2006-2 Working Paper

# The use of orange-fleshed sweetpotato to combat Vitamin A deficiency in Uganda

## A study of varietal preferences, extension strategies and post-harvest utilization

**David Yanggen,** International Potato Center (CIP)
**Stella Nagujja,** International Potato Center (CIP)

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**David Yanggen,** International Potato Center (CIP)*

**Stella Nagujja,** International Potato Center (CIP)

*Currently affiliated to United States Agency for International Development Central African Regional Program for the Environment (USAID/CARPE)

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Comments are invited.

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International Potato Center
Apartado 1558, Lima 12, Peru
cip@cgiar.org • www.cipotato.org

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# Foreword

The International Potato Center (CIP) has been participating in an initiative known as Harvest Plus, which seeks to increase the micronutrient content (vitamin A, Iron, Zinc), in key staple crops in order to alleviate malnutrition. This initiative complements the ongoing CIP-led initiative known as VITAA or Vitamin A for Africa. Both the Harvest Plus and VITAA initiatives are focusing on promoting orange-fleshed sweetpotato (OFSP) rich in beta-carotene (a precursor of vitamin A) as a means of fighting vitamin A deficiency (VAD) in Uganda as well as other countries.

The Harvest Plus Initiative undertook a number of studies to document the situation of sweetpotato in Uganda with a focus on OFSP. These studies examined producer and consumer preferences, extension strategies and post harvest utilization.

Surveys were conducted and data collected from all four of Uganda's regions while considering intervention (communities in which some OFSP promotional activities had taken place) and non-intervention areas. The data was analyzed and the results are presented in this report. Chapter one, the introduction, gives the background on sweetpotato production, vitamin A deficiency prevalence in Uganda and the potential of OFSP in eradicating VAD. Chapter two presents the methodology for this study. This chapter includes the methods used to select study areas, sample communities, data collection and analysis. Results of the study are presented and discussed in chapters three, four and five which respectively cover producer and consumer and preferences, extension and outreach strategies and post harvest utilization. Each of these chapters gives a brief introduction, spells out the objectives of each thematic area and presents and discusses the empirical results based on data collected from the different regions of Uganda. The sixth chapter presents conclusions and recommendations drawn from the study.

# Acknowledgements

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Our special gratitude goes to the members of the survey households and individual farmers (who made up the focus groups) for giving of their time and responding to the questions. We thank the Sub county chiefs from all the sub-counties selected in the different districts and the Local Councils (LC 1) at village level for providing and creating an enabling environment to carry out the survey.

This report and underlying field work and data processing would not have been feasible without the essential and valuable contribution of Patrick Engoru, Patience Byaruhanga, Silver Tumwegamire, Sam Namanda, Richard Bukenya, Annet Birungi and the research assistants Toby Ojok, John Bamuturaki, Daniel Ikaaba, Peter Egonyu, Max Olupot, Jamina Ongodia, Judith Nalukwago, Micheal Kazooba, Andrew Baguma, Charles Alonya, Richard Ogwal and Olive Nakiwu.

Last but not least we gratefully acknowledge the financial support of the Bill and Melinda Gates Foundation, the Danish International Development Assistance (DANIDA), the World Bank, the United States Agency for International Development (USAID) and the Swedish International Development Assistance (SIDA).

Our apologies to contributors to this report who we may have inadvertently omitted recognizing on this page.

# The use of orange-fleshed sweetpotato to combat Vitamin A deficiency in Uganda.
## A study of varietal preferences, extension strategies and post-harvest utilization

## 1. INTRODUCTION
## 1.1. Uganda and Sweetpotato Production
### 1.1.1. Profile of Uganda

**Geographical and demographic information of Uganda**

Uganda is a land-locked country in Eastern Africa, located between 4˚N and 1˚S of the equator and 30˚W and 35˚E of Greenwich. The county has a population of 24,023,000 people of which 50.5% are female and 49.5% are male. A majority of the population (85.4%) lives in rural areas (FAOSTAT Database, 2004). Nearly half of the population (52%) is under the age of 15 years (DHS survey, 2000-2001). Infant mortality rate is 88 per 1,000 births while under-five mortality is estimated at 152 deaths per 1,000 live births. The maternal mortality rate is 505 per 100,000.

**Climate**

Uganda has a favorable climate because of its relatively high altitude. The central, eastern and western regions of the country have two rainy seasons per year, with heavy rains from March to May and light rains between September and December. The level of rainfall decreases towards the north, turning into just one rainy season in a year.

**Administrative units**

Major administrative units are the districts (see appendix 1). The districts are made up of counties, which are further sub-divided into sub-counties.

**Uganda's agricultural systems**

The country is characterized by seven different farming systems (see appendix 2).

**Economy**

The economy is predominantly agricultural with the majority of the population dependent on subsistence farming and light agro-based industries. The country is self sufficient in food, although distribution is uneven. Coffee, tea, and cotton are the major earners of Uganda's foreign exchange.

### 1.1.2. World Sweetpotato Production

Sweetpotato (*Ipomea batatas* (L.) Lam.) is among the world's most important, versatile, and unexploited food crops. With more than 133 million tons in annual production, sweetpotato currently ranks as the fifth most important food crop on a fresh-weight basis in developing countries after rice, wheat, maize and cassava (FAO 2003). Only in the last decade has the crop been the focus of an intense, coordinated, global effort to realize its full potential as a source of food, feed, processed products, and income for millions of small farmers and low-income consumers in Africa, Asia, and Latin America[1].

### 1.1.3. Sweetpotato Production in Uganda

Sweetpotato is one of the most important crops in densely populated Eastern Africa and is a major food staple in Uganda. It is grown throughout the country as a subsistence food crop. A typical household cultivates a sweetpotato plot of just less than one acre and containing on average five different varieties (Bashaasha *et al.*, 1995). The sweetpotato is considered a priority crop and its importance has increased significantly over the years. Originally introduced by missionaries in the early 1900s (Akimanzi, 1982), production has increased from a few gardens to about 480,000 ha (1986-2002) with an annual production of 1.8 million MT and an average annual yield of 4.2 t/ha (PRAPACE, 2003). Figure 1.1 shows the trend of sweetpotato production, area under production and yield between 1986-2002.

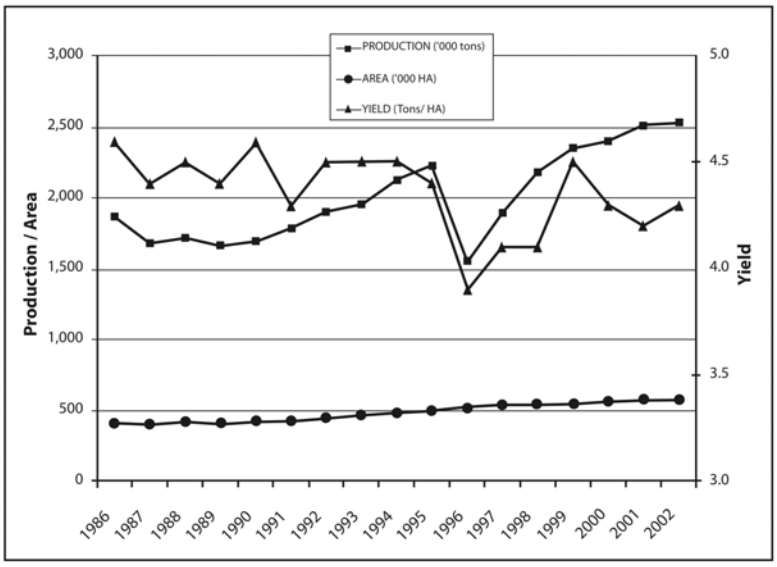



**Figure 1.1** Uganda sweetpotato production, area and yield between 1986-2002.

**Source:** FAOSTAT Database 2004

[1] www.cipotato.org/market/sweetpfacts/swtpfact.htm, 2004

There has been a marked increase in production from 231,000 ha in 1980 to 572,000 ha in 2002 with corresponding outputs of 1.2 million MT and 2.5 million MT respectively (FAOSTAT database 2004). Unfortunately this has mostly been due to increases in land area under sweetpotato production, rather than higher productivity per unit area. Acreage under sweetpotato has increased by about 40% between 1986 and 2002 (PRAPACE, 2003). As area planted continued to expand yields have been stagnating and even declining slightly from an average of 4.5 tons/ha in the period 1986 –1994 to 4.2 tons/ha in the years from 1995-2002.

The average yield of sweetpotato in Uganda of 4.2 (tons/ha) is low compared to 25 t/ha under optimal management, 15t/ha under improved management and 5t/ha under poor management. Cultivation takes place mostly in subsistence systems using indigenous cultivars, with no application of productivity enhancing inputs or technologies such as fertilizers, pesticides or irrigation and faces a high incidence of diseases and pests.

Sweetpotato is grown in all districts of Uganda, however major production areas include northeastern and southwestern regions of Uganda (Hakiza *et al.*, 2000). The major sweetpotato producing districts in Uganda are as follows. In the Eastern region, they include Mbale, Iganga, Kumi, Pallisa and Kamuli. In the Northern region, the districts of Kitgum, Gulu, and Apac are known to be high productivity areas. In the west, Hoima and Masindi are known for high production of sweetpotato while in the central region there are the districts of Mukono and Rakai.

### 1.1.4. Sweetpotato Consumption

Sweetpotato is used for human consumption, as livestock feed, and in industrial processes to make alcohol and starch. Sweetpotato is high in carbohydrates. The orange-flesh varieties also provide vitamins A and C. In addition, the green leaves of the plant can be consumed by both humans and animals providing additional protein, vitamins and minerals.

Sweetpotato is one of the important staple crops in Uganda. FAO Statistics (2004) shows that Uganda is one of the countries with the highest annual per capita sweetpotato consumption in Africa estimated at 82.5 kg. Table 1.1 shows that, next to bananas and cassava, sweetpotato comes in third in the amount of per capita consumption (kg/yr) as well as the amount of kilocalories per person per day provided when compared to other staples.

### 1.1.5. Sweetpotato Varieties in Uganda

Because of the important role Sweetpotato plays in the nutrition, food security and economy of the people (Bashaasha *et al.*, 1995), the Government of Uganda, through the National Agricultural

Research Organization (NARO), has given high priority to research on the crop. The National Sweetpotato Program of NARO has released twelve sweetpotato cultivars, six in 1995 and the other six in 1999 (Mwanga *et. al.* 2004). The six cultivars released in 1995 were Kawogo, Sowola, Tororo 3, Bwanjule, Tanzania and Wagabolige, and the NASPOT series 1 to 6 were released in 1999. New Kawogo, Tanzania and NASPOT 1 have gained importance in local Ugandan markets and in export trade to Europe, especially the UK and the Netherlands. Except for the orange-fleshed NASPOT 5, the remaining 11 cultivars have white or yellow flesh. White- and yellow-fleshed sweetpotato cultivars have little on no beta-carotene content (the precursor for vitamin A) whereas orange-fleshed sweetpotato (OFSP) cultivars have high beta-carotene content.

**Table 1.1.** Major staple utilization in Uganda (1990-2001)

| Staple crop | Amt. produced ('000 MT) | Amt. for feed ('000 MT) | Amt. for seed ('000 MT) | Amt. for processing ('000 MT) | Amt. wasted ('000 MT) | Amt. for food ('000 MT) | Per capita production (kg/person/yr) | Per capita consumption (kg/person/yr) | Per capita calories per day |
|---|---|---|---|---|---|---|---|---|---|
| Maize | 845 | 93 | 17 | 102 | 108 | 561 | 41.2 | 21.4 | 229 |
| Millet | 609 | 61 | 10 | 74 | 43 | 421 | 29.7 | 20.5 | 153 |
| Sorghum | 373 | 38 | 8 | 174 | 38 | 115 | 18.2 | 5.61 | 50 |
| Cassava | 3320 | 1048 | 0 | 0 | 346 | 1926 | 162.0 | 93.9 | 283 |
| Potatoes | 361 | - | 44 | - | 72 | 245 | 17.6 | 11.9 | 23 |
| Sweetpotato | 2048 | - | - | - | 356 | 1,692 | 99.9 | 82.5 | 218 |
| Bananas | 8776 | 2194 | - | 1755 | 979 | 3,848 | 428.3 | 187.7 | 45 |

**Note:** Average population size (1990-2001) = 20,492,500 people
Conversion: 1000kg=1 metric ton
**Source**: FAOSTAT data, 2004[2]

Most of the sweetpotato varieties grown in the country are white-fleshed. Farmers prefer white-fleshed sweetpotato varieties to orange-fleshed sweetpotatoes because they are more resistant to prolonged drought and disease stress, such as sweetpotato virus disease and Alternaria leaf spot and stem blight (*Alternaria* spp). Most of the OFSP are introductions from temperate countries and thus are susceptible to tropical diseases, in particular sweetpotato viruses (SPVD).

Two new and particularly promising OFSP cultivars, "Ejumula" and SPK004 (Kakamega) have high beta-carotene content and have been widely evaluated in Uganda performing well in term of yields and their acceptability by producers, consumers and processors. These varieties were released officially in 2003 (Mwanga *et al.,* 2004).

