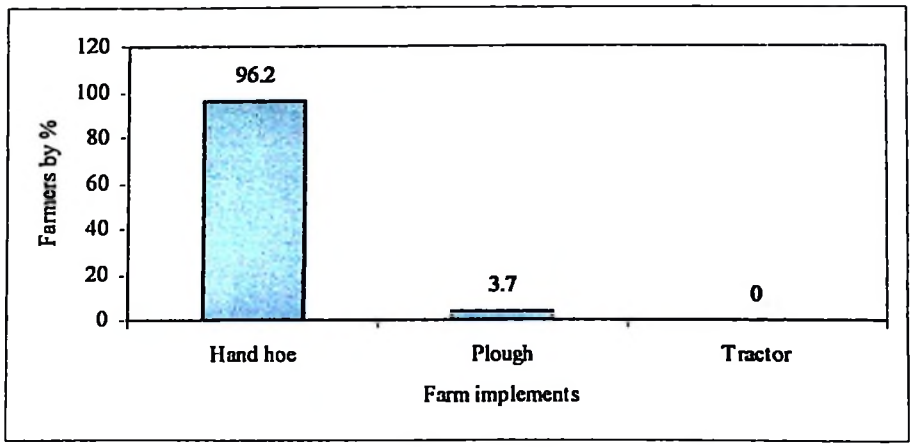


Figure 7. Farm implements used in the surveyed zones

Majority of the farmers were found to use hand hoe, very few households reported to use draft animals, but no one ever used a tractor in sweet potato production (Fig. 7). This result may have negative impact on farm expansion resulting to low adoption of the technology. Respondents reported to use drought animals were found in Mwasonge village (Mwanza region).

b) Soil fertility improvement

Most farmers in the surveyed area were found to grow sweet potato in ridges in which crop residues, weeds and other organic matters were incorporated into soils during land preparation. Ridges set across hills prevent soil erosion and by organic matter incorporated soil fertility were improved. Use of farmyard manure and inorganic fertilizers was reported, soil fertility improved. Sweet potato varieties with high biomass were reported to improve soil fertility (example, *Ukerewe, Gairo, Mbega, Matako mapana, Pananzala).* The crop was said to be friendly to the environmental conditions.

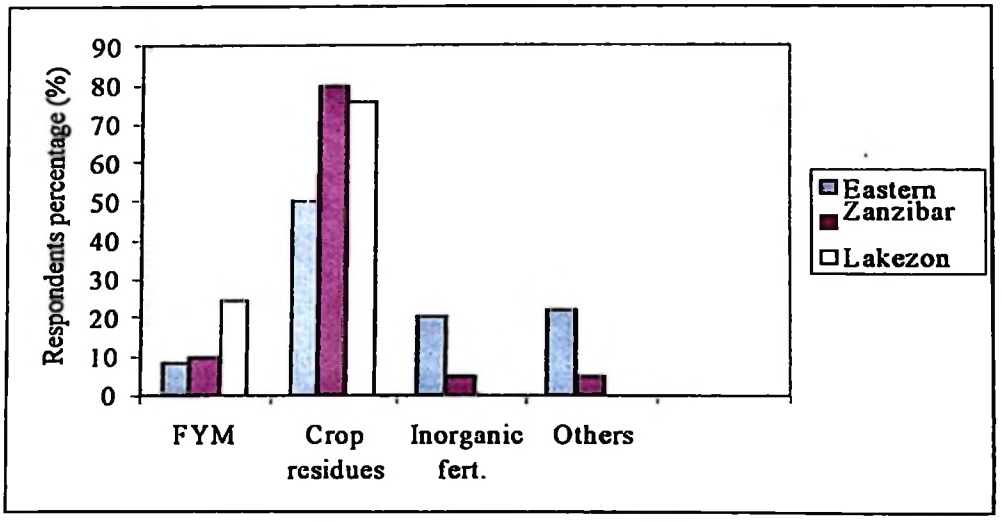


Figure 9 Soil management and improvement

It was revealed that, respondents who have used fertilizers in their sweet potato farms (60.9%) were male and (39.1%) were female farmers. Of these, Eastern zone was leading, followed by Lake Zone and lastly Zanzibar. More than one third (34.4%) of the respondents had used organic and inorganic fertilizers in sweet potato production. Use of fertilizers may be attributed by the crop being on transition from subsistence to commercial in some areas as explained before.

Chanika village (Dar es Salaam) was leading in use of organic and inorganic fertilizers. About one third (33.3%) of respondents reported to incorporate crop residues with soils, few (16.7%) of respondents used fertilizers, very few (6.7%) of the respondent used farm yard manure. In Mwasonge village (Mwanza) about 45.7% of the respondents used farm yard manure and very few (2.8%) of respondents used composite manure whilst the rest who were majority used crop residues and weeds which were incorporated with soil.

In Donge-kipange (Unguja) (12.1%) respondents reported to use farmyard manure, few (9.1%) respondents reported to use inorganic fertilizers and crop residues. Chanika and Donge-kipange villages were found to use inorganic fertilizers in all villages surveyed. The identified inorganic fertilizers were Calcium Ammonium Nitrate (CAN) and Nitrogen Phosphorus and Potassium (NPK). However, Kiilima village in Kagera region do not use organic and inorganic fertilizer almost all households used crop residues in their sweet potato plots. This may be due to the poor market for sweet potato in the area.

Results on sweet potato sales prove the assumption that; respondents who reported to apply fertilizers are those on transition commercial production for high yield. Expectation of good returns motivates farmers to produce more by using improved varieties as well as

expanding their fields. However, farmers reported that, sweet potato do not normally require high levels of input Woolfe, (1992) reported that, sweet potato do not need much input can be grown in marginal land.

c) Communication

Market information contributes a lot to crop production. Even though, market information was a major constraint in all villages-surveyed. Farmers were just producing without knowing market forces. Roads were passable in the surveyed villages except for Mwasonge village (Mwanza) the road used by farmers as a shortcut to sweet potato selling centre at Mkolani area had a big river with no bridge which hinders communication.

Unlike coffee, cotton, cloves, sisal and other cash crops, the marketing of sweet potato is not institutionally; private traders handle large proportion through the open market. The individual traders buy sweet potato from farmers in the village and sell them in the urban market. Due to this system, prices of sweet potato roots are mainly determined by forces of demand and supply in the market. About 50.7% respondents reported to sale their sweet potato at (farm gate price) home. About a quarter (20.4%) sold in rural open market and at the town centre and very few (8.5%) sold in the village-trading centre (Appendix 3j). It was revealed that there were no significant difference ($P>0.05$) between adopters and non-adopters on place of selling. All respondents sold in same places.

4.7.12.3 Human capital

a) Education and knowledge on sweet potato production and processing

Few respondents in Mwasonge village were reported to process sweet potato. The processors were asked to mention the source of technology, which was noted to be indigenous technology system (ITS), which has been improved by researchers, and value added to diversify utilization. Most of the improved technology was disseminated by organisations (69.6%), researchers working with farmers on testing and evaluation (26.1%) and finally by neighbours and friends (4.3%) (Table 26).

Table 26: Source of improved post-harvest technology

	Adopters who process sweet potato	
Source	No.	%
Research	6	26.1
Organisation	16	69.6
Neighbours/friends	1	4.3

During PRA it was noted that, in the Eastern zone processing of sweet potato is difficult. The Sukuma migrants tried to use their ITS and experience to process sweet potato roots to dried chips for storage, but did not succeed. "Sweet potato roots are difficult to dry in sun as chips in Chanika village, because instead of drying the chips gets rot" (personal communication, Mahungija, 2004), the same was reported in Matimbwa village in the Eastern zone, rotting might be attributed to high humidity in the coast areas. This is a challenge as far as post-harvest technology is concerned, however more research need to be done.

b) Extension service

Extension service was considered as one of the important factors, which may affect adoption of ISPV for food security. This study (Table 27) has some data on contact and frequency of contact for adopters and non-adopters.

Table 27: Extension service contacts and frequency to farmers

Extension service	Adopters (n=131)		Non Adopters (n=55)		Total (n=186)		χ^2
	No.	%	No.	%	No.	%	
Had contact	91	69.5	24	43.6	115	61.8	
Had no contact	40	30.5	31	56.4	71	38.2	10.95*
Visit frequency							
Regularly	30	22.9	6	10.9	36	19.4	3.20ns
Few times	57	43.5	16	29.1	73	39.2	3.37ns
Very seldom	8	6.1	1	1.8	9	4.8	1.55ns
No visit	36	27.5	32	58.2	68	36.6	15.74*

Note: ns not statically significant

*Statistical significant at 0.05 probability level

It was reported that, two third (61.8%) of respondents had contact with their extension worker. Of these, about one third (39.2%) of respondents were visited at few times, few (19.4%) of them were visited regularly and very few (4.8%) of respondents were visited very seldom; whilst the rest (36.6%) of the respondents had no contact at all with extension worker. Reasons for few visits were unavailability of extension staff, as reported by respondents (19.9%), few (18.3%) of the respondents reported that the Village Extension Officer (VEO) had high workload, however (11.8%) respondents had no time for extension worker contact, and about half of the respondents (50%) were uncertain.

However, adopters who reported to have contact with extension worker were many (69.5%) compared to their counterpart who was only (43.6%). The chi-square results revealed a statistically significant different between adopters and non-adopters ($P<0.05$). This result proves that contact with extension worker may influence adoption. Rutatora and Matee (2001) reported that, farmers' contact with extension staff increases the probability of adopting the introduced technology. The reason is that extension services create awareness on the availability and importance of new innovation to economic development of smallholder farmers.

c) Main source of farm labour

Majority (97%) of respondents reported that family members carried out most of sweet potato production activities. In almost all villages male were found to participate fully in sweet potato production such as land preparation up to marketing (Table 9). In few cases households, normally those producing in large plots for sales had to hire labour especially on land preparation (ridge making) and sometimes on harvesting.

d) Health status of individual and population

During PRA participants were requested to mention the common diseases in their respective areas. The leading disease was malaria, a deadly one, followed by HIV/AIDS, bilharzias, diarrhoea and worms. These diseases were reported to use most of their resources, which could be useful in sweet potato production; in terms of personnel, money and inputs. A sick person, who is weak, may not work, and normally money is directed to treatment rather than production. Also the care takers fail to go to the farm, hence production is reduced. However, sickness was reported to be associated with crop sales for

medical bill coverings. The situation was mentioned to threat food security at household level. Yet, some village had no or, had only one dispensary or health centre and/or the hospital located far away. One may conclude that, illness may hinder adoption and hence food insecurity.

4.7.12.4 Financial capital

Access to credit

Result shows that, only a few (23.7%) respondents received credit and the majority (76.3%) had never received credit. This was attributed by few credit institutions which results to poor credit accessibility. Reasons given by respondents to lack of credit were; no access to credit (36%), lack of information on credit procedures (22.6%) and fear of large interest (8.1%). However, few respondents reported to have credit, 31.8% and 45.5% for Mitakawani (Zanzibar) and Mwasonge (Mwanza) respectively. Institutions identified to offer credit were TAHEA, HISA, Informal credit, religion institution, FINCA and TGO.

Majority (88.6%) of respondents who received credit were ISPV adopters, with average credit of TShs. 37 251.91 annually, whilst their counterparts had TShs. 13 545.45 annually. However, some of the adopters (64.8%) had never ever received credit. One may conclude that, ISPV was not influenced by credit because even the non-credit members were adopters of ISPV. This may be attributed by the low need of input for sweet potato production. Type of technology may influence adoption, because of the technology characteristics Rogers, (1983) reported on technology characteristics being, relative advantage, compatibility, complexity, trainability and observability. In this case other factors may have been the causative of adoption. Farmers are very rationally and

therefore can adopt the introduced technology if yields will be increased and if the technology is easy to apply and affordable. Adesina and Forson, (1995) reported that, higher yields influences positively and significantly the adoption of technology.

4.7.12.5 Social capital

Social capital refers to social networks and associations in which people participate, help one another in improving their way of living. Share resources and ideas sometimes, form a sort of relationship of trust, such as church economic associations, participated in research trials, extension meetings, NGO/CBO (such as TAHEA, Farmer Research Groups, CARE and World vision Tanzania) in agricultural activities. Those who participate were likely to adopt new innovation due to increased exposure and information network.

4.8 Diffusion and adoption technology

4.8.1 Logit/Probit Regression Analysis on ISPV adoption

This section specifically attempted to statistically confirm the significance of various observations that is, determining factors influencing adoption of ISPV, made previously by running a probit regression analysis. The regression was run on all the households in the survey. The dependent variable was household adopted ISPV, with values of 0 for non-adopters and 1 for adopters (Gujarati, 1995). The probit model that estimated adoption included the following independent variables: age, education, and household size, access to credit, extension services, and participation in research trials, total land owned, sex, market and experience in farming. Probit model estimates that affects adoption of ISPV or non-adoption are displayed (Table 28).

Table 28: Probit model estimates for ISPV adoption

Variables	Coefficient	Chi-square-statistic
Constant	-2.4137	4.21*
Age	-0.0272	0.67ns
Education (dummy)	0.0524	0.03ns
Household size	0.0403	0.18ns
Credit (dummy)	0.3115	0.97ns
Extension service(dummy)	0.4814	4.54*
Participation (dummy)	1.6419	33.28*
Total land owned	-0.0628	0.96ns
Sex (dummy)	-0.5959	2.63ns
Market (dummy)	0.2286	1.84ns
Experience in farming	0.0871	5.05*

Note: ns= non-significant

*= Statistically significant at 0.05 probability level

Extension services, farmer's participation in on-farm research trials, or farmer groups who works with different Non-governmental Organization (NGOs) and Community Based Organization (CBOs) and experience in farming were positive and highly significant ($P<0.05$) factor affecting adoption between adopters and non-adopters. Extension and participation has increased exposure and awareness of households to adopt new sweet potato varieties. Participation on agricultural activities with researchers or NGOs was found to be of high significant at all surveyed zones.

Extension service had high influence on adoption in Mwanza, (Lake Zone) compared to other places. This may be attributed by the activities carried out by Ukiriguru Agricultural Research Institute (ARI) on research trials and Tanzania Home Economics Association (TAHEA) as they employed an extension officer in the village surveyed. It was observed that, farmers participating in research trials, NGO and CBO technological activities with extension worker contact were likely to adopt new innovation than their counterparts. Extension service was found to be very important for sweet potato adoption, Blum (1989)

identified length of time and availability of extension service as factors that influenced adoption of agricultural innovations in Israel. Experience in farming has shown influence on adoption. The experienced respondents may be risk takers; they are eager to try new technology whenever comes. Innovators of new technology are risk takers always! A probit result, revealed adoption of ISPV in the Eastern zone was influenced by sweet potato farming experience. Thus number of years of working in the farm develops technical know how which is useful on adoption. Senkondo *et al.,* (1998), revealed that, adopter of the water-harvest technology were the experienced farmers.

Household size, access to credit, sweet potato market availability and education of the head of the household, were found to be positive but was not statistically significant ($P>0.05$) between adopters and non-adopters. The positive coefficient means education is important in adoption since majority had primary education the level was enough for them to capture technologies from different sources. This may imply that the technology is simple and affordable and its application does not need high education.