### 1.1.6. Likely Impact of OFSP on Vitamin A Deficiency (VAD)

During the last decade, substantial efforts have been made to reduce VAD in developing countries. Food fortification, supplementation and dietary education programmes have been

[2] www.faostat.fao.org/faostat/collections?subset=agriculture

undertaken. Emphasis in many countries was initially placed on supplementation programs in the belief that distribution of vitamin capsules could solve the problem quickly. However experience has shown that, although supplementation may be effective in preventing VAD, it must be repeated every six months and is therefore costly. In many countries with poorly developed health and road infrastructure, supplementation can be logistically difficult to implement, and has been principally sustained through continued support of donors (Low *et al.*, 2001).

Orange-fleshed sweetpotato varieties have the potential to provide an inexpensive, year-round source of dietary vitamin A available to poor families in the region. A recent ex ante impact assessment carried out by Low *et al.* (2001), indicates that the OFSP can make a major contribution to alleviating vitamin A malnutrition in Sub-Saharan Africa. A 100g serving (about half a cup full) of boiled roots can supply about 50% of the daily vitamin A requirement of a young child. Weight for weight, current varieties of OFSP contain 20-30 times more beta-carotene than does Golden rice (Ye *et al.*, 2000).

Sweetpotato in Sub-Saharan Africa is increasing in importance largely due to the crop's relatively high productivity across a range of environments, its short cropping season, and its flexibility in planting and harvesting schedules (Ewell, 1993). Sweetpotato is an important source of calories consumed by all age groups but particularly liked by infants, a group particularly vulnerable to VAD (Low *et al.*, 1997). Replacing the white- and yellow-fleshed varieties now grown by farmers with new high beta-carotene cultivars that meet local preferences would benefit an estimated 50 million children under age 6 who are currently at risk (Low *et al.*, 2001).

Sweetpotato, which is a common staple food in about 90% of Ugandan households, can be used as one of those foods to provide the much needed beta-carotene. This can be achieved by promoting the orange-fleshed sweetpotato (OFSP), which has the additional advantage of the beta-carotene being more bio-available compared to other plant sources of beta-carotene (Allen and Gillespie, 2001). According to Mwanga *et al.*, (2004) OFSP can grow in remote areas where numerous families have no access to the vitamin A supplements due to poverty and poor infrastructure or where wars and natural disasters such as floods, landslides, and earthquakes impede the mass distribution of vitamin A capsules. OFSP can thus complement supplementation and fortification initiatives. In particular, OFSP can provide a source of vitamin A that is accessible to isolated, small rural communities, and most important, has the potential to be self-sustaining over time if the varieties are incorporated into farmers' production systems.

Promoting the consumption of OFSP rich in vitamin A seeks to combat VAD thereby improving the health of particularly vulnerable groups such as children and pregnant and lactating women. Improved health can lead to reduced mortality rates as well as save foreign exchange spent on the purchase of vitamin A capsules (Mwanga *et al.*, 2004).

A study carried out by the Medical Research Council of South Africa in 2003 reveled that the vitamin A status of 5-10 year old children improved after consuming about 125g of boiled and mashed beta-carotene rich OFSP for 53 days compared with a group of children fed the same amount of boiled and mashed WFSP devoid of pro-vitamin A caroteniods.

The OFSP contributed significantly to the overall daily vitamin A intake of the children. It contained 12,375 µg beta-carotene (1,031 µg RAE) per 125g serving, which is about 250% of the RDA for 4-8 year old children. The consumption of the beta-carotene-rich OFSP reduced self-reported morbidity in the children, compared to the control group. Fewer children in the intervention group were absent from school and also lost fewer days due to upper respiratory tract-related illness and skin related conditions as compared to those in the control group. Also children in the intervention group were sick less often than those in the control group (Jaarsveld *et al.*, 2003).

## 1.2. Vitamin A Deficiency (VAD) and Related Diseases

Vitamin A is fat-soluble and occurs in two forms, the active (preformed) and the precursor form. The most frequent active form is retinol, which can only be synthesized in animals and humans. The precursor forms known as caroteniods are common in many fruits and vegetables. The most well known caroteniod is beta-carotene, which the human body can convert to retinol. When VA supply is lower than the recommended dietary allowance (RDA), the individual risks suffering from acute and chronic health impairments (Zimmermann and Qaim 2004).

VAD is subdivided into two categories: sub-clinical and clinical VAD. Sub-clinical VAD is usually not associated with immediate symptoms. But, as VA plays an important role in maintaining the integrity of the human immune system, sub-clinical VAD can compromise the immune system leading to high morbidity and mortality, especially among children. Occurrence of measles, diarrhea and other infectious diseases, as well as fatalities from these condition, are significantly higher in VA-deficient groups than in populations with normal VA status (Underwood, 1998). A link has been established between VAD and maternal survival up to two years following delivery (WHO, 2002; West and Darton-Hill, 2001). Clinical VAD involves a variety of ocular manifestations, usually referred to as “xerophthalmia”. Xerophthalmia can be sub-divided into the following

levels according to degree of VAD and medical severity (WHO, 1982): (i) night blindness, (ii) Bigot's spot and (iii) corneal ulceration and corneal scars.

According to the WHO website (www.who.int/vaccines-diseases/en/vitamina/science/sci02.shtml), globally, 3 million children suffer clinical VAD (exhibiting the signs and symptoms of eye damage and xerophthalmia). However, the full magnitude of VAD often remains hidden: an estimated 140-250 million children under five years of age are at risk of sub-clinical VAD, mainly in Asia and Africa. Apart from the eye symptoms, VAD also weakens the immune system, thus increasing the incidence and severity of infectious diseases. For adults the implications can be serious too, especially for pregnant and lactating women. Nearly 600,000 women die from childbirth–related causes each year, many of them complications that could be reduced through better provision of vitamin A (Sommer and West, 1996). The most affected are the poor, whose diets are dominated by less nutritious staple foods due to inadequate purchasing power and limited awareness.

### 1.2.1. Vitamin A Deficiency (VAD) among Ugandan children and women

Vitamin A deficiency is one of the most widespread deficiencies in developing countries. Unfortunately, Uganda is among the 90 countries worldwide that are categorized by the World Health Organization (WHO) as having a public health problem concerning clinical (very severe) and/or sub-clinical (severe) vitamin A deficiency.

The earliest formal survey on VAD prevalence was carried out in Uganda in 1991. The results suggested that VAD was a public-health problem in the country according to World Health Organization (WHO) criteria. Xerophthalmia was diagnosed in 5.38% of the 5,074 children younger than 6 years, 2.52% had night blindness, 1.74% had corneal scars, 1.04% had Bigot's spots, and 0.26% had corneal xerosis (Kawuma and Sserujogi, 1991).

Three years later, a rapid nutrition survey in 37 districts used night blindness as an indicator for VAD and reported deficiencies in all six districts. In 1999, the visiting international assessment team on vitamin A observed that the main source of vitamin A in the Ugandan diet was green leafy vegetables invariably boiled or steamed, with hardly any fat. Animal protein was scarce, limiting bioavailability of all micronutrients. They concluded that more than 50% of the children consumed inadequate vitamin A from their diets and that the risk of VAD was higher in children from rural households (Harvey *et al,* 1999).

The Ugandan Ministry of Health in the 1990's implemented a national protocol for vitamin A supplementation that included supplementing postpartum mothers, administering vitamin A capsules with measles immunization at 9 months, and treating children with protein–energy malnutrition, xerophthalmia, measles, diarrhea, and pneumonia at health facilities and districts. The Ministry has since revised its vitamin A protocol to include biannual supplementation for all children younger than five years. However, there is no well–established system for the distribution of vitamin A capsules. Only a few mothers, primarily those who use health facilities to deliver their babies and those who bring their infants for immunization against tuberculosis, receive the vitamin A capsules available for administration postpartum.

In 1999, vitamin A capsules were successfully given on National Immunization Days in 25 of 49 districts through the Uganda National Extended Programme for Immunization. Vitamin A capsules are supplied by United Nations International Children's Education Fund, the WHO, Lions Norway, and Medical International Health Volunteers. The capsules are dispatched to the districts as parts of the combined packages of Maternal and Child Health services. Despite the efforts made, Uganda is still included in the clinical vitamin A deficiency category because, according to the 2001 Uganda Demographic and health survey, 30% of children and 50% of women have VAD. Figure 1.2 shows the percentage of children and mothers with VAD in the four regions of Uganda.

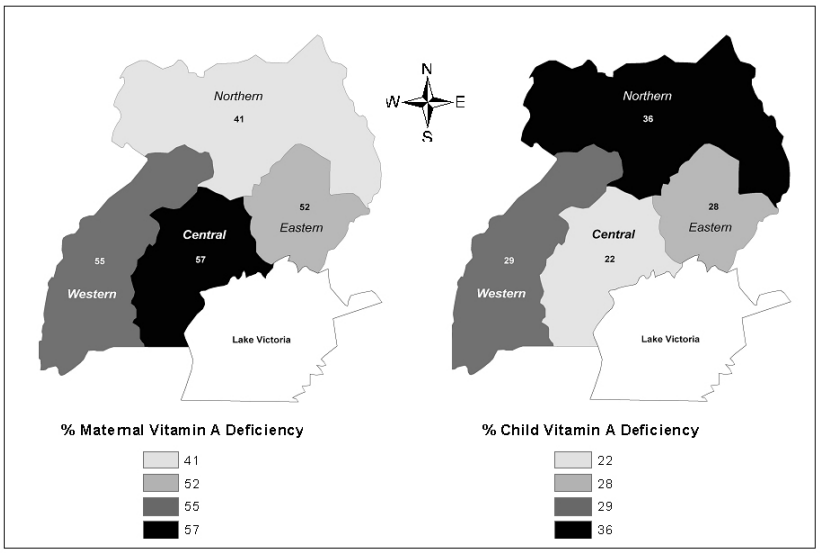



**Figure 1.2** Maps showing percentage Maternal and child VAD in four regions of Uganda.

**Source**: UBOS, 2001

With regard to regional differentials, Figure 1.2 shows that VAD in women is more common in the Central region followed by the Western region. The Eastern and Northern have lower levels of VAD prevalence among women. On the other hand, VAD in children is more common in the

Northern region and Western region than in the Eastern and Central region. These results are likely to be explained by the difference in eating habits of ethnic groups in these areas, but also for the Northern region political insurgencies that have persisted for more than 10 years might have contributed to the observed trend in children.

According to the DHS survey 2000-2001, only 11% of mothers in Uganda receive vitamin A supplementation postpartum. This percentage is higher for urban mothers relative to those living in rural areas. The greater proximity of health facilities providing supplementation in urban centers likely accounts for this difference. Figure 1.3 indicates that rural women are more likely than urban women to be deficient in Vitamin A (53% compared to 45%).

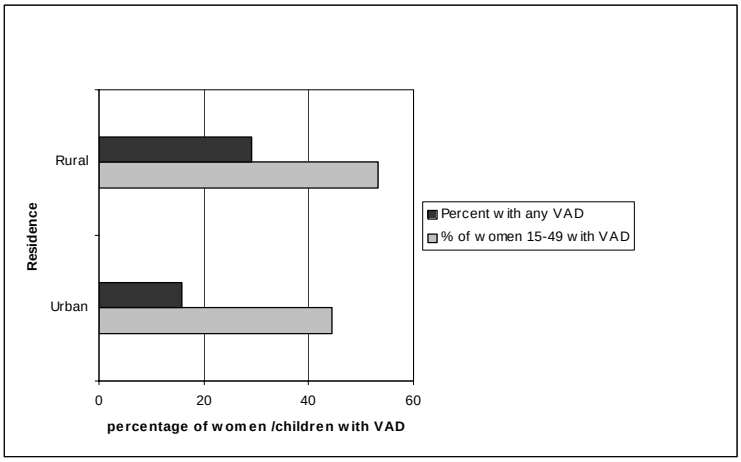



**Figure 1.3** Percentage of mothers and children with VAD by Residence.

**Source**: UBOS, 2001.

## 1.3. Overall Objectives of this Research

As emphasized in this introductory section, VAD constitutes a serious public health problem in Uganda. The potential of OFSP to combat VAD in Uganda is promising given its high content of beta-carotene and the fact that sweetpotato is consumed in most households. The International Potato Center as part of the Harvest Plus and VITAA initiatives therefore decided to undertake the three related studies found in this publication that document the situation of sweetpotato in Uganda with a focus on OFSP. The situation of OFSP is unique in among the crops prioritized by the Harvest Plus Initiative for initial emphasis (wheat, maize, rice, cassava, bean, and sweetpotato) in that it is the only high micronutrient staple already being actively promoted in the field. This research therefore sought to study key aspects of the initial results of these efforts in order to learn from these experiences. The guiding principal in deciding on what aspects of these promotional aspects to focus on was simple: what can we learn that will help make future

efforts at promoting OFSP and other biofortified crops successful. Based on that overarching criteria, the authors of this study decided to analyze the following three aspects of OFSP: i.) Producer and consumer preferences ii.) Extension strategies used for promotion and iii.) Post-harvest utilization and transformation. The results of this research are intended to provide feedback to institutions promoting OFSP in order to help increase the effectiveness of varietal development and diffusion efforts.

## 2. METHODOLOGY

### 2.1 Site Selection Criteria

The field research for these studies was undertaken in all four regions of the country in order to have a broad representation. These included the Northern region, Eastern region, Western region and the Central region. The studies were carried out from December 6-18, 2004.