Moreover, sweet potato being important due to its drought tolerant the household head is considerate of the crop for his/her household regardless of level of education. The ISPV technology does not need very special treatment or extra labour, labour need was just the same to local cultivars (land preparation, planting, weeding, harvesting, post-harvest and marketing). This implies that, if labour was a constraint in ISPV production the same applies to the local cultivars in the household. Labour was an important factor for a household new technology adoption, the result had positive coefficient estimate meaning that, family labour was used in ISPV production, and the probability of using resources to

hire labour is high. However, ISPV has a relative advantage on labour use over local cultivars in weeding frequency, which may be reduced due to the characteristic of early maturity.

The positive coefficient estimate for credit might be used in sweet potato production to purchase farm inputs and hiring labour. Also the credit may be used as initial capital for petty trade and later on used for sweet potato production. When current market status for ISPV was compared to local sweet potato cultivars did not differ at all as long as the desired root characteristics for consumer preference was met.

About quarter (30.6%) of the respondents, sold their ISPV in the year 2004, and other respondents (47.8%) reported to have sold local cultivars and less than a quarter (20.4%) of respondents sold both ISPV and local cultivars. Very few (1.3%) respondents did not remember type of varieties they sold. Market is an important attribute to adopt a new variety, there were no different because the ISPV have not completely overcome the local cultivars in the market. Market opportunity for sweet potato not well known, there is a need to explore more on this and set a sustainable system on the sweet potato products industry. Few market studies conducted should be summarized into user-friendly materials such as posters, brochures and leaflets as feedback to farmers and traders.

Total land ownership, age and sex of the head of the household, were found to be negative and statistically insignificant ($P>0.05$). This might imply that, for one acre increase in the farm size the probability of a household to adopt ISPV decreases by 6.3%. The negative coefficient estimate might mean that, while land is not planted with ISPV, the household

could have planted local cultivar and hence reducing the probability to adopt ISPV. Results on age might reflect the probability that, the household to produce ISPV was not influenced by age.

This might be due to the fact that, sweet potato is essential for food security and thus, all age groups participate fully to ensure household food security and for marketing. It was revealed that, adoption of ISPV was not influenced by sex. However, both male and female-headed household had participated and adopted equally (Fig. 3) the technology proofing that the sweet potato is important at household level. The negative coefficient estimate might mean that, when a household had not adopted the ISPV probably, had planted local cultivars obviously reducing the probability of household to adopt ISPV.

4.8.2 Root characteristics towards participation in ISPV adoption

Analysis was done to find out the reason for participation on ISPV production. Several attributes which were observable and the inherently factors were analysed and presented in Table 29.

Table 29: Probit model estimates for attributes caused participation

Variables	Coefficient	Chi-square
Intercept/Constant	5.97774	22.6870*
Fresh colour (dummy)	-0.60703	1.1442ns
Root colour (dummy)	-2.79970	6.7457*
Palatability (dummy)	-2.26115	11.6695*
Root size (dummy)	-4.82978	44.3947*
Maturity (dummy)	0.93776	2.3456ns

Note: ns= non-significant

*= Statistically significant at P< 0.05 probability level

The observable attributes were fresh colour, root colour, palatability, root size and maturity; these were attributes which consumers considered for market. Chi-square results revealed that, root skin colour, palatability and root size were negative and highly significant ($P<0.05$) whilst flesh colour was negative and root maturity was positive but, both were insignificant ($P>0.05$) when improved and local cultivars were compared. The inherently attributes were mentioned as yield, drought tolerance, pest and diseases.

One can conclude that for a new variety to be adopted should have a package of mentioned attributes as desired by consumers for home and for marketing. No matter the number of varieties that are released the farmer at the end will have the desired varieties.

4.9 ISPV production constraints compared to local cultivars

When ISPV are compared to local cultivars in productivity their constraints did not differ much, they were more less the same. Activities carried out in local sweet potato field are similar to that of improved ones. The constraints which were common to all zones were: pest and diseases, lack of post-harvest technology and poor farming knowledge, these constraints ranked high of all the listed constraints. Respondents were requested to give their own coping mechanisms on combating the constraints (Table 30).

Majority (93.8%) of respondents reported that, pests and diseases are the most prominent constraints in sweet potato production and ranked first of all the listed production constraints Kapinga *et al.*, (1995) reported that, pests constraint in production ranked the first by 60% respondents. The higher the drought the higher the pest infestation, ISPV was

reported to be more susceptible to pests attack, compared to local cultivars. Farmers were requested to give reasons to why the ISPV are more susceptible to pests attack than local cultivars. By their observation, ISPV usually produce roots at the upper surface compared to local cultivars, which are bit deep in ground. Due to exposure, the roots are easily attacked by sweet potato weevils, mentioned to be the most destructive pest. The attacked roots results to poor quality for consumption and marketing ultimately total loss.

Vermin (wild pigs, monkeys and mole rats) are also pests reported to destroy sweet potato roots and vines. Coping strategy to vermin mentioned was early harvesting where, the harvested roots are consumed at home and excess roots are sold or processed (in Mwanza) and stored for future use or given to relatives and friends. Scaring and trapping of vermin are the common measure used by respondents. Also, the most destructive disease mentioned by respondents was SPVD, which hinders sweet potato adoption. Uprooting of the infected vines was mentioned as a control measure to prevent spreading of the disease in the field.

Majority (85.2%) of the participants in PRA, mentioned lack of post-harvest technology as a constraint in sweetpotato production. This constraint ranked the second, as most participants have no processing knowledge and diversified utilization, which could encourage farmers to produce more. Coping strategies mentioned was none for processing except for Mwanza who carry out processing, for utilization the local methods such as boiling is the common cooking methods.

Poor farming knowledge was also mentioned to hinder sweet potato production, majority (83.3%) of the participants reported to have poor farming technology. This could be attributed by poor extension service of which was reported by about (60%) of the participants as a constraint in sweet potato production. Coping strategy given by participants were the use of ITS and sharing of new technology with migrants.

Poor soil fertility was mentioned by about 78% of the participants and ranked the fourth of all constraints listed. The coping strategy mentioned to this constraint was use of crop residues and weeds incorporated with soils, farmyard manures and inorganic fertilizers (Fig.8). Poor market was also mentioned by about 74% of the participants as unstable and unreliable resulting to constant or low production. Most participants reported that, access to reliable and stable market could motivate farmers to grow more of sweet potato and hence food security and improved household income. Market access was limited by poor communication and poor market information in villages. The coping strategies to this constraint mentioned were selling sweet potato to the available market (at home, village open market, village trading centre and in town) (Appendix 3j).

Majority (71.6%) of respondents reported to have poor access to planting material, of these Eastern Zone (78%), Lake Zone (56.9%) and Zanzibar (79.9%). Kapinga *et al.*, (1995) reported lack of sufficient planting materials as a constraint across all zones, Central (25%), Southern (26%), Southern Highlands (11%), Eastern (29%), Lake (66%) and Northern zones (70%) and the constraint ranked the third of all the constraints listed. When the results were compared the problem of poor access to planting materials is increasing. At least for the Lake Zone an improvement was noted probably because of the

NGO (TAHEA), which is promoting the ISPV to farmers in Mwasonge village (Mwanza), one of the surveyed villages in the Lake Zone. The constraint is most serious at the beginning of the growing season just after the long dry period. Also, no well set sustainable systems for planting material sustainability in all zones and probably for the whole country. Respondents depend on small wet spots where they make nurseries, but they fail to have enough planting material on time, as the nurseries are few and small. Coping strategies mentioned were, to find some vines from friends and neighbours as a quick method to have them in field before the season is off. Selection of the drought tolerant sweet potato varieties was also employed as a long-term process to make sure some vines exist during drought.

Table 30: Sweet potato production constraints by zone/village (%)

Production constraint	Eastern Zone		Lake Zone		Zanzibar Zone		Mean	Rank
	Chanika (n=23)	Matimbwa (n=25)	Mwasonge (n=29)	Kiilima (n=19)	Mitakawani (n=22)	D/kipange (n=20)		
Pest and diseases	83.3	93.3	100.0	100.0	86.0	100.0	93.8	1
No post-harvest technology	100.0	100.0	11.4	100.0	100.0	100.0	85.2	2
Poor knowledge	93.3	90.0	71.4	80.6	74.1	90.9	83.3	3
Poor soils fertility	65	60.0	82.8	100.0	77.8	81.8	77.9	4
Poor marketing	46.7	86.7	48.5	100.0	86.0	39.4	73.6	5
Poor access to planting materials	56.0	100.0	20.3	93.5	75.0	84.8	71.6	6
Poor extension services	100.0	80.0	14.3	51.6	74.1	39.4	59.9	7
Poor access to inputs	97.2	52.0	57.0	0	43.0	100.0	58.2	8
Land scarcity	60	46.7	8.6	38.7	88.9	45.4	48.1	9
Drought	64.3	66.7	0	54.8	37.0	39.4	43.7	10
Shortage of labour	53.3	0	0	35.5	0	72.7	26.9	11
Transport	0	0	100.0	0	0	0	16.7	12
Unavailability of labour saving irrigation tools	0	0	100.0	0	0	0	16.7	12

Note: Respondents mentioned more than one problem

About 48% of the PRA participants reported that low production is somehow attributed by land scarcity. The constraint was more serious in Unguja in average (67.2%) respondents reported to have land shortage compared to mainland only average of (38.5%) reported to have land shortage. Coping strategies mentioned were borrowing land from relatives, neighbours and friends, renting where one has to pay about TShs. 5 000.00 to 10 000.00 per acre to land owners.

Transport and unavailability of labour saving irrigation tools was the least of the listed constraints, only few (12%) participants mentioned it as a constraint. Poor transport was mentioned as a constraint in sweet potato production, since; it hinders transportation of inputs as well as produced sweet potato roots, which are bulky. Sweet potato bulkiness was a headache on transportation. Respondents reported to carry sweet potato roots on their head or by bicycles to the selling places. Irrigation tool requirements, was mentioned in Mwasonge village where farmers cultivate sweet potato in uplands during rain season and in lowlands in dry season. Irrigation facilities/tools were mentioned as a constraint in production. Coping strategy was the use of simple irrigation machine, which is known as "Money maker", the irrigation tool used to make money. However, respondents complained that, the technology is not well applicable in sweet potato production and other horticultural production due to its labour intensive.

4.10 Identified sweet potato varieties preferred for the market

Sweet potato was reported to contribute to household income in almost all villages surveyed. Almost all households consume sweet potato and sale for income. Consumption

and marketing of a product are normally inter-related and tend to influence each other. The two are guided by some preferential qualities of a particular product selected and consumed. Likewise, specific sweet potato varieties must have the qualities preferred by consumers. Farmers had their own criteria on variety selection in the field adhering to consumer preference.

Secondary data revealed that, before sweet potato variety was released as ISPV; evaluation and assessment by researcher and farmers was done on-station and on-farm (Chirimi *et al.*, 2000; Masumba *et al.*, 2002). Thus, farmer selection is a continuous process to get a desired variety with at least most of the desirable characteristics. The outcome of reselection was found to be uptake of the new variety or rejecting those with undesirable characteristics.

However, preferences for sweet potato vary; of course, the most preferred for taste will be good for sale. Apart from specific genetic qualities of a variety other important characteristics for sale includes price and popularity. Thus, identification of sweet potato varieties preferred for market in the growing areas was very crucial. Most preferred sweet potato varieties were the local cultivars in all surveyed zones (Table 31).

Only in the Eastern zone *Ukerewe* and *Sinia* among the varieties released officially, were found to compete. Other varieties (*Simama, Jitihada, Vumilia,* and *Mavuno*) were rejected due to several reasons. Among the reasons for not adopting those varieties was, local cultivars was equal/better than the ISPV. Due to this reasons, farmers tend to continue using their traditional practices on the assumption that they can live comfortably.

Senkondo *et al.*, (1998) reported that, farmer is likely to adopt the technology if the utility of that technology is higher than utility derived from the traditional technology.

A farmer's decision to select a particular sweet potato cultivar or variety is based on a combination of technical and socio-economic factors. Yield, root characteristics, growth duration, plant morphology and agroecological suitability are the primary biophysical concerns. Socio-economic factors, particularly culinary factors, consumer acceptance, and market price for commercial sale are integral. Most farmers weigh the combination of these factors in justifying their varietal selections in relation to their particular situations.

Table31: Sweet potato varieties most preferred for market by zone

		Agronomic		Preferences			Post harvest			
Zone	Variety	Early Maturity	High Yielding quality	Drought Tolerant	Pest & disease tolerant	Good skin colour	High starch content	Palatable	Mean	Rank
Eastern (n=28)	*Pananzala/ Mbutu*	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	1
	Ukerewe†	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	1
	Sinia†	92.8	100.0	57.1	100.0	100.0	100.0	100.0	92.8	3
Lake (n=30)	*Sekondari*	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	1
	Bilagala	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	1
	Polista	98.2	100.0	100.0	100.0	100.0	100.0	100.0	99.7	2
	Kakamega†	63.0	76.3	66.7	60.0	100.0	90.0	100.0	80.8	5
	Tonic	80.0	100.0	76.3	100.0	100.0	100.0	100.0	79.5	6
	Karoti Dsm	100.0	90.0	66.7	60.0	20.0	92.5	100.0	75.6	8
	Resisto†	100.0	83.0	16.7	0	100.0	67.0	100.0	66.7	9
Zanzibar (n=26)	*Shangazi*	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.o	1
	Mkombozi	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	1
	Kizimbani mayai†	100.0	61.5	60.0	65.4	100.0	100.0	100.0	83.8	4
	Bolibo	100.0	23.1	60.0	60.0	100.0	100.0	100.0	77.6	7
	Mdega	100.0	100.0	0	0	100.0	30.8	20.0	50.1	10

Note: † improved sweet potato variety

4.11 Sweet potato varieties identified as unacceptable for market

It was revealed during the survey that, some of the sweet potato varieties were not preferred for market due to different undesirable attributes. Sweet potato with white root skin colour were not preferred by consumers, buyers try to avoid them as possible as they can and rush for purple, red, and cream root skin colour particularly in the Eastern zone and part of the Lake Zone (Mwanza). However, Kagera region (Lake Zone) and Unguja (Zanzibar) colour was not considered as a crucial criteria in the market. Sweet potato varieties with low yield quality and susceptible to drought and pests were likely to be rejected during selection. This was due to the fact that, most farmers prefer high yield varieties with most of important market attribute. Producers consume their sweet potato and sale for income.

During PRA, there was a discussion in Chanika, "We don't need sweet potato varieties which has poor or no market because we are not growing for consumption only but also for sale". For example, sweet potato with white root skin colour is disliked by almost all consumers, as a result buyers (whole sellers and retailers) try to avoid them as possible as they can, and due to this reason we no longer need them. Not only have that, but also sweet potato varieties with very low yield per unit area like Carrot C has been rejected although it is highly palatable with good aroma" (Personal communication, Madembwe, 2004).

Table 32: Sweet potato varieties considered unacceptable for market by zone

Zone	Sweet potato Variety	Undesirable characteristics
Eastern	*Bolibo*	Undesirable round shape
	Matako mapana	Skin colour*, easy bruising, round shape
	Carrot C	Very low yield
	Mavunoƚ	Low yield
	Simamaƚ	Root skin colour*
	Vumiliaƚ	Root skin colour*
Lake	*Carrot Dar es Salaam*	Root skin colour*,
	Zapalloƚ	Unattractive root appearance, very low starch content, susceptible to pests
	Simamaƚ	Root skin colour*
	Vumiliaƚ	Root skin colour*
	Mwanarugeto	Root skin colour*
	Mwanag'hurwa	Root skin colour*
Zanzibar	-	-

Note: - Not mentioned

* White skin colour (is undesirable for market in Eastern and Lake Zone)

† Improved sweet potato varieties

However, some few varieties, which were found to have poor market quality, were useful for food security. Some specification was observed in selecting sweet potato varieties. Sweet potato varieties, which were not desired in the market, were likely to be discarded. Not only ISPV but also local cultivar may be rejected equally if had no desired characteristics.