Selection of survey sites was done purposively to capture the main sweetpotato production areas in different agro-ecologies and regions of Uganda coupled with the prevalence of vitamin A deficiency. A ranking and weighting procedure based on prevalence of VAD and per capita production of sweetpotato was used to select the study sites (districts) (see appendix 4). A second selection criterion was the inclusion of intervention vs. non-intervention areas in each district (areas where farmers have been exposed to OFSP through demonstrations, farm trials, and farmer field schools vs. those where no efforts have been made).

The districts selected were those with high joint scores for both sweetpotato production and the high prevalence rates of VAD. Thus the study areas included:

**Central region:** Rakai, Luwero
**Western region:** Kabale, Hoima
**Northern region:** Apac, Lira
**Eastern region:** Kumi, Soroti

Reconnaissance visits were carried out to identify the specific study communities consisting of sub-counties. Discussions were held with agricultural officers and local leaders in the selected districts who helped provide information on sample selection. The following sub-counties were selected for the study:

| District | Intervention community (Sub-counties) | Non-Intervention community (Sub-counties) |
|---|---|---|
| 1. Luwero | Katikamu | Makulibita |
| 2. Hoima | Bugambe | Buhanika |
| 3. Kabale | Maziba | Rwamucucu |
| 4. Rakai | Lwankoni | Kasasa |
| 5. Kumi | Kumi | Atutur |
| 6. Soroti | Kyere | Asuret |
| 7. Lira | Adekoowok | Kwera |
| 8. Apac | Ayer | Chegere |

## 2.2 Sampling Frame

For the purpose of the survey, the enumeration areas (districts) were categorized into two strata. One strata comprised a sub-county where there had been no interventions made to introduce the OFSP and the other were there had been intervention efforts to introduce OFSP. In each district 2 communities were purposively selected. A total of 16 communities were thus studied.

The population targeted by the survey in each community included:

1. The extension worker who provides services to the community.
2. Representatives of two local organizations promoting OFSP
3. The District Agricultural Officer or the District Production Officer
4. The Sub-County Chief
5. Representatives of 10 households and caregivers
6. 2 focus groups, generally one for women and one for men with some mixed groups
7. One health worker

## 2.3 Methods of Data Collection

### 2.3.1 Primary Data Collection

Data were collected using open ended and structured questionnaires for the different individuals targeted by the survey. Different questionnaires were formulated and these included:

- Sweetpotato household questionnaire
- Focus group questionnaire
- Sweetpotato trader questionnaire
- Health worker questionnaire
- Extension agent questionnaire
- Sub-county chief questionnaire
- 24-hour recall questionnaire
- District Agricultural Officer questionnaire
- Processor's questionnaire

### 2.3.2 Focus Group Discussions

Adults from rural households were interviewed in focus groups that included women only groups, men only groups and mixed groups. Focus group interviews were held with at least two groups in each community and included 5-8 participants.

### 2.3.3 Individual Interviews

Information was collected principally through survey interviews. Individual farmer interviews were carried out by each of the enumerators who were fluent in the local language of each district. Individual interviews were used to collect information from key informants involved in OFSP activities such as individuals from community based organizations (CBOs), non-governmental organizations (NGOs), processors, traders, extension officers, district agricultural officers, farm households, care givers and health workers.

### 2.3.4 Study Team

The survey team was divided into two groups.

- Group 1 collected data from the Northern and Eastern regions
- Group 2 collected data from the Western and Central regions.

## 2.4 Analytical Methods

The research relied principally on analysis using descriptive statistics. The data were analyzed using Excel and SPSS data packages and are presented as percentages, frequencies and averages.

# 3. AN EVALUATION OF PRODUCER AND CONSUMER PREFERENCES FOR ORANGE-FLESHED SWEETPOTATO (OFSP)

## 3.1 Introduction

This section examines the preferred consumption and production characteristics of orange-fleshed sweetpotato (OFSP). Sweetpotato is produced in all districts of Uganda, is consumed by virtually all households and constitutes the third largest source of food by weight and in terms of calories. However, the vast majority of sweetpotato in Uganda is either white or yellow-fleshed and low in beta-carotene. One of the key factors that will determine the successful uptake of OFSP is whether or not the new orange-fleshed varieties that are introduced have the desired production and consumption characteristics. In particular, OFSP must be attractive relative to the white and yellow-fleshed varieties the farmers currently produce.

The introduction of OFSP into Uganda is still relatively recent[3]. Of the 14 sweetpotato varieties released by the national sweetpotato program, NARO, only two OFSP varieties Ejumula and SPK004 (Kakamega) have been promoted widely with these efforts beginning only in 2002. One previously introduced OFSP variety, NASPOT 5 introduced in 1999, did not take up well because of yield instability across locations.

The objective of this section is therefore to provide feedback to the institutions promoting OFSP and in particular to breeders working on improving the characteristics of OFSP. To this end, the International Potato Center (CIP) undertook both individual household and focus group surveys on preferences related to sweetpotato.

This section proceeds as follows. First, it present figures on the percentages of acreage under orange, white and yellow varieties in order to take stock of current varietal preferences related to flesh color. It then presents the principal constraints farmers report facing in sweetpotato production. Survey results concerning the characteristics farmers most look for in a sweetpotato variety then follow. This includes gender differentiation to see if there are significant differences between men and women's preferences. Finally, this section compares farmers' perceptions of orange-fleshed varieties to the dominant white and yellow-fleshed varieties. This analysis is also disaggregated. First, it compares communities where OFSP has been actively promoted to nearby communities where it has not to see if promotional activities have influenced preferences. Second, it distinguishes between the improved and the local landrace varieties of OFSP to see if there are significant differences between these two categories.

[3] There are some local landraces of OFSP in Uganda but they have remained marginal from a production and consumption perspective.

## 3.2 Adoption of Orange-Fleshed Sweetpotato in Uganda

As mentioned, the first question this study examines is the degree of uptake of OFSP in Uganda. Because the introduction is so recent, we decided to look at communities where OFSP had been introduced and other nearby communities where it had not. The results of interviews with farmers presented in Table 3.1 show that the amount of adoption remains quite limited in the non-intervention communities, only just over 3% of cultivated area. Nevertheless more than a fifth of farmers currently plant at least some OFSP. In the intervention communities the level of adoption is substantially higher at 22% of planted area and 64% of farmers have at least some area in production. These low figures coincide with the survey of Kampala urban and peri-urban markets that indicated that only 6% of traders sell principally OFSP varieties. Scott and Ewell (1992) similarly report a strong preference for white-fleshed sweetpotato varieties in Eastern Africa as a whole.

A couple of initial observations can be made based on these figures. First, interventions are clearly making a difference in terms of substantially increasing the acreage and number of individuals planting orange-fleshed sweetpotato. Secondly, to date, there has been relatively little spontaneous spillover effect from the intervention to the non-intervention areas. This despite the fact that farmers' source of vines are gifts nearly a third of the time thereby potentially facilitating the spontaneous movement of OFSP planting material.

**Table 3.1** Adoption of sweetpotato according to flesh color.

| | | White/Cream | Yellow | Orange | Other |
|---|---|---|---|---|---|
| **Non-Intervention (n=83)** | Mean Adoption % | 60.2 | 35.2 | 3.3 | 1.3 |
| | Frequency Adoption % | 92.8 | 84.3 | 21.7 | 4.8 |
| **Intervention (n=84)** | Mean Adoption % | 48.3 | 26.3 | 22.4 | 3.2 |
| | Frequency Adoption % | 89.3 | 61.9 | 64.3 | 8.3 |

The issue of vegetative propagation of sweetpotato (from vines) merits a brief mention at this point. Vegetative propagation allows improved varieties to be replicated on farm without the need to purchase new planting material or seed. This makes it potentially easier for the material to spread, in particular where there is a tradition of vine exchange as mentioned above. This situation contrasts to grain crops such as corn, maize and wheat where improved hybrid seed cannot be sustainably replanted without substantial degeneration in its improved characteristics.

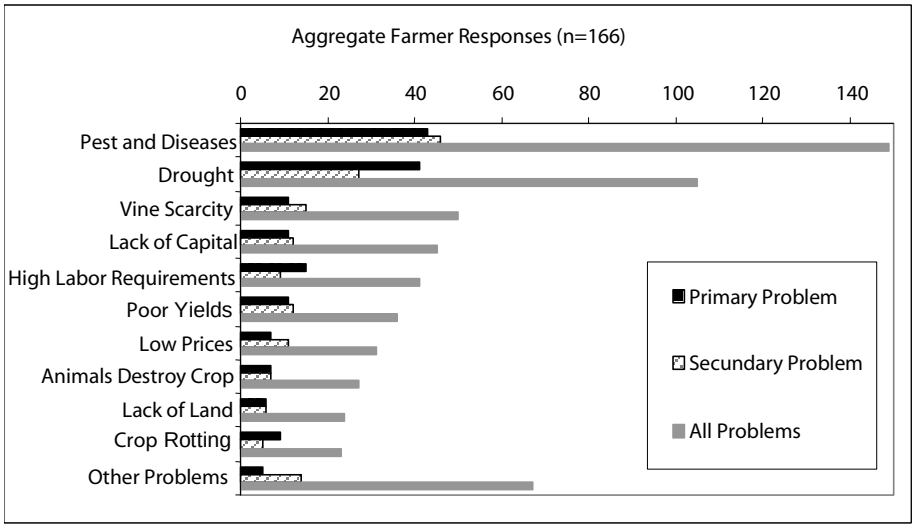
Farmers must consistently purchase improved seed. The diffusion of improved seed therefore depends on the existence of a commercial seed sector and the willingness and ability of farmers to purchase seed. On the other hand, one potential disadvantage of vegetatively replicated crops is the perishable nature of vines, which limits the ability to transport and store planting material for substantial periods of time. A second disadvantage is the greater propensity to transmit diseases such as viruses from one planting season to the next.

The low uptake rates of orange-fleshed sweetpotato varieties may well be a function of the very short time period that improved orange-fleshed varieties have been introduced. Since only a relatively small percentage of communities are likely to receive direct interventions to promote OFSP, large-scale adoption will depend to a large degree on spontaneous diffusion i.e. without the help of outside support. Indeed, in the absence of significant spontaneous adoption, it is legitimate to ask whether the adoption in the intervention communities themselves would be sustainable without outside support from the institutions supporting the orange varieties. Given the very early stage of the diffusion process, it is necessary to wait before drawing any definitive conclusions about the sustainability of the uptake of OFSP.

## 3.3 Sweetpotato Production Constraints

In order to begin the analysis of preferences, we first asked a sample of 166 farmers their opinions concerning the principal problems related to the production of sweetpotato in order to gain insights into the reasons for varietal preferences. Farmers ranked their problems in the order of their severity. The results showed in Figure 3.1 present the number of responses each production constraint received as either the farmer's primary or secondary production constraint or the number of times it showed up in the list of all problems at any level of ranking.

**Figure 3.1** Principal sweetpotato production constraints identified by farmers.



The problem of pests and diseases in general, a traditional breeding objective, came out as the principal production constraint. Of these pests and diseases specifically identified, weevils, as expected, were the most frequently mentioned. After pests and diseases, nearly as many respondents mentioned drought as their primary production constraint. Ugandan farmers likewise identified drought as the most important abiotic constraint in a study by Bashaasha *et al.* (1995). Drought, however, has received relatively less attention from breeders.

The third most important production constraint mentioned was the availability of vines. As previously mentioned, sweetpotato is reproduced vegetatively using vines. The principal sources of vines for farmers are from their own previous crop (46%), gifts from family, neighbors or friends (31%) and purchase (14%).

There is thus only a very limited commercial system of vine distribution. This is largely due to the fact that sweetpotato itself is a largely subsistence crop. Farmers only sell 21.5% of their production on average. Given that sweetpotato is largely a subsistence crop and the extreme poverty of farmers in general, very few farmers have the incentive or financial resources to pay for vines.

The lack of a commercial vine distribution is not directly a breeding issue that can be dealt with by improved varieties. However, when farmers are not able to obtain vines from their own production, this is essentially due to drought, regions with prolonged dry seasons or a lack of access to a water source to maintain a vine nursery during the dry season. In this sense, there is an agronomic issue involved. Vines obtained from previous crops are generally harvested from volunteer plants. That is, in the process of harvesting the previous crop, a small percentage of roots are inadvertently left in the soil and grow as volunteer plants at the beginning of the next rainy season. The vines of these volunteer plants are used for planting material. Varieties that are not drought resistant typically do not survive droughts or prolonged dry seasons and thus do not provide planting material for the next crop. In sum, the lack of vines for planting material can be attributed to a substantial degree to an agronomic characteristic-susceptibility to drought-that could be addressed by breeding. Thus drought itself is not only the second most important production constraint, but is also a key factor in the third most important production constraint, vine availability. A study by Mudiope *et al.* (2000) in Eastern Uganda likewise found both drought susceptibility and availability of planting material to be major sweetpotato production constraints.

When farmers obtain vines as gifts this is often from family or friends that have access to a water source and therefore are able to maintain year-round production or a vine nursery. Thus another solution to vine shortage is to provide farmers with access to water or other technological options that allow for the maintenance of vines. An additional water source could, for example, include irrigation or deep drill hand pumps. An interesting technological option we observed during our survey was a farmer who was able to maintain a small number of sweetpotato plants over the dry season in the moist microclimate provided by the shade of a plantain plantation. This is a good example of a low cost easy to manage solution to overcome the critical bottleneck of vine planting material availability.