Shape of sweet potato roots was found to be important factor in adoption, for example *Bolibo* which has round shape variety was rejected in Chanika village since buyers disliked them due to difficulties on packing. Sweet potato roots with white skin colour had poor market particularly in the Eastern zone and Lake Zone (Mwanza). However, some

were found to be useful for food security due to their high yield and processing quality. For example, *Matako mapana* in Eastern zone is not desirable because of its white root skin colour, easily bruising and round shape but it has high ground storability (8-12 months), very high yield, big roots, very high starch content, low sugar content, high tolerant to drought, tolerant to pest and diseases and many vines. The variety was mentioned to be very useful in food security at household level in Matimbwa village. Due to its high tolerance to drought conditions vines never die. Farmers grow the variety mainly for food at home.

Mwanarugeto and *Mwanag'hurwa* are local varieties with good processing quality, high starch content, very tolerant to drought, and high tolerant to pest and diseases. These are highly grown in the Lake zone for food. Others listed sweet potato with white skin mentioned were; *Simama* and *Vumilia* were reported to be rejected by most farmers due to their poor marketability.

Table 33: Sweet potato varieties ranked according to their preference by Zone

Zone	Variety/cultivar	Improved	Local
Eastern	1.*Pananzala/Mbutu*	-	√
	2.*Ukerewe*	√	-
	3. *Simama, Sinia*	√	-
	4. *Matako mapana*	-	√
	5. *Gairo*	-	√
Lake	1. *Polista*	-	√
	2. *Sekondari, Tonik*	-	√
	3.*Carrot Dar Es Salaam*	-	√
	4. *Sinia, Simama, Jitihada*	√	-
	5. *Rushuli, Bilagala*	-	-
Zanzibar	1. *Shangazi*	-	√
	2. *Mkombozi*	-	√
	3. *Kizimani mayai*	√	-
	4. *Mdega*	-	√
	5. *Boribo*	-	√

Note: = Not applicable

√= Accepted

1 = the most preferred

5 = the less preferred

The popular and highly grown sweet potato variety in the Eastern zone was *Pananzala/Mbutu* which is a local cultivar. It ranked first followed by *Ukerewe* (improved variety). *Pananzala* and *Mbutu* is the same cultivar with different names at different location. In Chanika village called *Pananzala* and in Matimbwa village called *Mbutu*. Pananzala means "no food insecurity" it was shortened from "*hapana nzala*" a Sukuma/Nyamwezi word. The source of *Pananzala* was said to be Kigamboni Dar es Salaam, where the cultivar was brought by Sukuma migrant, also in Matimbwa the cultivar was received from *Mbutu* and it was named *Mbutu*, meaning a place but also originated from Sukuma land via Kigamboni.

Nevertheless, *Ukerewe* was highly adopted in the Eastern zone. The *Ukerewe* variety has been nicknamed "Form six" as revealed during PRA. One farmer in Matimbwa; "*Ukerewe* has been nicknamed form six because it has almost all attributes desired by consumers" (Personal communication, Mbega, 2004). Polista, Sekondari and Rushuli were the three leading varieties in the Lake zone. *Shangazi, Mkombozi* and *Kizimbani mayai* in Zanzibar. The popular highly grown local varieties in each zone are shown in Table 33.

4.12 Local cultivar preference

Results (Table 33) revealed that the highly grown and preferred local cultivars in the Eastern zone mentioned by farmers were *Pananzala/Mbutu, Matako mapana* and *Gairo*. In the Lake Zone, *Polista* ranked the first, followed by *Sekondari* and *Tonic* and the third was Carrot Dar es Salaam. In Zanzibar *Shangazi* ranked the first followed by *Mkombozi* and the third was *Mdega*. Most of the local cultivars preferred were found to have most of important attributes. These are, tolerant to pest and diseases, tolerant to drought, high yield quality, and good for food security or market, palatability, early maturing quality and large and good roots.

CHAPTER FIVE

CONCLUSIONS AND RECOMMENDATIONS

1. Both males (41.2%) and females (58.8%) were involved in sweet potato production with the exceptional of Kiilima village (Kagera). Change in gender roles was noted as well as change from subsistence to commercial production in sweet potato.

2. Majority (97.8%) of respondent reported ISPV to have great role in contribution to food security and cash income at the household level. Significant difference ($P<0.05$) between household type in contribution to food security was noted.

3. Adoption of ISPV was found to increase and statistically was significant ($P<0.05$) when compared to local cultivar but in slow pace. Highly adopted ISPV in the Eastern zone are *Ukerewe* and *Simama*, Lake zone are *Jitihada*, *Simama* and *Sinia* and Zanzibar *Kizimbani mayai*, *Sinia* and *Simama*. *Mavuno* and *Simama* were rejected. It sets a challenge to seed production systems in relation to seed quality and provision. Therefore, unless seeds are of the desired quality and distributed on time, farmers will continue to rely on local sources.

4. Sweet potato production trend was found to increase, (60.2%) of respondents reported with significant difference ($P<0.05$), few respondents 17.7% and 17.2% reported constant and decreasing production trend respectively, however there were no increase in acreage.

5. Farm implements used in sweet potato production were hand hoe and limited use of fertilizers due to poor access and high prices. Credit availability was revealed to be very poor, sweet potato market not reliable and market information is lacking.

6. There was no significant statistical difference ($P>0.05$) observed between adopters and non-adopters respondents in terms of personnel characteristics. However significant differences ($P<0.05$) were observed in institutional factors, (extension service and participation) and socio-economic factor (farming experience). However, extension service was limited to non-adopters, this may be due to large size of the operational areas coupled with inadequate logistic support and poor motivation have greatly minimised the farmers' access to extension services.

7. Common constraints in all villages surveyed were poor farming knowledge, poor extension service and pest and diseases in sweet potato production. More identified were land scarcity and poor soils, unreliable sweet potato market and poor access to sweet potato vines, difference when compared to local cultivars was very minimal only for susceptibility to pests and vine access local sweet potatoes cultivars were better off.

8. Most preferred sweet potato varieties for food security and income had several attributes such as early maturity, high yielding quality, drought tolerant, pest and disease tolerant, good skin colour appearance (purple, red or creamy), high starch content, palatability and good processing quality. Unacceptable varieties in market

were; roots with unattractive root skin (white root skin colour) low yield quality, susceptible to diseases and pests and drought, most of these varieties were grown in very low amount most of them rejected by farmers.

9. The highly grown local cultivars in the surveyed villages were *Pananzala/Mbutu and Matako mapana* (in the Eastern zone) *Polista, Sekondari* and *Tonik* (in the Lake zone) *Shangazi, Mkombozi,* and *Mdega* (in Zanzibar). They were found to be famous due to their food security or market quality preferred by consumers at household level and in the market.

5.1 Conclusion and recommendations

5.1.1 Conclusion

This study concludes that ISPV play a greater role in household food security and generate income for their livelihoods. Sweet potato is a secondary staple food in almost all surveyed zones and during food shortage it was used as a staple food. It is dependable, once plant forms edible roots, a hungry family can start eating; an established patch keeps producing despite drought, for months. It saves hunger in drought conditions when grain harvest are poor, it is a "poor man's food". Both men and female were found to plant ISPV in their plots. Adoption of ISPV was statistically significant but only few varieties were adopted the rest were rejected. In the Eastern Zone *Ukerewe* is highly adopted; few farmers had *Simama* and *Sinia* varieties however, *Yumilia, Jitihada* and *mavuno* was rejected. In the Lake Zone *Jitihada, Simama* and *Sinia* are grown in small amount; *Yumilia* and *Mavuno* were completely rejected. In Zanzibar *Kizimbani mayai* is highly

adopted and few of *Sinia* and *Simama*. Rejected varieties means unaccepted, farmers now look for high dry matter content, good eating quality, early maturity, uniformly large roots, attractive shape, colour and good storage quality. Demand for varieties with above-mentioned attributes has not been met.

5.1.2 Recommendations

On the basis of the findings of this study, the following recommendations are made;

1. Encourage participation in agricultural production groups such as farmer research groups (FRGs), extension farmer groups (EFG), non-governmental organisation production groups and different meetings enhances contact to extension worker, and are likely to have advantage of becoming aware of new innovations. Option for farmer organization should be accessed as means of enabling better market access for sweet potato.

2. Research Institutions, extension, NGOs/CBOs like TAHEA, CARE, World vision should promote use of sweet potato recipes in communities like schools, colleges, army, prisons and hospitals where larger quantities of energy are required per feed. Also included to menus in hotels and small restaurants (locally known as *mgahawa* or *mamalishe*). By doing so the market potential will be increased, hence improve nutritional status of consumer as well as livelihood of sweet potato growers as they will win sweet potato market.

3. The ISPV which have been generated, together with the improved production technologies available, have not got to a wider section of the farming community. As more and more varieties are being generated, effort to get them across to the farmers and other end users should be strengthened. Technology uptake pathways and partnership should be increased and utilised. Use of farmers' Field Schools (FFS) and national and international organisation, non-governmental organisations like TAHEA, World Vision and other food security related organisations, together with promotion of private sector involvement in the sweet potato industry should be highly encouraged.

4. Researchers and extension staffs should produce friendly user materials (leaflets, brochures and posters) on standardised new cropping and husbandry practices, diseases and pests control and post-harvest and storage technology. Training of farmers on good sweet potato practices and post-harvest technologies and diversified utilization will increase sweet potato production.

5. In order to ensure that the selected technologies meet the specific needs of a particular clientele at its respective localities, it is important that all the attributes of the innovations are carefully taken care of by the extension staff, research staff and the farmers during the selection, dissemination and adoption. The package should be economically viable accessible and should take account of risks.

6. The future direction of sweet potato breeding must be geared towards selection of varieties adapted to specific growing conditions, and with specific uses. Moreover, it must be farmer-participatory and oriented towards market driven demands.

7. Proposed strategy for sweet potato breeding is to collect, conserve, evaluate and use sweet potato genetic resources; develop new technology to enlarge genetic variation; develop breeding lines with highly general and specific combining abilities, establish efficient selection methods; and develop simple evaluation techniques for quality.

5.2 Areas for future research

The feedback flow process obtained from this study will help researchers to target research towards demand driven priorities

1. Further research is recommended on the proper use of fertilizers (organic and inorganic) with proper recommendation rate for commercial sweet potato production

2. More breeding work should be done on sweet potato varieties which are drought and pest tolerant, with good skin colour for marketing. Make use of local cultivars, which are commonly cultivated and popular in the society for breeding work. Grown in institute's germ plasm, testing for officially release, and use them in cross breeding to have desired quality.

3. Scale up post-harvest technology to sweet potato growing areas in Tanzania. Processing increases shelf life of perishable sweet potato. Food security is as much about processing as it is about production. When dry season sets in, weevils start to proliferate to keep the sweet potato root from being destroyed; researchers should impact proper techniques on processing, packaging, storage and utilisation of sweet potato. Areas with high humidity Coast, Dar es Salaam and Zanzibar should have special attention.

4. Socio-economist should find out the market opportunity for sweet potato within the country and outside the country, which will be reliable and sustainable so that farmers' constraint on poor marketing will be solved.

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APPENDICES

Appendix 1: Questionnaire for Household members

Please, you are kindly asked to provide accurate information on the following questions. All information provided will strictly be treated confidentially.

Region	District	Division	Ward	Village
Name of enumerator		Date	Questionnaire number	

A: Farmers Characteristics

A1. Sex of respondent

1= Male.....

2= Female.....

A2. What is your age (years).....

A3. What is your marital status?

1. Single.....
2. Married.....
3. Divorced.....
4. Widowed.....
5. Others (specify)....

A4. Household composition

How many people live in your household?

Number of people	Adult (>18 years)	Under 18 years	Elderly (60+)

B. Crop Production

B1.How did you acquire the land?.....

B2. What is the number of your farm plots?.....

B3. What is the total acreage of plots?..... , is it enough 1= Yes, 2=No

If not enough where did you get land?

1= borrowing from friends/relative/neighbours

2= Renting

3=Clear bush

4= Inherited

5= Others (specify).....

B4. What is the acreage for sweet potato crop for the past four years/season?.....

B5. What is your main crop?.....

1= Sweet potato, 2= Maize, 3= Rice, 4= Bananas, 5= Cassava, 6= Others (specify).....

B6.Why this particular crop?.....

B7. Apart from main crop mentioned above, what other crops do you cultivate in your farm?

Crop		Plot size (acre)	Yield from last season	1=sold, 2=not sold
1.	Maize	.....	.....	
2.	Bananas	.....	.....	
3.	Sweet potato	.....	.....	
4.	Cassava	.....	.....	
5.	Rice	.....	.....	

B8. Can you estimate the average income from selling the crops mentioned above (refer last season).

1. Below 10,000/=
2. 10,000-50,000/=
3. 50,000-100,000/=
4. 100,000/=-150,000/=
5. 150,000/=-200,000/=
6. Above 200,000/=

B9. What is your main source of labour.

1. Family labour
2. Hired labour
3. Both

B10. Do you use the following in your farm?

(i) Tractor..... 1=Yes, 2=No

(ii) O-plough..... 1=Yes, 2=No

(iii) Hand hoe..... 1=Yes, 2=No

B11. From question B10 above, if using either of the two, do you own

	1=Hire	2=Own	3=Both
Tractor	.....	.....	.....
O-plough	.....	.....	.....

B12. Do you use the following in your sweet potato production?

(i) Fertilizer (chemicals)..... 1=Yes, 2=No

(ii) Pesticides..... 1=Yes, 2=No

(iii) Irrigation..... 1=Yes, 2=No

B13. If using (i) and (ii) above where do you get them

1= Buying from private shops

2= Cooperative union

3= Extension office

4= Others (specify).....

B14. Do you have any access to credit facility? 1=Yes, 2=No (GO to Qn. B17)

B15. If yes where?

1= Bank

2= NGO

3= Informal lender

4= Others (specify).....

B16. If yes how much.....

B17. If no, why .....

1= Not available

2= Not interested

3= Never thought of that

4= High risk/afraid

5= Other reason (specify.....)

B18. Do you have contact with village extension worker?

1=Yes, 2=No

B19. If yes, can you estimate the average number of contact you have had with the VEO per season?

1= Regularly

2= Few times

3= Very seldom

4= No visit

5= Others (specify).....

B20. How do you contact VEO's?.....

1= They visit at their own time

2= Farmer calls them when in need

3= They have specific time/place to meet farmers

4= They are available anyhow

5= Other means (specify).....

B21. What type of advices do you get from VEO's?.....

1= on crop management

2= On land preparations

3= On pest and diseases problems

4= On storage issues

5= On marketing issues

6= Others (specify).....

C. Sweet potato production and adoption of ISPV

C1. Do you anything about ISPV?..... 1=Yes, 2=No

C2. What ISPV do you know?

1= Sinia

2= Vumilia

3= Mavuno

4= Jitihada

5= Simama

6= Ukerewe

7= Others (specify).....

C3. Which of these did you grow in your farm last season.....(use varieties code above)

Variety (code no.)	Plot size	Yield
(i).....	.....	.....
(ii).....	.....	.....
(iii).....	.....	.....
(iv).....	.....	.....