The next two most important constraints involve a lack of capital and labor. The principal financial cost associated with sweetpotato crop production is in fact the hiring of labor as there is only a very small use of purchased capital inputs such as fertilizers and pesticides. In this sense, the capital and labor constraints are one and the same i.e. capital is used predominantly to purchase labor. Sweetpotato cultivation involves substantial labor inputs. Most parts of the country are still relatively land abundant and farmers therefore tend to use crop rotations with fairly long fallows. In the relatively humid and fertile tropical conditions of Uganda fallow vegetation grows quite rapidly. Most land for sweetpotato is cleared by hand and thus involves labor-intensive removal of fallow vegetation. Other labor-intensive aspects of sweetpotato production include: hand plowing; the heaping of mounds around each plant to promote root growth; and the need to dig up roots in the harvesting process.

Yield comes in surprisingly low as a production problem. This may be due to the fact farmers do not view yields as a production constraint per se but rather the indirect result of other production constraints such as pests and drought. The only other agronomic constraint is rotting of the crop in the field. This, however, ranks quite low and it's likely that there are multiple causal factors.

### 3.4 Sweetpotato Varietal Characteristic Preferred by Farmer

The logical next step in analyzing preferences for varieties involved asking farmers to rank the favorable characteristics they look for most in a sweetpotato variety. Figure 3.2 shows the percentage of farmers that ranked each varietal characteristic as the number one preferred characteristic and the percentage a given characteristic received of the total of all favorable characteristics irrespective of ranking.

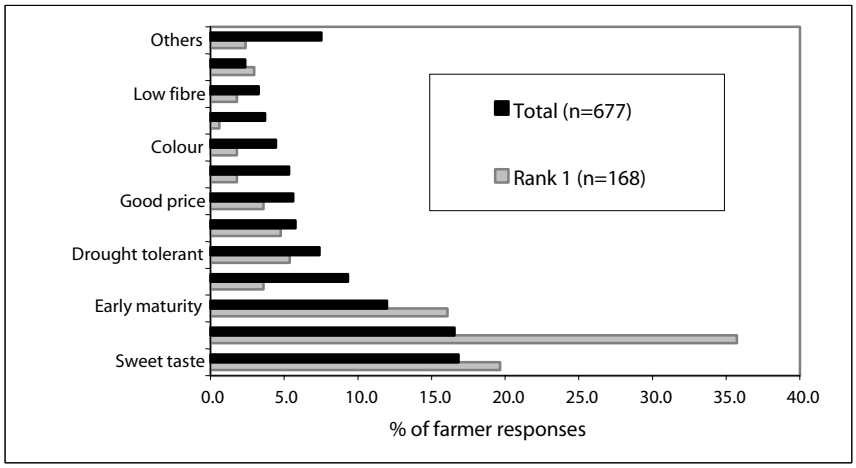



**Figure 3.2** Favorable characteristics of farmers look for in sweetpotato varieties.

High yield is by far the characteristic that is most often ranked as number one in importance. This clearly shows the importance of overall production goals. Given that only a small proportion of sweetpotato is commercialized, the interest in high yield is probably only partially due to the desire to produce a surplus for the market. A second factor explaining the importance of yield is that, given the high labor intensivity of this crop, farmers want high yields on the limited land area that they are able to cultivate with available labor resources. It is worth noting as well that yield is an overarching factor that may include other agronomic characteristics such as pest and drought resistance.

Interestingly, a consumer characteristic, sweet taste, came in slightly higher than yield when measured as a percentage of favorable characteristics of any rank. This is potentially good news for OFSP, which tends to be sweeter than varieties of other colors. Other consumer characteristics, though ranked substantially lower, included high dry matter content, color and low fiber.

The third most sought after favorable characteristic identified by farmers was early maturity. This is a characteristic that varies substantially between different varieties and has been a traditional focus of breeding programs. The most commonly mentioned reason for early maturity was that farmers simply want access to food earlier rather than later so that can get over the hungry season as farmers wait for the harvest and food from the previous cropping season becomes progressively scarce. Farmers also mentioned early maturity as important for avoiding pests and diseases as well as minimizing rotting of the crop in the field. It is also important because farmers tend to practice piece meal harvesting of sweetpotato. According to Ewell (2002), sweetpotato harvesting can take place over a 3 to 10 month time period. Farmers frequently harvest fields

little by little because sweetpotato doesn't not store well post-harvest due to its high moisture content. This practice is further explained by the fact that relatively little of the production is sold and because of the labor intensity of digging up roots for harvest. Early maturity allows farmers to stretch piecemeal harvesting over a longer period of time.

Drought resistance comes in fourth in terms of first ranked preferred characteristics and pest and disease resistance comes in fifth. The two switch places when measured by the percentage of all ranking they received. Again, these may be to some degree subsumed as a part of farmers overall concern for yield, but in general this response is consistent with the previous response on production constraints and reiterates their importance.

A series of consumer characteristics follow. These include: tuber quality, good price, high dry matter, color, good storability, low fiber, and nutritional content. The tuber qualities most sought after by farmers included medium to large straight roots. Good price is a function of overall quality characteristics. Its relatively low prioritization likely reflects the current low levels of commercialization. High dry matter content implies that the variety is less watery and more filling when eaten. The color characteristic is ambiguous in that exact color preferences are highly variable. Good storability is an important factor given the perishable nature of this crop in terms of its tendency to rot. It refers to both in-ground and post-harvest storage. In-ground storage refers once again to the practice of piecemeal harvesting and certain varieties do significantly better than others in resisting in-field rotting with delayed harvest.

Nutritional content comes in last in the survey. This should serve as a reminder that staple crops have not traditionally been viewed at sources of vitamins and minerals. The fact that it shows up at all is probably a function of the fact that the survey purposely included half of the communities as intervention communities. Indeed 81% of those few that mentioned nutrition were from intervention communities.

In addition, when farmers were asked to rank their principal health problems, general malnutrition problems ranked quite low. It came in fifth in importance for children under six (after malaria, respiratory infections, worms and diarrhea) and only constituted seven percent of total responses. Furthermore vitamin A deficiency (VAD) was never mentioned nor were any medical conditions directly related to VAD such as night blindness, corneal scarring or blinding ever mentioned for children under six. This does not imply that VAD is not a serious problem; indeed many studies in Uganda indicate that it is. What is does indicate is that it is that the problem is not perceived by farmers.

These results generally coincide with a study of varietal preference in Tanzania by Rees *et al.* (2003), notably in terms of four highest ranked characteristics: high yield, early maturity, sweetness and disease tolerance. This study also did not identify nutritional aspects as a factor in evaluating varietal preferences. The principal difference was that the Tanzania study did not pick up the issue of drought resistance.

The question of varietal preferences was also asked to just men and just women in segregated focus groups to see if there were any important gender-based differences (mixed focus groups account for the additional responses in the total). The results are presented in the Figure 3.3 below.

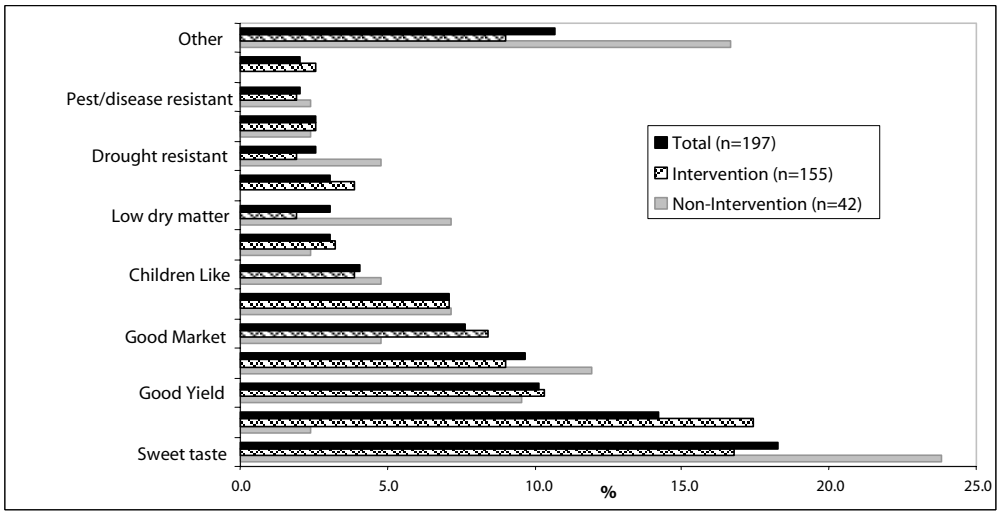



**Figure 3.3** Favorable sweetpotato characteristics stratified by gender.

The results are interesting in that they are generally similar but do capture a few important gender-based differences. The first three responses coincide with the household survey for this same question by naming yields, taste and early maturity as the three most important characteristics. Men and women are both involved in the production of sweetpotato and, naturally, both consume sweetpotato and strongly coincide on the prioritization of these three characteristics.

Where they differ is on varietal characteristics related to the gender-based roles of food preparation and family nutrition dominated by women. More women mentioned quality roots, which are important for food preparation, as are the issues of storage and rotting also emphasized by women.

Perhaps the most important gender-based difference is the importance of nutritional value. This was rated as the fourth most important sweetpotato characteristic by women but received no responses at all by men. Women are responsible for providing nutrition to the family in particular for young children. Given that the nutritional focus of the OFSP initiative, this has clear implications for emphasizing outreach to women.

### 3.5 Advantages and disadvantages of OFSP compared to other varieties

This subsection provides the results of farmers' comparisons between OFSP varieties and non-OFSP varieties. These results merit particular attention because OFSP must be competitive with the currently dominant white and yellow varieties if it is to be adopted on a significant scale. Figures 3.4 and 3.5 present the results of this survey question stratified by intervention communities and non-intervention communities.

Farmers identified sweet taste, a consumer characteristic as the most important advantage of OFSP. This was somewhat higher for non-intervention communities. In general, OFSP is sweeter than most varieties of white- and yellow-fleshed varieties and are especially like by children.

The second most important advantage is the recognition of OFSP's nutrition value. In this case, there was a striking difference between intervention and non-intervention communities, with almost all respondents who identified this advantage coming from intervention communities. This is good news in the sense that clearly interventions are having a significant impact on people's knowledge of the nutritional aspects of OFSP. However, it bears reminding that recognition of this nutritional advantage over non-orange varieties doesn't not imply that nutritional content is a highly sought after characteristic. Indeed farmers ranked nutritional content as a low priority.

Intervention communities also gave a higher degree of positive responses concerning the marketability of OFSP although this remained the fifth most commonly mentioned advantage. Most intervention efforts have promoted efforts at post harvest transformation and sale of OFSP products and this appears to have some impact on their perceived attractiveness.

The first, third and fourth most important advantages of OFSP varieties respectively include taste, yield and early maturity. This is good news in that these characteristics coincide with the characteristics previously identified as the most sought after in a sweetpotato variety. Vine sales, however came in very low further reflecting the absence of a dynamic vine planting material sector for either OFSP or sweetpotato in general.

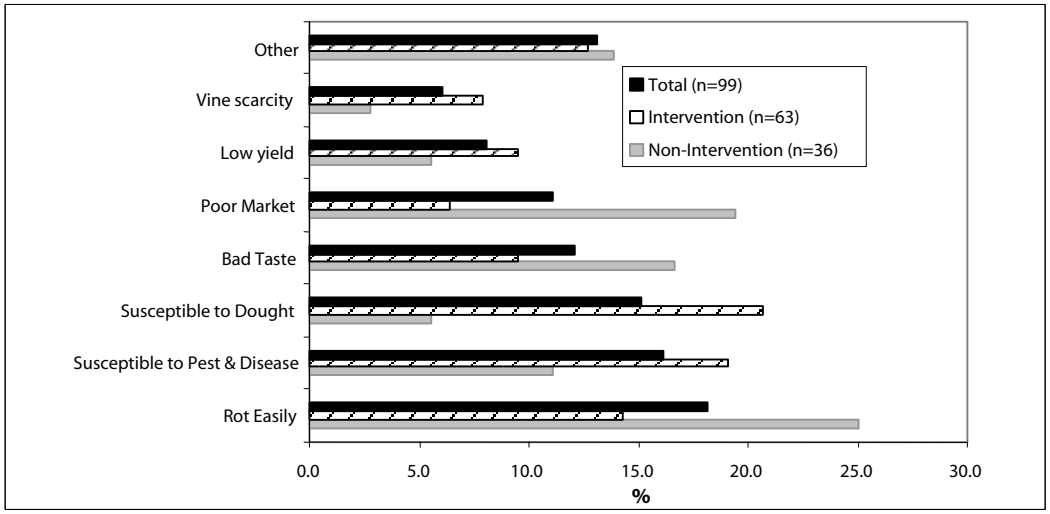



**Figure 3.4**
Advantages of OFSP stratified by the existence of interventions.

The stated disadvantages of OFSP relative to non-OFSP varieties are equally illuminating. The number one concern involves susceptibility to rotting. The genetic characteristics of OFSP appear to increase this susceptibility. In some cases, OFSP varieties are early maturing and have low in-ground storability making them particularly vulnerable to rotting and pest damage.

The second most important disadvantage involves OFSP's susceptibility to pests and diseases. This is a cause for concern in that pests and diseases are mentioned as the principal production constraints for sweetpotato production in general. Susceptibility to drought, the third most important disadvantage was also mentioned as the second most important general sweetpotato production constraint again raising concerns.