C4. Why did you grow these varieties? (use variety codes above)

Variety (i).....

Variety (ii).....

Variety (iii).....

Variety (iv).....

C5. From whom did you learn about each of the above varieties? (stick to the variety codes)

1 ..... a. fellow farmer

2.....b. Extension worker

3.....c. Mass media

4.....d. Research (you may select more than one)

C6.Where did you get the ISPV seeds/vines for each of the above variety for the last season?.....

1= Own nurseries

2= Private sellers

3= Research

4= Extension worker

5= Friends/relatives/neighbours

6= Others (specify).....

C7. Which technology introduced by the research do you know, say yes or no

(1=yes, 2=No)

1= *Yumilia* sweet potato variety.....

2= *Juhudi* sweet potato variety.....

3=*Mavuno* sweet potato variety.....

4= *Sinia* sweet potato variety.....

5=*Simama* sweet potato variety.....

6=*Ukerewe* sweet potato variety.....

C8. From the answer(s) in (C7), above which one(s) did you use/adopt

(i) Adopted no. 1?..... 1=Yes, 2= No

(ii) Adopted no. 2?.....1=Yes, 2=No

(iii)Adopted no. 3?..... 1=Yes, 2=No

C9. Why did you adopt the above mentioned technologies?

1= High yield

2= Easy managed in the farm

3= Stable to weather changes

4= Good marketability

5= Other reasons (specify).....

C10. How do you compare the technology introduced by the research to those used before?

1= Excellent

2= Very good

3= Satisfactory

4= Bad

5= Very bad

C11.Why?.....

C12. For how many years have grown any of the ISPV?.....

C13. For how long have you been in sweet potato production.....

1= less than a year

2= 1-5 years

3= 5-10 years

4= More than 10 years

C14. Did you stop producing any crop in favour of;

(i). *Vumilia*.....1= Yes, 2=No

(ii). *Sinia*.....1= Yes, 2= No

(iii). *Jitihada*.....1= Yes, 2= No

(iv).*Simama*.....1= Yes, 2= No

(v) *Mavuno*.....1= Yes, 2= No

(vi). *Ukerewe*.....1= Yes, 2=No

C15. If yes, which crop(s) did you switch from.....

1= Maize

2= Local sweet potato cultivars

3= Bananas

4= Rice

5= Cassava

6= Others (specify).....

C16. Did you reduce a plot size of any crop to increase the ISPV crop size? 1=Yes, 2=No

C17. How much land has increased/reduced?.....acre

C18. Why did you grow sweet potato?

1= Family consumption

2= For sale

3= Both

4= Other reason (specify)

C19. Give your views, what is the trend of ISPV production in five years

1= increasing

2= Constant

3= Decreasing

C20. What is the production constraints in ISPV compared to local sweet potato cultivar?

Constraints	Coping strategies

D. Role of sweet potato to food security

D1. How often does your family consume sweet potato?

1= Very often 2= Occasionally 3= Never consumed

D2. State the reason for your choice in D1?.....

D3. Where do you get sweet potato for household consumption?

1= Family farm 2= Market 3= Both (1) and (2)

4= Friends and relatives 5= Other sources (Specify).....

D4. Which variety and how much of each was consumed from the last season? (Use the variety and source of sweet potato codes from C2 and D3 respectively)

Variety	Amount consumed	Source of sweet potato
1.....	.....	.....
2.....	.....	.....
3.....	.....	.....

D5. How would you compare the consumption of sweet potato varieties?

1= Improved varieties from research

2= Local cultivars were consumed more

3= Both were equally consumed

4= None were consumed

D6. State the reason for your choice in D5

1.....

2.....

3.....

D7. What type of dish does your family prefer mostly to have with sweet potato variety?

1= Breakfast 2. Lunch 3. Dinner 4. 1 &2 5. 1 & 3

D8. What is the meal frequency per day in your household?

Adult.....Children under five .....

E. General Questions

E1. Did you process sweet potato in the previous harvest? 1= Yes; 2=No

E2. If yes, from did you learn about the processing technology?

1= Extension worker

2=Fellow farmer

3= Research

4= Others (specify).....

E3. Did you make any confectioneries using sweet potato flour? 1= Yes; 2= No

E4. Did you store any sweet potato in the previous harvest? 1=Yes; 2=No

E5. If yes, which storage method did you use?

1= In-ground storage

2= Pit storage

3= Mound storage

4= Others specify).....

E6. Do you have any comments on the ISPV production? 1= Yes; 2= No

E7. If yes, comment.....

E8.Are you ready to continue/start planting the ISPV and use introduced technologies

1= Yes; 2= No

E9. Why?.....

THANK YOU FOR YOUR COOPERATON!

Appendix 2: Semi-structured Interview guide

Checklist for Focused Group Discussion (FGD)

1. List all type of food crops grown in your village.....
2. Of these rank by importance then carryout pair wise ranking for food and income for at least seven important crops
3. List all sweet potato (local cultivar and improved varieties) grown in this village.
4. For each variety describe its important attribute, field characteristics, preference and consumption, marketing and post-harvest characteristics.
5. Type of cropping system as far as the sweet potato production is concerned.
6. Pie diagrams on income and expenditure of the household income
7. List all the sweet potato production constrains and rank them, give their probe strategies
8. Community health: common diseases, water sources, schools number and dispensary/clinic.
9. Give gender roles in sweet potato production (land preparation, planting, weeding, harvesting, processing, storage and marketing in the household)

Crop combination (pair wise ranking) based on income generation (PRA Results)

Appendix 3a: Food crops for income-Mwasonge village

Crops	Cassava	Maize	Paddy	Sp	Beans	C/pea	g/gram	Score	Rank
1.Cassava		1	3	4	1	1	1	4	3
2.Maize			3	4	2	2	2	3	4
3.Paddy				4	3	3	3	5	2
4.Sweetpotato					4	4	4	6	1
5.Beans						5	5	2	5
6.Cowpea							7	0	7
7.Greengram								1	6

Appendix 3b: Food crops for income-Chanika village

	1	2	3	4	5	6	7	Score	Rank
1. Sweet potato		1	1	4	1	1	1	5	2
2. Cassava			2	4	2	2	2	4	3
3. Cowpea				4	3	3	3	3	4
4. Cucumber/watermelon					4	4	4	6	1
5. Pigeon pea						5	5	2	5
6. Maize							7	0	7
7. Groundnuts								1	6

Appendix 3c: Food crops for income-Matimbwa village

	1	2	3	4	5	6	7	8	9	Score	Rank
1. Cassava		1	1	4	5	1	1	1	1	6	3
2. Sweet potato			3	4	5	6	2	2	2	3	6
3. Paddy				4	5	6	3	3	3	4	5
4. Cashew nuts					5	4	4	4	4	7	2
5. Coconut						5	5	5	5	8	1
6. Mango							6	6	6	5	4
7. Oranges								8	9	0	9
8. Maize									8	2	7
9. Cow/pigeon pea										1	8

Appendix 3d: Food crops for income-Mitakawani village

	1	2	3	4	5	6	7	8	Score	Rank
1. Sweet potato		2	3	1	5	1	1	1	4	4
2. Cassava			3	2	5	2	2	2	5	3
3. Banana				3	5	3	3	3	6	2
4.Yams					5	4	4	4	3	5
5. Coconut						5	5	5	7	1
6. Maize							6	6	2	6
7. Cloves								7	1	7
8. Yams									0	8

Crop combination (pair wise ranking) based on food consumption

(PRA- results)

Appendix 3e: Food crops-Mwasonge village

Crops	1	2	3	4	5	6	7	Score	Rank
1.Cassava		1	1	1	1	1	1	6	1
2.Maize			2	2	2	2	2	5	2
3.Paddy				4	3	3	3	3	4
4.Sweet potato					4	4	4	4	3
5.Beans						6	7	0	7
6.Cowpea							7	1	6
7.Greengram								2	5