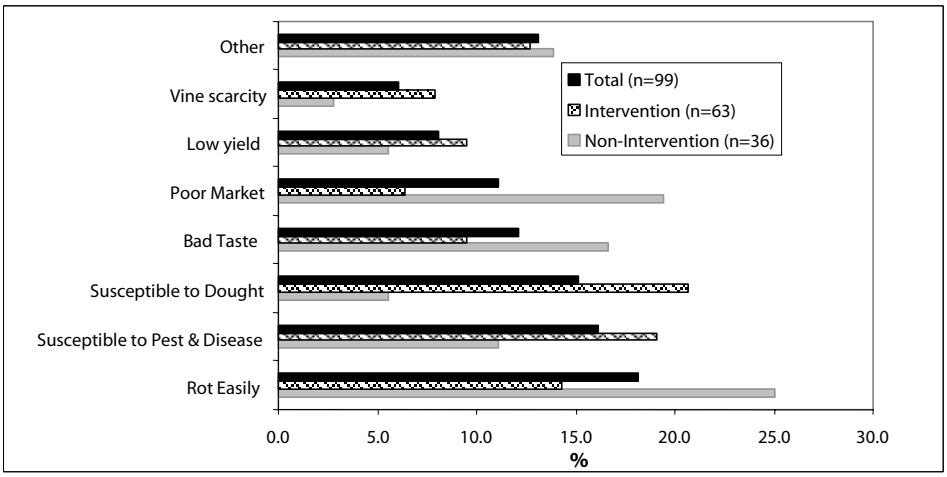



**Figure 3.5**
Disadvantages of OFSP stratified by the existence of interventions.

Bad taste is the fourth most important disadvantage. This is curious because farmers also identified taste as OFSP's number one advantage. This apparent contradiction is discussed in some greater detail below. Yield is also judged as an advantage and a disadvantage. Apparently, the yield factor depends on the variety in question and the agro-ecological zone where it is planted. Overall yield does not appear to stand out strongly as a differentiating factor between OFSP and non-OFSP varieties in terms of stated preferences.

Vine scarcity is a further disadvantage. This once again may be related to a greater drought susceptibility of the new OFSP varieties, particularly given that vine scarcity actually appears to be worse of a problem in the intervention communities where vine distribution is in fact being promoted.

There are a number of differences between the intervention and non-intervention communities that merit pointing out. The most striking is the difference in the susceptibility to drought. This is much higher in intervention zones and may indicate that the new varieties introduced are more vulnerable to this problem.

The other important difference relates to marketing problems. While marketing problems remain important, they are substantially reduced in communities that have received interventions. An important component of many interventions is to help communities market the OFSP and this appears to be having a positive effect.

Another question of interest is the comparison between local and improved varieties of OFSP. Forty-two percent of communities reported having local varieties of OFSP. Figure 3.6 presents the advantages of both the local and improved varieties of OFSP and Figure 3.7 present the disadvantages of each category of OFSP. These results are based on interviews with individual farmers and the figures present the percentage of respondents that mentioned a given advantage or disadvantage. In general, the same categories of advantages and disadvantages were mentioned for both local and improved OFSP varieties.

In terms of advantages, the main difference appears to be a degree of improvement in taste for the new varieties as compared to the local varieties. This is important in that farmers identify taste along with yield as the most important characteristics they look for in a sweetpotato variety. However, the question of taste is in fact more complicated. In both this and the previous question the taste of OFSP came out as both an important favorable and unfavorable characteristic.

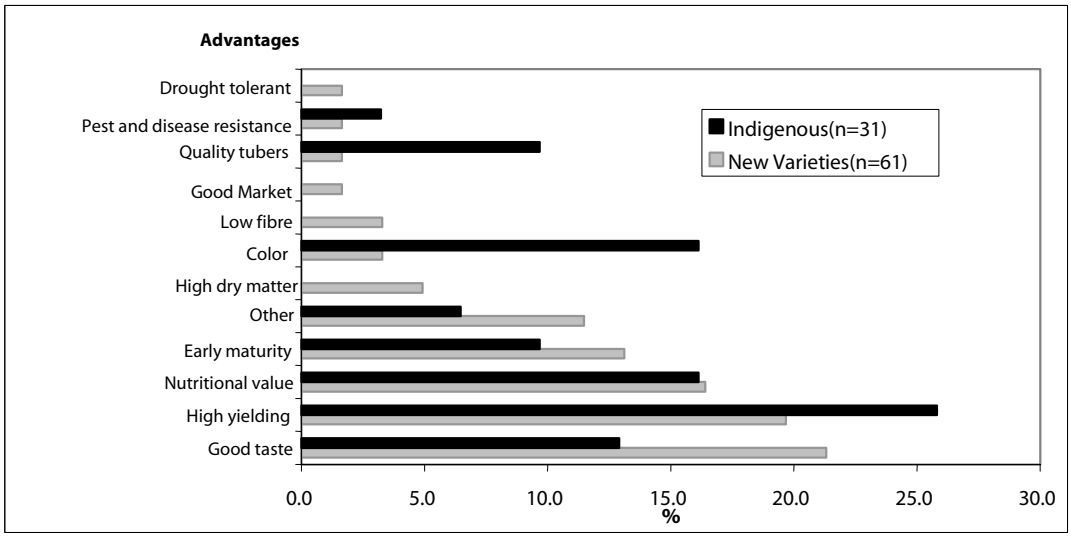



**Figure 3.6** Advantages of OFSP stratified by improved versus local varieties.

One could try to explain this apparent contradiction by saying that it must be that some specific OFSP varieties taste good while other varieties are considered unpleasant. Yet when we do this analysis individually for both Ejumula and Kakamega, the two most frequently mentioned promising varieties of OFSP, the same result is obtained. They are individually characterized as both good and bad tasting.

One thing that appears clear is that OFSP tastes *different.* Some people like it and some people don't. The Rees *et al*. study (2003) likewise found taste issues to be quite subjective. One group that farmers consistently mention as loving OFSP is children. The reasons given are that it is sweeter than other varieties and because children like the orange color. The reason other people do not like it is because it is described as having an "off" flavor. If children are the biggest fans of OFSP it would appear that adults are among its principal detractors. One wonders if adults have become so accustomed to sweetpotato with certain flavors and that they simply reject OFSP for being different.

A second surprise from the list of advantages is that a greater percentage of farmers mentioned yields more frequently as an advantage of the local orange varieties compared to the improved OFSP. While the difference is not particularly large-around seven percent-this is somewhat surprising given that yield is a central breeding objective and recently released improved varieties generally have more disease and pest free planting material that typically give them at least an initial yield boost. This appears to indicate that breeding efforts may have some way to go in order to adapt new varieties to local agronomic and production conditions.

On the disadvantage side, an important difference is that new OFSP varieties are more frequently identified as being susceptible to drought. This is obviously important in terms of the risk of crop loss to drought in a country where most regions have important problems with periodic dry spells. Of additional importance is the issue of vine propagation. As previously mentioned, the principal source of vines is from volunteer plants from the previous year's fields. Varieties that are susceptible to drought typically do not produce volunteer plants and therefore a major bottleneck in OFSP production may arise. In fact, vine scarcity is mentioned as a principal disadvantage of new varieties but not for local ones, though this may in part be due to the newness of the improved varieties. Without the availability of planting material, the sustainability of production is undermined. Given the lack of a commercial system of vine propagation and distribution, own sources of planting material are going to be particularly important and therefore drought susceptibility is of particular concern.

The other important difference is that of rotting. Farmers reported this as a problem with greater frequency for the new varieties. This problem has not been a principal focus of breeding and therefore merits closer attention.

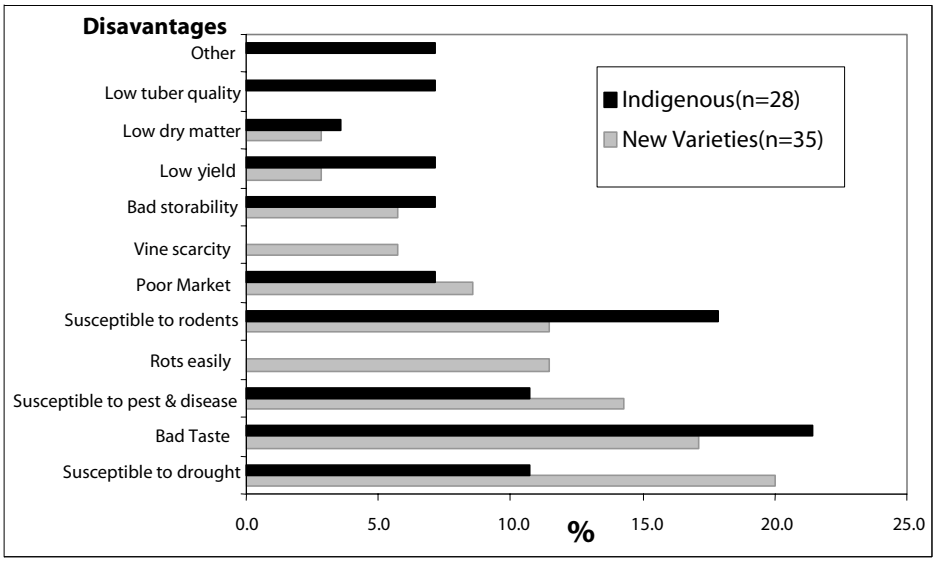



**Figure 3.7** Disadvantages of OFSP stratified by improved versus local varieties.

When this same analysis is stratified for the two varieties that are currently generally held out as the most promising new varieties, Ejumula and Kakamega, similar results appear. Both have as their main advantage taste and nutrition. Both, however, are identified as having serious problems with drought susceptibility. Ejumala's second principal problem is vine shortage whereas farmers report that Kakamega has significant problems with rotting and storage as well as pest and disease susceptibility.

# 4. ASSESSMENT OF EXTENSION STRATEGIES FOR THE PROMOTION OF ORANGE-FLESHED SWEETPOTATO (OFSP)

## 4.1 Introduction

### 4.1.1 Efforts to Combat Micronutrient Deficiency Through Promotion of OFSP

In recent years, the VITAA (Vitamin A for Africa) initiative led by the International Potato Center in collaboration with a broad network of partners has promoted the use of orange flesh sweetpotato (OFSP) rich in beta-carotene to fight vitamin A deficiency (VAD) in Africa. The VITAA initiative arguably has the one of the most advanced programs of introducing micronutrient rich varieties of a staple crop into the field via a number of extension strategies.

Among the VITAA countries, Uganda has quite high levels of VAD as well as sweetpotato production (principally white-fleshed) and has been a center of VITAA extension activities. A variety of different strategies have been employed to help get OFSP to consumers and farmers in different parts of Uganda. Notable among these strategies are the use of farmer field schools, training programs, vine multiplication, production of knowledge dissemination materials in form of manuals, organization of field days, promotion by VIPs such as the Queen of Buganda and numerous parliamentarians, promotion of home gardens, and collaborations with NGO's and health institutions.

VITAA and sweetpotato have gotten a head start on other staple crops in the Harvest Plus initiative because there are extremely high levels of the micronutrient occurring naturally in the orange varieties whereas most other crops (rice, beans, maize, cassava, and wheat) need more breeding efforts to increase their micronutrient content before releasing new varieties into the field. Nevertheless, the VITAA initiative is still relatively young having only been launched in 2001.

The Government of Uganda and various collaborators have also promoted OFSP. Development and promotion of OFSP has become part of the overall strategy to add value to the crop, increase storage life, expand market opportunities and combat vitamin A deficiency. The Government of Uganda through the National Agricultural Research Organisation (NARO) has given high priority to research on the crop. The sweetpotato programme based at NAARI whose mandate is to generate, test and disseminate sweetpotato production technologies together with major collaborators like the post-harvest programme at KARI, Makerere University, PRAPACE, CIP, MOH, MAAIF, non-governmental institutions and community based organizations have been instrumental in the promotion of OFSP.

### 4.1.2 Study Objectives

Given the relatively advanced work of VITAA and other partners in promoting beta-carotene rich sweetpotato in the field, the general objective of this section is to evaluate extension and outreach strategies employed in promotion of OFSP in Uganda. This section is meant to provide feedback to collaborators in the VITAA partnership as well as to institutions working on the Harvest Plus initiative on other staple crops in order to support the development of strategies that will improve the impact of the OFSP. The specific objectives are given as follows:

1. To document existing strategies used to promote OFSP in Uganda and assess their effectiveness.
2. To identify the farmers' principal sources for obtaining i.) information concerning the benefits of OFSP and ii.) OFSP planting material
3. To identify constraints to the promotion of OFSP

This section gives a brief description of the extension organizations and institutions involved in the promotion of OFSP in the study areas. This is followed by information on the different varieties that farmers say are indigenous or have been introduced into their areas. This section then presents the pathways for introduction of the new varieties together with the strategies employed for the promotion of OFSP. This section goes on to compare the effectiveness of the strategies employed and finally gives the constraints faced in the diffusion of OFSP. Data in this section is stratified according to regions and the presence of OFSP promotional activities.