Appendix 3f: Food crops-Chanika village

	1	2	3	4	5	6	7	Score	Rank
1. Sweet potato		2	1	1	1	1	1	5	2
2. Cassava			2	2	2	2	2	6	1
3. Cowpea				3	3	3	3	4	3
4 Cucumber/watermelon					5	6	7	0	7
5. Pigeon pea						6	5	2	5
6. Maize							6	3	4
7. Groundnuts								1	6

Appendix 3g: Food crops-Matimbwa village

	1	2	3	4	5	6	7	8	9	Score	Rank
1. Cassava		1	1	1	1	1	1	1	1	8	1
2. Sweet potato			3	2	2	2	2	2	2	6	3
3. Paddy				3	3	3	3	3	3	7	2
4. Cashew nuts					5	6	7	8	9	0	9
5. Coconut						5	5	5	5	5	4
6. Mango							6	6	9	3	6
7. Oranges								8	9	1	8
8. Maize									9	2	7
9. Cow/pigeon pea										4	5

Appendix 3h: Food crops-Mitakawani village

	1	2	3	4	5	6	7	8	Score	Rank
1. Sweet potato		2	3	4	1	1	1	1	4	3
2. Cassava			2	2	2	2	2	2	7	1
3. Banana				3	3	3	3	3	6	2
4.Yams					4	4	4	4	4	3
5. Coconut						6	5	8	1	6
6. Maize							6	8	2	5
7. Cloves								8	0	7
8. Yams									3	4

Appendix 3i: Farmers perception on ISPV production trend by Zone

Production	Eastern zone		Lake zone		Zanzibar		Total		X^2
	No.	%	Na.	%	Na.	%	Na.	%	
Increasing	32	53.3	42	37.5	38	63.3	112	60.2	0.002**
Decreasing	9	15.0	10	16.7	13	19.7	32	17.2	
Constant	10	16.7	12	20.0	11	16.7	33	17.7	
Uncertain	9	15.0	-	-	-	-	9	4.8	

Note: - Not mentioned

*Statistically significant at ($p<0.5$)

Appendix 3j: Market place for sweet potato sales

Place	Adopters (n=135)		Non adopters (n=7)		Total (n=142)		X^2
	No.	%	No.	%	No.	%	
At home	68	50.4	4	57.1	72	50.7	
Village open market	29	21.5	-	-	29	20.4	
Village trading centre	12	8.9	-	-	1	8.5	
Town	26	19.3	42.9	29	29	20.4	0.261ns

Appendix 3k: Sweet potato production by gender (labour division of work)

Activity	Central (N=109)	Lake (N=186)	Northern *	Southern (n=200)	Eastern (N=146)	Overall mean
	F (M)	F (M)	F (M)	F (M)	F (M)	F (M)
Field preparation	60 (40)	52 (48)	50 (50)	50 (50)	50 (0)	52 (48)
Planting	100 (0)	100 (0)	100 (0)	100 (0)	80 (20)	96 (4)
Weeding	100 (0)	90 (10)	60 (40)	80 (20)	50 (50)	76 (24)
Harvesting	80 (20)	100 (0)	100 (0)	100 (0)	50 (50)	86 (14)
Processing	100 (0)	100 (0)	Na (Na)	100 (0)	100 (0)	100 (0)
Storage of processed product	100 (0)	100 (0)	Na (Na)	80 (20)	60 (40)	85 (15)
Rural area marketing	30 (70)	50 (50)	50 (50)	40 (60)	50 (50)	44 (56)

Note: Na= not applicable; F=Female and M=Male

Source: Kapinga *et al.*, 1995.

Appendix 3l: Household headship by Zones

Sex	Eastern Zone (n=60)		Lake Zone (n=66)		Zanzibar Zone (n=60)		Total (n=186)	
	No.	%	No.	%	No.	%	No.	%
Male	57	95	50	75.8	52	86.7	159	85.5
Female	3	5	16	24.2	8	13.3	27	14.5

Appendix 3m: Income from sweet potato sales used to buy other food items

Reasons for sale	**Adopters (n=131)**		**Non adopters (n=55)**		**Total (n=186)**	
	No.	%	No.	%	No.	%
Household expenditure	55	42	19	34.5	74	39.8
Buy other foods items	24	18.3	10	18.2	34	18.3
Earn income	19	14.5	6	10.6	25	13.4
Avoid crop loss	10	8.6	6	10.9	16	8.7

Appendix 3n: Adoption level of official released ISPV in the study area

Variety	Level	Eastern zone		Lake zone		Zanzibar		χ^2
		N	%	N	%	N	%	
Simama	Innovators	1	1.7	5	7.6	13	21.7	25.8*
	Early adopters	-	-	4	6.1	2	3.3	
	Late adopters	3	5.0	1	1.5	2	3.3	
	Early majority	6	10.0	9	13.6	2	3.3	
	Late majority	-	-	2	3.0	-	-	
Jitihada	Innovators	1	1.7	4	6.1	-	-	21.7*
	Early adopters	-	-	4	6.1	-	-	
	Late adopters	1	1.7	1	1.5	-	-	
	Early majority	-	-	4	6.1	-	-	
Vumilia	Innovators	1	1.7	1	1.5	-	-	6.8ns
	Early adopters	1	1.7	2	3.0	-	-	
	Late adopters	1	1.7	-	-	1	1.7	
	Early majority	1	1.7	2	3	-	-	
Mavuno	Innovators	-	-	1	1.5	-	-	2.4ns
	Late adopters	2	3.3	1	1.5	1	1.7	
Ukerewe	Innovators	2	3.3	-	-	-	-	87.4*
	Early adopters	10	16.7	-	-	-	-	
	Late adopters	11	18.3	-	-	-	-	
	Early majority	10	16.7	-	-	-	-	
	Late majority	1	1.7	-	-	-	-	
Kizimban i mayai	Innovators	9	15	-	-	-	-	84.2*
	Early adopters	6	10	-	-	-	-	
	Late adopters	9	15	-	-	-	-	
	Early majority	9	15	-	-	-	-	
Sinia	Innovators	-	-	6	9.1	-	-	18.5*
	Late adopters	1	1.7	3	4.5	1	1.7	
	Early majority	1	1.7	3	4.5	-	-	
	Laggards	-	-	1	0.5	1	1.5	

Note: ns = Not significant

*=Statistically significant at P< 0.05

- = Not Mentioned

Appendix 3o: Probit model estimates for credit participation

Analysis of Maximum Likelihood Estimates

Effect	Parameter	Estimate	Standard Error	Chi-Square	Pr > ChiSq
Intercept	1	-2.4137	1.175b8	4.21	0.0401
age	2	-0.0272	0.0332	0.67	0.4127
educ	3	0.0524	0.2906	0.03	0.8570
hhs	4	0.0403	0.0946	0.18	0.6701
credit	5	0.3115	0.3163	0.97	0.3247
ext	6	0.4814	0.2258	4.54	0.0331
part	7	1.6419	0.2846	33.28	<.0001
tloa	8	-0.0628	0.0643	0.96	0.3283
sex	9	-0.5959	0.3674	2.63	0.1048
mark	10	0.3099	0.2286	1.84	0.1751
exp	11	0.0871	0.0388	5.05	0.0247

Appendix 3p: Analysis of Parameter Estimates

Variable	DF	Estimate	Standard Error	Chi-Square	Pr > ChiSq	Label
Intercept	1	5.97774	1.25501	22.6870	<.0001	Intercept
fresc	1	-0.60703	0.56748	1.1442	0.2848	
rotc	1	-2.07704	0.79970	6.7457	0.0094	
palt	1	-2.26115	0.66191	11.6695	0.0006	
size	1	-4.82978	0.72487	44.3947	<.0001	
matur	1	-0.93776	0.61230	2.3456	0.1256	