## 4.2 Extension Efforts

### 4.2.1 Overview of Extension Efforts and Institutions

A total of 16 extension agents were interviewed in the 16 communities sampled in the four regions. The extension agents were from the district agricultural offices and some came from the NGOs operating within the study areas. The extension agents were asked to indicate the names, activities and areas of specialization of the institutions to which they belonged and others that promoted OFSP production in the districts where they operate. Table 4.1 shows the different organizations that were known to be active in the study areas and their OFSP-related activities. Groups involved in promoting OFSP though not directly covered by this study include: VEDCO, Bajjabasaga Sweetpotato farmers and processors, Farmers groups in Luwero, Urban Harvest in Kampala urban and peri-urban schools (Central region), SOCADIDO, Abuket Sweetpotato farmers and Processors and the Joint Energy and Environmental Program (Eastern region). In the Northern region, the World Food Program and World Vision have been particularly active. The

Uganda Parliamentarian Forum on Food Security and Population Development has distributed vines in several parts of the country, mainly in the Eastern and Northern regions.

**Table 4.1** Organizations involved in OFSP extension work

| Region | Name of organization | Type of organization (Government, NGO/ CBO) | Activities |
|---|---|---|---|
| **Central** | Buganda Cultural Development Foundation (BUCADEF) | CBO | 1. Nutrition Education<br>2. Vine multiplication<br>3. On-farm assessment of varieties |
| | Rakai District Farmer's Association (RADFA) | CBO | 1. Demonstration<br>2. Training of farmers |
| | Community Enterprise Development Organization (CEDO) | NGO | 1. Provision of vines<br>2. Training of farmers on OFSP management<br>3. Monitoring farmers' activities<br>4. Provision of market information and linking farmers to markets |
| | ADRA | NGO | 1. Educating farmers |
| | Concerned Women (COWO) | NGO | 1. Training of farmers<br>2. Sensitization of farmers about new technologies<br>3. Vine multiplication |
| | Masaka District Development Organization (MADDO) | NGO | 1. Training of farmers<br>2. Provision of vines |
| **Western** | Hoima District Farmers Association (HODIFA) | CBO | 1. Vine distribution<br>2. Demonstration gardens<br>3. Nutrition education |
| | Sub-county Offices | Government | 1. Vine multiplication<br>2. Promotion of commercialization |
| | District Agricultural Office | Government | 1. Training farmers<br>2. Demonstrations<br>3. Vine distribution<br>4. Monitoring and evaluation |
| | Africare | NGO | 1. Buying and distributing vines to farmers<br>2. Sensitization of farmers |
| | National Agricultural Advisory Service (NAADS) | Government | 1. Vine distribution to farmers |
| **Eastern** | National Agricultural Advisory Service (NAADS) | Government | 1. Provision of training to service providers<br>2. Monitoring and evaluation<br>3. Promoting market oriented products |
| **Northern** | James Arwata Foundation (JAF) | NGO | 1. Acquisition and provision of OFSP vines to farmers through local policy makers |

Government research institutions carry out research on new sweetpotato production technologies however these have to get to the end-user. Government bodies like NARO and NAADS have concentrated on carrying out research, setting up on-farm trials and demonstrations, provision of post harvest information and vine distribution. The CBOs, on the other hand, have been important in reaching the end-user through training and carrying out demonstrations while NGOs are active in vine multiplication and sensitization of farmers. CBOS and NGOs can reach the grassroots better and therefore can be better utilized in sensitization of farmers and dissemination of research results.

Given the different mandates of the institutions involved in OFSP promotion, synergy and collaboration is very important to ensure that extension efforts are not duplicated and that resources are put to the most effective use.

### 4.2.2 Indigenous and Introduced Varieties of Sweetpotato

In the study areas some new sweetpotato varieties have been introduced and others were found to be indigenous. Ten of the twenty-four focus groups stated that there were indigenous OFSP varieties in their areas. The information provided on indigenous varieties can't be taken as conclusive since some of the varieties such as Kala and Tanzania, that farmers say are indigenous are known to be have been introduced. The presence of indigenous varieties with orange flesh color, however may present an opportunity to breeders if some of these varieties are more adapted to local agro-ecological environments.

The farmers sampled were asked to identify the new sweetpotato varieties that had been introduced into their areas and the sources of information on these varieties. Sixty seven percent (67%) of farmers in the study areas said there had been new varieties introduced into their communities while 33% did not think that new varieties had been introduced. Table 4.2 shows the most important varieties that farmers considered to have been introduced into their areas and the estimated time of introduction.

The largest number of new varieties said to have been introduced to the communities were white/cream (15) followed by yellow (11), orange (9) and purple (1). The results also revealed that seven (7) orange-fleshed varieties had been introduced into intervention communities as compared to only two (2) in the non-intervention communities.

The information presented in this report on varieties may not be exhaustive in describing all the varieties that have been introduced to the study areas since the methodology that used was based uniquely on key informants in these areas. Between 1995-2004, NARO released 14 high-yielding sweetpotato varieties. In 1995 the National Sweetpotato Program of NARO released 6 cultivars including: New Kawogo, Sowola, Tororo 3, Bwanjule, Tanzania and Wagabolige. In 1999, the NASPOT series 1 to 6 were released. Eleven of these twelve varieties were white- or yellow-fleshed sweetpotato. Naspot 5 was the only orange-fleshed variety. More recently, in 2004, two orange-fleshed varieties Ejumula and SPK004 (Kakamega) were officially released (Mwanga *et al.*, 2004).

**Table 4.2** Varieties introduced and time of introduction

| Regions | Existence of Intervention | Varieties Introduced | Year of Introduction | Flesh Color |
|---|---|---|---|---|
| **Central** | Intervention communities | Mbale | 2001-2002 | Cream |
| | | Nakakande | 2002 | White |
| | | Kipapali | 2001 | Orange |
| | Non- intervention communities | Mbale | 2001-2002 | Cream |
| | | Kasaniya/ Kasamba | 1999-2000 | White-cream |
| | | Kawogo (new) | 2001 | White |
| | | Dimbuka | 1998 | Cream-white |
| | | Ntudebuleku | 10+ years | Yellow |
| | | Kalebe (New) | 1994 | White |
| **Western** | Intervention communities | Kirisabana | 2003 | Orange |
| | | Kidodo/polly | 1998-1999 | Yellow |
| | | Unknown variety | 2002 | Yellow |
| | | Kabukazi | 2002 | White |
| | | Rwabwisyo | 1998 | White |
| | Non- intervention communities | Muhulu ahuluguma | 2000 | Yellow |
| | | Tanzania | | Yellow |
| | | Owembala | 2000 | Cream |
| | | Bunduguza | 2004 | Light yellow |
| | | Mwolanfuzi | 2002 | White |
| | | Kipapali | 2002 | Orange |
| | | Mugurusi/Ryakimwe | 2000 | White |
| | | Kakakmega | 2002 | Orange |
| **Eastern** | Intervention communities | Ekakamega | 2002 | Orange |
| | | Ejumula | 2002 | Orange |
| | | Amogin | 2002 | Yellow |
| | | Kala | 2002 | Orange |
| | Non- intervention communities | Latest | 1999 | White |
| | | Kassim | Unknown | Yellow |
| | | Amogin | | Yellow |
| | | Esapat | 1994 | Yellow |
| **Northern** | Intervention communities | OFSP variety 1(RK) | 2003 | Orange |
| | | Otada(Lira lira) | 2000-2001 | White |
| | | Raka raka | 2001 | Purple |
| | | OFSP variety 2(RK) | 2003 | Orange |
| | | Edule | 2001 | Orange |
| | Non- intervention communities | Kenya | 1997 | Yellow |
| | | Latest | 2000 | White |

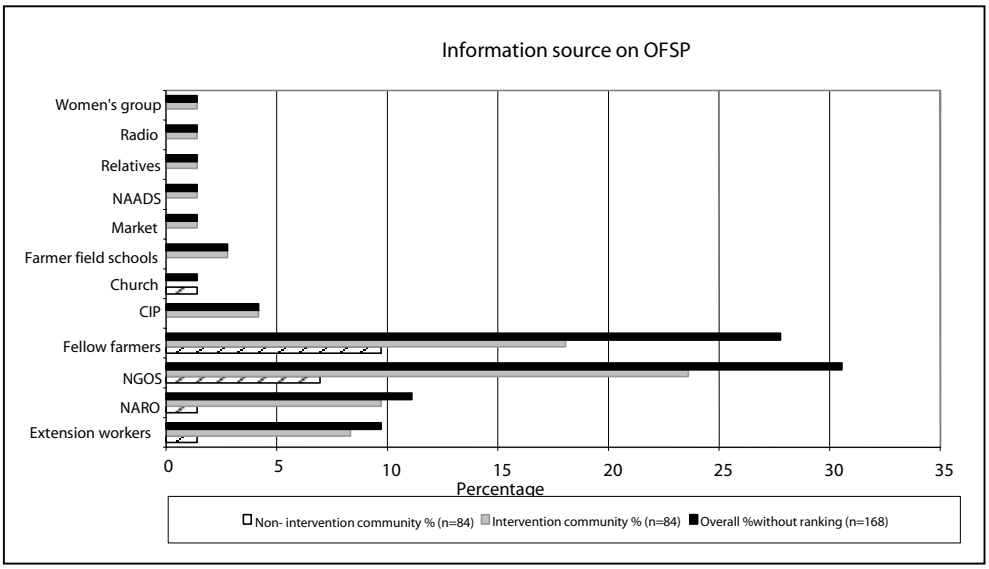
These varieties, though released with official names, have also been given diverse names in different parts of Uganda making them difficult to trace unless one has knowledge of their morphological characteristics. Regional nomenclature of sweetpotato is often based on varietal characteristics such as yield, maturity period, root size and shape, leaf size and shape, and other factors such as place of origin and person who introduced the variety (Bashaasha *et al.*, 1995). For instance, prominent OFSP varieties like Kakamega, Ejumula and Kala are given different names in the different regions such as Kipapali and Kilisabana. For this reason NARO is currently undertaking germplasm collection in seven regions of Uganda to carry out a morphological and molecular characterization of sweetpotato varieties (Mwanga *et al.,* 2005).

The results from the study showed that OFSP varieties had already been introduced to some of the study areas one or two years (2001-2003) before they were officially released. In general, however, the earliest introduction dates were only a maximum of four years prior to this field research. This probably explains why spillover effects from the intervention to the non-intervention areas may not be observable given this short time period.

### 4.2.3 Pathways for Introduction of OFSP

Different information sources on OFSP were cited by the farmers and were ranked in order of importance. Figure 4.1 shows the information sources that were ranked the highest by farmers in the dissemination of information on OFSP.

**Figure 4.1** Information sources on OFSP.




NGOs were found to be the most important source of information on OFSP in both intervention and non-intervention communities followed by fellow farmers. The third and fourth sources of information were NARO and agricultural extension workers. In fifth position was CIP, which was only found in intervention areas. Generally, more farmers in intervention areas than in non-intervention communities received information from all the other sources.

In ranking the effectiveness of the different sources of information, farmers in the focus groups considered the NGOs as the most effective information source followed by fellow farmers. Non-governmental organizations that were cited by farmers included SOCADIDO, VEDCO, JAF, Africare, and Send a Cow. The information provided by these NGOs was mainly focused on vine

propagation, cultivation, cooking, pests and diseases control and storage. Fellow farmers were important in providing information on vine propagation, cooking, storage and pests and diseases. The least effective information sources were extension workers, NARO and CIP.

A study done during a communication evaluation of OFSP activities of the MOST program (2002) in the Luwero district provided similar results. The study revealed that friends (fellow farmers) followed by NARO were the first source of information on OFSP for both growers and non-growers of OFSP. NARO provided information on the growing of OFSP, problems encountered while growing OFSP and provided solutions to these problems. Although the radio featured several times as a major source of information on health, nutrition and feeding of children and farming matters it was not as effective in providing information about the OFSP (MOST program, 2002).

Information from both these studies serves to show the importance of farmers as a means of spreading information on OFSP in their communities and to other fellow farmers. Next in importance are NARO, NGO's and extension workers. Establishing partnerships and networking between these groups is one way that OFSP can be promoted.

### 4.2.4 Vine Distribution

The main method though which sweetpotato varieties are introduced into an area is by distribution of vines. The district Agricultural and sub-county offices to which the agricultural extension agents are attached have been involved in distribution of OFSP vines in the different regions of the country. In some of the districts, the district Agricultural offices have distributed vines. Figure 4.2 shows the percentage coverage of vine distribution by the district agricultural office.

The coverage was estimated by determining the number of sub-counties that received vines from the district agricultural offices as compared to those that did not. Information provided by the district agricultural Officers showed that Soroti district in Eastern Uganda had the widest coverage of distribution of vines. No vines were distributed in Kabale and Rakai district in Western and Central regions respectively. On average vine distribution coverage was widest in Eastern followed by the Northern region with the lowest coverage in the Central and western region.

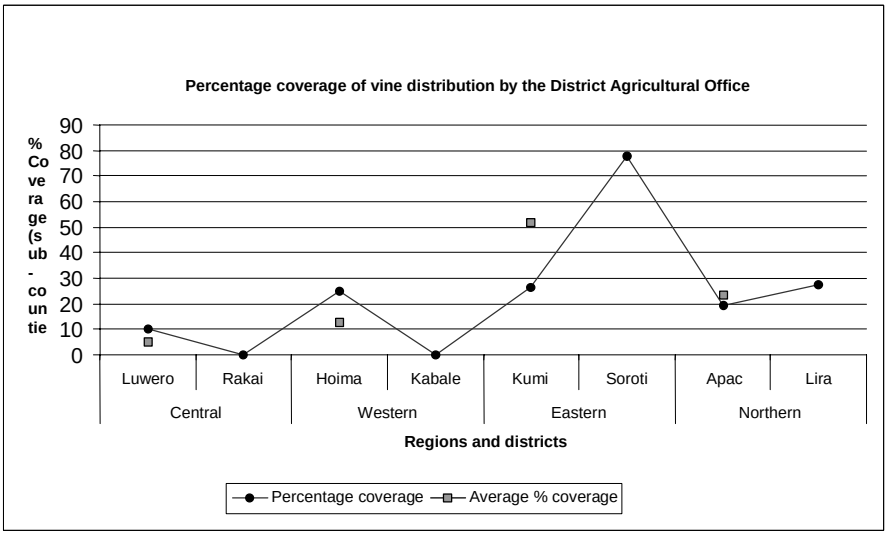



**Figure 4.2** Estimated coverage of vine distribution by the District Agricultural Offices.

Another issue that emerged was that of limited commercialization of sweetpotato in these areas where there was no vine distribution, thus it was not taken as a high priority crop for commercialization by the Agricultural departments. A trader's survey in Rakai district, for example, revealed that there were very few traders selling sweetpotatoes. The implication drawn from these findings is that the commercialization of sweetpotato affects the demand for vines.

Extension agents followed certain criteria for the distribution of vines. In the central region, farmers who were willing to manage the demonstration plots were chosen as recipients of vines. The farmers' plots would then be used to show the other farmers how to multiply vines and also demonstrate improved cultivation techniques. In Hoima district, sub-counties with women farmer groups were considered as starting points for multiplication of vines. In the eastern region distribution was demand driven; selected sub-counties with established groups of sweetpotato growers were given vines sometimes on request. In the northern region, extension workers identified pioneer or contact farmers and interested individuals from randomly selected sub-counties as multiplication points for vines. The general practice was for the initial recipients of vines to act as multiplication points by giving out vines to more farmers at the end of the production season. Other recipients of vines in the northern region were Government institutions such as prisons and schools.

Farmers obtain vines for both OFSP and NON-OFSP from different sources. Figure 4.3 shows the different sources of OFSP and NON-OFSP vines and the percentage number of farmers that derived vines from a particular source. Majority of the farmers cited the previous crop as the leading source of NON-OFSP and OFSP vines respectively. The previous crop was a major source of vines for NON-OFSP compared to OFSP vines.

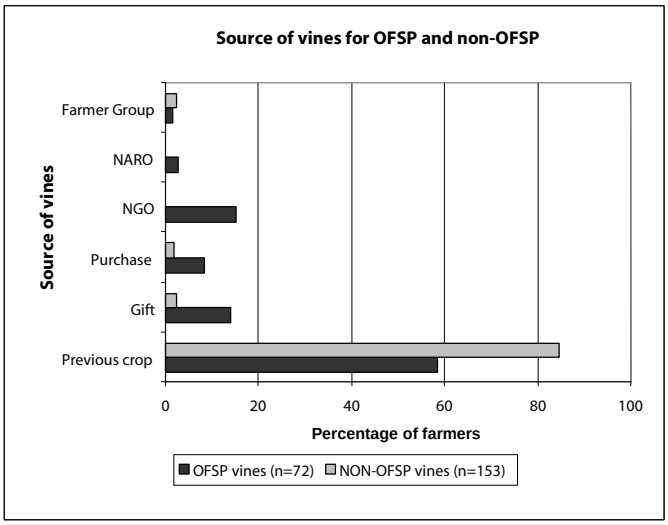



**Figure 4.3** Source of OFSP and non-OFSP vines.

The second source of OFSP vines for farmers was through NGOs. The third source of vines was through gifts, which are usually given by family and friends. Very few farmers used purchasing of vines as a source of OFSP vines mainly because vines were said to be expensive and scarce. Some farmers cited the lack of a market for OFSP as a factor that discouraged them from purchasing vines. For farmers that buy the vines, they feel that they should be able to sell the final product if the costs incurred in purchasing vines are to be recouped. With the lack of a market for OFSP the potential for development of a commercial vine sector may be limited.

## 4.3 Strategies for the Promotion of OFSP

### 4.3.1 Description of Strategies

Different strategies have been employed to promote the OFSP in different parts of the country. Interviews with extension workers identified twenty different promotion strategies (see table 4.3). Information collected from extension workers and district Agricultural Officers provided insights into some of the strategies that have been used to promote OFSP and the relative advantages and disadvantages of each.

**Table 4.3** Strategies used to promote OFSP

| Extension strategies | Region used | | | | Description of strategy | Advantage of strategy | Disadvantage of strategy |
|---|---|---|---|---|---|---|---|
| | C | W | E | N | | | |
| 1. Education | • | | | | Agronomic and nutrition information | Many farmers are reached | 1. Expensive<br>2. Requires follow up |
| 2. Community Demo plots | • | | | | A Farmer's plot is chosen; extension worker provides vines; community provides labor and management | Works well | |
| 3. Linking to the market | • | | | | Provide contacts between farmers and buyers; give market information to farmers | Provides access to markets | 1. Farmers fail to provide acceptable quantity and quality of SP<br>2. Price variability causes disagreement between farmers and buyers<br>3. If prices are low farmers don't want to produce |
| 4. Farmer groups | • | • | | | 1. Work with farmers groups; provide vines to groups.<br>2. Sensitize farmers on OFSP advantages and disadvantages | 1. Diffuses quickly in the village<br>2. Follow up can be done<br>3. Group members adopt easily due to clear information flow | 1. Long process<br>2. Few farmers at a time receive vines<br>3. Limitations to joining groups<br>4. Some group member reluctant to participate<br>5. A few members in the group may get access to information. |
| 6. Agricultural shows | | | • | | Vines are given away at agricultural shows | 1. People are able to buy vines<br>2. Many people can be reached | Difficult follow-up |
| 7. On-stations demo's | | • | | | Farmers view experimental plots at research centers | Large quantity of vines produced | Few farmers turn up |
| 8. Field demo's | | | • | • | 1. NARO sets up demonstration plots in farmers' communities<br>2. Established at group level for OFSP variety evaluation | 1. Farmers choose variety based on personal observation<br>2. Farmers awaiting the vines to multiply assured vine source<br>3. Raises awareness improved varieties/encourages adoption | 1. Time consuming<br>2. Mistakes/Problems like drought may cause rejection but don't reflect true potential.<br>3. Narrow coverage of the area and benefits few farmers. |
| 9. Communal multiplication plots | | • | | | NGO gives vines to community members cultivate; distribute vines to individuals and also share harvested roots. | 1. Can reach large group at once<br>2. Suitable due to group pressure on individuals to participate | Group dynamics can be difficult, some people don't participate for example some feel superior. |
| 10. Drama and theatre groups | | • | | | Drama plays with hired groups depicting hygiene, nutrition, OFSP. | 1. Captures both genders<br>2. Open to all community members beyond group participants | 1. Difficult to follow-up<br>2. Viewed as a leisure activity, lowers participation |
| 11. Sensitization | | | • | • | 1. Participatory learning farmer gps encourage OFSP adoption.<br>2. In group meeting explain OFSP importance<br>3. Sub-county team holds parish-level meeting for OFSP awareness raising and mobilizing farmers to cultivate and consume OFSP | 1. Many farmers get the information quickly<br>2. Has the mandate of the policy makers<br>3. Wide coverage | 1. Information is interpreted differently by different farmers so few may take up innovation<br>2. Requires a lot of follow-up visits.<br>3. Absentee participants get second hand information<br>4. Costly because stakeholders involved need facilitation<br>5. Difficult to make follow-ups |

| Extension strategies | Region used | | | | Description of strategy | Advantage of strategy | Disadvantage of strategy |
|---|---|---|---|---|---|---|---|
| | C | W | E | N | | | |
| 12. Workshops | | • | | | Hold workshops with individuals from different communities | 1. Rep's from different localities spread information to diverse communities<br>2. A few serious farmers try out what they learn. | 1. Workshops are viewed as trips<br>2. Farmers are given very little in terms of knowledge. |
| 13. Use of Progressive farmers | | • | | | 1. Vines bought from progressive farmers and given freely to the less progressive farmers<br>2. Vines sold to progressive farmers | 1. Source of vines is assured<br>2. Progressive farmers become multipliers | 1. Few people are reached.<br>2. High costs involved. |
| 14. Use of farmers who have adopted OFSP | | • | | | NGO buys vines from farmers who have adopted OFSP and distributes them freely to other farmers | 1. Many farmers produce OFSP income source selling both vines and roots<br>2. Increased planting material sources | |
| 15. Farmer to farmer exchange visits | • | | | | 1. Farmers who have not adopted visit villages where farmers have adopted | 1. Farmer adoption motivates non-adopters<br>2. More credible because other farmers have done it.<br>3. Also some adoption other technologies | 1. Poor farmer participation wastes resources<br>2. High transport costs |
| 16. Field days | • | | | • | Farmers compare OFSP vs. non OFSP in the field | Many people are reached targeted and non-targeted groups | Costly in money and time |
| 17. Mass campaigns | • | | | | Done at social gatherings | 1. Many people receive information at a go<br>2. Less costly | Information given at a social gathering may not be taken seriously |
| 18. On farm training | | | • | | Demonstrations are conducted for farmers to learn by seeing | Easily adopted | Expensive and time consuming |
| 19. Off farm Training | | | | • | Training of farmers on agronomic practices and post harvest handling | 1. More specific and addresses technical aspects<br>2. Many farmers are reached | Most farmers don't practice what they learn |
| 20. Use of policy makers | | | | • | Local policy makers use NGO to acquire & distribute OFSP vines | Policy makers support enhances acceptability | Exclusion of extension agents may compromise technical aspects |

**Note:** C= Central W=Western E=Eastern N=Northern

### 4.3.2 Effectiveness of Extension Strategies

Some strategies used to promote OFSP have however been noted to be more effective than others. Extension agents were asked to rank the different extension strategies based on the effectiveness of the strategy in promoting OFSP. Table 4.4 shows the ranking of the extension strategies and reasons why the strategy was thought to have been effective or ineffective.

**Table 4.4** Effectiveness of different extension strategies (n=16)

| Extension strategy | Ranking 1=least effective 5=most effective | Reason for effectiveness/ Ineffectiveness |
|---|---|---|
| Education campaigns | 4 | Many farmers are reached |
| Mass media (Radio and newspapers) | 2 | |
| Farmer groups | 3 | Focuses on income generation and nutrition; easy to mobilize farmers into groups |
| Demonstration on station | 3 | Lots of vines are available |
| Agricultural shows | 2 | Vines are available |
| Progressive farmers | 2 | No interaction with non-progressive farmers |
| Communal multiplication plots | 3.5 | Reaches many people with planting material |
| Farmer to farmer exchanges | 2 | Farmers believe other farmers (credible); farmers adopt other technologies as well |
| Drama (theater groups) | 2 | Many people turn up for the fun |
| Workshops | 1 | Not effective because it is viewed as a relaxation activity |
| Sensitization through group meetings | 3.5 | Many farmers are reached |
| Use of farmers who have adopted | 2 | Many farmers get motivated |
| Field days | 2.5 | Farmers are able to see the actual situation in the field; farmers are able to make their own personal evaluations |
| Mass campaigns | 2 | Adoption may be very low |
| On-farm training | 4 | Farmers learn by seeing |
| Demonstrations | 4 | Farmers believe by seeing |
| Off farm Training | 1 | Most agronomic practices don't change as regards Sweetpotato production |
| Use of policy makers | 4 | Program is initiated by area policy makers |

Results showed that the most effective strategies were found to be education campaigns, on-farm training, demonstrations and use of policy makers. These were followed by communal multiplication plots and sensitization through group meetings.

The least effective strategies were off farm training and workshops. Farmers advanced a number of reasons as to why some extension strategies were considered ineffective. There was a lack of knowledge especially on the nutritional benefits of OFSP, which was often referred to as only for children. Most of the educational efforts concerning the nutritional benefits of OFSP activities involved only women with men left out. This would explain in part why children and women

most frequently consumed OFSP. While women may indeed be responsible for food preparation decisions and participate extensively in agricultural labor, men still dominate decisions about agronomic management and crops choice including the decision on what variety of sweetpotato to plant.

Another reason that led to ineffectiveness of extension strategies was that the community leadership was noted to be weak and could not adequately support the OFSP promotional programs. Future OFSP promotional programs may need to involve at least a wider audience of stakeholders at the community level so as to build acceptability and support. The use of politicians is one strategy that has been noted to be effective in OFSP promotion and could help solidify community support for programs.

Some of the efforts at OFSP promotion deliver vines but provide no training support to farmers. Often the quantity of vines initially distributed was limited and therefore both training and institutional mechanisms for vine multiplication need to be put in place. Another important problem mentioned by farmers is the susceptibility of OFSP to drought. Plants often wither over the dry season leaving no vine planting material for the next cropping season. In some cases, the delivery of vines was done during the dry season when farmers lacked access to water to cultivate nurseries for vine propagation. In general, extension efforts need to ensure that there is a permanent and reliable source of vine planting material if OFSP is to spread sustainably throughout the communities where it is introduced.

## 4.4 Constraints to the Diffusion of OFSP

The adoption of OFSP has been hindered by a variety of factors. Focus group discussions revealed a number of constraints. Table 4.5 presents the most important constraints to OFSP diffusion in the communities studied.

**Table 4.5** Constraints to diffusion of OFSP

| **Constraint** | **Number of focus groups that mentioned particular constraint (n=24)** | | | | |
|---|---|---|---|---|---|
| | **Central** | **Western** | **Eastern** | **Northern** | **Total** |
| Scarcity of vines | 1 | 4 | - | 2 | 7 |
| Lack knowledge of OFSP | 1 | - | 3 | - | 4 |
| Lack of market | 1 | - | 2 | - | 3 |
| Lack of capital | 1 | - | - | - | 1 |
| Unpleasant taste | 1 | 1 | - | - | 2 |

The most important constraint faced was the scarcity of vines for use during planting season, which was mentioned by 7 of the 24 focus groups. This problem appears greater in Western Uganda. Kapinga *et al.* (1995) cited in Kapinga *et al.* (2000), identified the critical shortage of planting materials as a major constraint to sweetpotato and cassava production in the lake zone of Tanzania. Hagenimana (1999) in Rees *et al.* (2003) similarly acknowledged the lack of good quality planting material of improved varieties as a major constraint to sweetpotato crop production in Sub-Saharan Africa. The second most important constraint to diffusion of OFSP was the lack of knowledge of OFSP, which was more pertinent in Eastern Uganda. Farmers in the Eastern and Central region were faced with the problem of the lack of markets.

Other important constraints that were identified included the unpleasant smell and taste, which made OFSP unpopular for adoption and the lack of capital. Ogubi *et al.* (2004) identified another set of constraints to sweetpotato production and consumption of which pests (animals such as moles) posed the greatest challenge. Bashaasha *et al.* (1995) reported labor shortage, lack of farm implements and land scarcity as important constraints in Uganda, while Mudiope *et al.* (2000) indicated that labor shortage and the lack of planting material were the first and second biggest bottlenecks to production.

Constraints faced in the production of sweetpotato ultimately affect the diffusion of new varieties. These constraints will have to be addressed if the benefits of OFSP are to be realized**.** In sum, the most urgent priorities involve improving the availability of vines, building awareness of OFSP, increasing the commercial opportunities of OFSP and the enhancement of the sensory attributes of OFSP.

# 5. POST HARVEST UTILIZATION OF SWEETPOTATO IN UGANDA

## 5.1 Introduction

### 5.1.1 Post Harvest Utilization of Sweetpotato

Globally, utilization of sweetpotatoes varies from simple methods of food preparation in fresh form to sophisticated methods of adding value to them for human and animal consumption (Scott and Wheatley, 1997). The pattern of sweetpotato production and utilization is highly seasonal and depends on the pattern of rainfall distribution and soil types. In areas with bimodal rainfall distribution and two planting seasons, there is greater year-round production and households predominantly consume fresh roots. Despite being a moderately drought tolerant crop, in areas with unimodal rainfall fresh root utilization is short lived. In this context, dried chip utilization tends to predominate during the dry months when most of the other sources of carbohydrates are still out of season (Agona, 1996).

Though commonly categorized as strictly a "subsistence", food security" or "famine relief crop", sweetpotato's uses have diversified considerably in developing countries over the last decades. Hence while subsistence use is still important in many countries, other uses have emerged in parts of Sub-Saharan Africa. In East Africa, although sweetpotatoes are grown principally for human consumption, some farmers also feed vines to livestock and leaves are eaten as a vegetable (Cary *et al.*, 1997).

The sweetpotato is a major staple in Uganda that is produced for food security and to a small degree cash generation. The crop is grown throughout the country as a subsistence food crop and plays a significant role in the diet of most Ugandan families. As a source of carbohydrates, it ranks third after bananas and cassava (Fowler and Stabrawa, 1993), though it is more nutritious than both these crops (Woolfe, 1993).

The utilization of the sweetpotato includes consumption, storage, cooking and transformation (flour, chips, cakes etc.). Sweetpotato is mainly eaten as fresh roots and to a lesser extent as dried chips. The fresh roots can be boiled, steamed or roasted. In areas were dried sweetpotato chips are eaten; the chips are put in water and boiled or mixed with cereals (sorghum and millet) and ground into composite flour (Agona, 1996). Dried sweetpotato chip processing is common in the east of the country. In parts of northern Uganda, sweetpotato roots are chipped and sun-dried to prolong their shelf life (Carey *et al.*, 1997; Okoth, 2000). However, the market options for sweetpotato in Uganda are limited and the cases of processing the crop into marketable products are few (Hagenimana and Owori, 1997). There is little availability of adapted processing technologies and little market demand for traditionally processed products.

With the promotion of the OFSP in Uganda, a range of new products is being introduced to farmers and consumers. These include composite flour, porridge, weaning foods, juices, doughnuts, pancakes and animal feed.

Efforts by different actors have focused on developing post harvest processing technologies to improve the household utilization of OFSP in order to reduce VAD. Postharvest technologies have included chipping machines to facilitate the production of sweetpotato chips and increase the shelf life of OFSP and the development of recipes for sweetpotato based products.
The objectives of this section are to document OFSP post harvest utilization and processing technologies; to identify constraints to processing and utilization of OFSP and to provide feedback to partners/collaborators on post-harvest technologies that would expand the utilization of sweetpotato processed products in existing and new markets.

This section presents results according to the four major components of post harvest root utilization, which are consumption, processing, storage and marketing. Consumption includes a comparison of OFSP and non-OFSP intake, the sources of OFSP consumed by households as well as the frequency of consumption, and forms and preparation methods used. Results on consumption were disaggregated according to region. Survey results concerning processing focus mainly on the products derived from sweetpotato roots. Storage techniques of both traditional and non-traditional sweetpotato products were compared and damage experienced using each technique was identified. This section concludes with an examination of the commercialization of sweetpotato.

## 5.2 Consumption of Sweetpotato

While non-OFSP varieties have been predominant, OFSP has been making inroads into the household diet. Table 5.1 below shows that in non-intervention communities roughly 25% of households consume OFSP. This level jumps to nearly 70% of farmers in intervention communities. Clearly interventions have an important impact on the numbers of people consuming OFSP. These figures parallel very closely to the numbers of households cultivating OFSP for intervention and non-intervention communities. Because intervention communities represent only a tiny percentage of total households, the figures for non-intervention communities should be very close to the averages for Uganda as a whole.

**Table 5.1** Consumption of OFSP and Non-OFSP.

| | Non-Intervention | Intervention |
|---|---|---|
| **Consume OFSP** | 24.7% | 68.8% |
| **Consume non-OFSP** | 98.8% | 95.2% |

These numbers represent the percentage of households that consume any OFSP and not the total percentage of sweetpotato consumption represented by OFSP. The percentage of OFSP production as a part of total sweetpotato production is just 3.2% in non-intervention communities and this is likely close to the total percentage of OFSP consumed in Uganda.

Figure 5.1 shows that the source of the vast majority of both OFSP and non-OFSP roots for consumption in the rural study communities comes from home production. This further reflects the fact that sweetpotato is predominantly a food security crop. Roughly 90% of OFSP comes from home production whereas this figure is 95.5% for non-OFSP. OFSP has only a slightly higher level of purchase 5.0 vs. 3.8%.

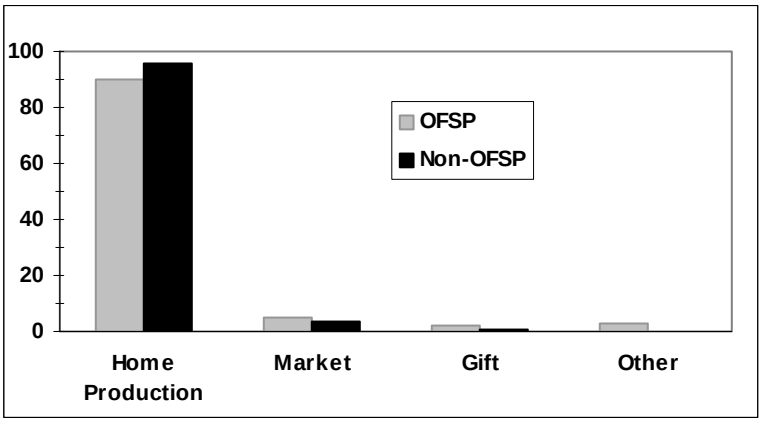



**Figure 5.1** Sources of sweetpotato for consumption.

### 5.2.1 Frequency of OFSP and non-OFSP Consumption at the Household Level

All members of the households sampled consumed sweetpotatoes however certain groups consume it more frequently than others. Table 5.2 below shows that children were ranked first in the frequency of consumption of OFSP and non-OFSP. These were followed by mothers, adolescents, fathers and the elderly in that order.

**Table 5.2** Frequency of OFSP and non-OFSP consumption at household level

| All Regions | Group | Frequency of farmers who mentioned a particular ranking (1=most frequent, 5=Least frequent) | | | | |
|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 |
| **Consumption of OFSP (n=73)** | Children | 62 | 6 | 1 | - | - |
| | Mothers | 6 | 43 | 15 | 4 | - |
| | Fathers | - | 4 | 40 | 14 | 1 |
| | Adolescents | 1 | 17 | 5 | 5 | 1 |
| | Elderly | 1 | - | 1 | 2 | 9 |
| **Consumption of non-OFSP (n=163)** | Children | 112 | 21 | 18 | 3 | 6 |
| | Mothers | 21 | 87 | 36 | 11 | 1 |
| | Fathers | 14 | 23 | 73 | 29 | 2 |
| | Adolescents | 4 | 31 | 12 | 14 | 1 |
| | Elderly | 11 | 4 | 4 | 5 | 4 |

In general, the fact that sweetpotato is most frequently eaten by the two groups most vulnerable to VAD, women and children bodes well for reaching these groups with high vitamin A deficiency. Children particularly liked OFSP and caregivers cited its orange color and sweetness as the reasons for children's preference.

Mothers also consumed OFSP mainly because most times they were responsible for preparation of the meals for the children. Some mothers gave OFSP to the children because extension officers and health workers had informed them that OFSP was good for the children as well as for pregnant and lactating women. These factors together provide potential advantages to OFSP relative to non-OFSP.

Survey results reveled that the most popular consumption forms were found to be the steamed and boiled form (Figure 5.2). Owori and Agona (2003) in Rees *et al.* (2003) likewise acknowledged that boiling or steaming roots was the main method used for the preparation of sweetpotato for home consumption. In the dry areas of Uganda sun drying sliced pieces was practiced during the dry season, primarily as a means for storing roots (*op .cit*). Apart from boiling and steaming there were other consumption forms that were mentioned by the households as shown in Table 5.3 below.

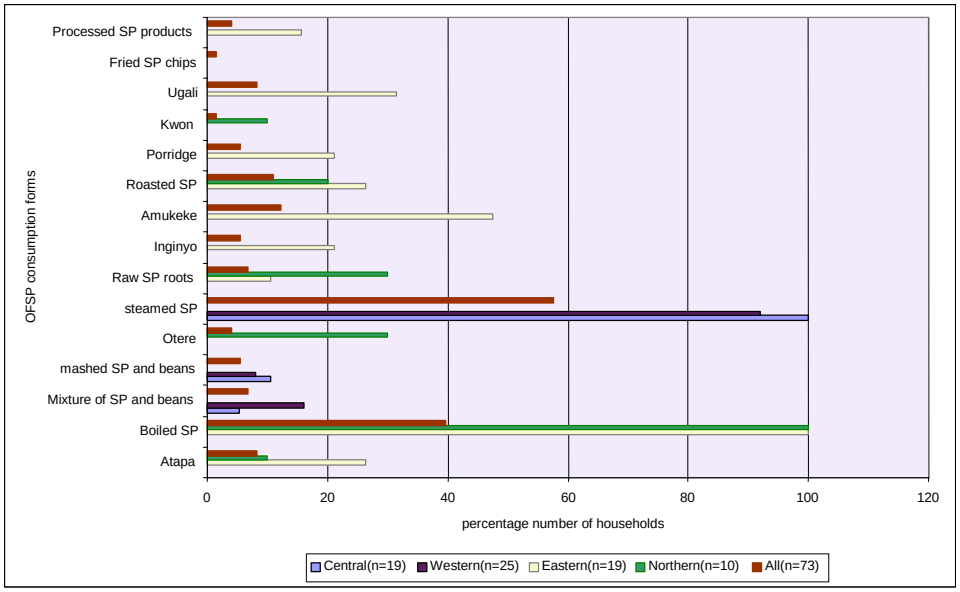



**Figure 5.2** Consumption forms of OFSP at household level.

**Table 5.3** Major consumption forms and their preparation methods

| Consumption form | Preparation method |
|---|---|
| Atapa | *Atapa* is made from sweetpotato flour (derived from Amukeke or Inginyo) mixed with either millet or cassava flour, re-hydrated with boiling water and cooked over heat into a brown edible bread like paste. SP flour alone may also be used and mixed with tamarinds or sour milk to neutralize the sweetness (regarded as undesirable). |
| Boiled Sweetpotato | Sweetpotato roots are peeled (or left unpeeled) and washed. The roots are boiled in water. |
| Mixture of Sweetpotato and beans | Sweetpotato roots and beans are boiled separately and then mixed when ready |
| Mashed Sweetpotato and beans | Raw Sweetpotato roots are added to boiled beans cooked and mashed when ready. |
| Otere | *Otere* is made from dried chips of Sweetpotato, which are boiled, salt added, and either eaten in that form or mashed. Otere is a similar product to Amukeke though it is given a different name by the Langi ethnic group from Lira and Apac. |
| Steamed Sweetpotato | Sweetpotato roots are peeled, washed and then steamed in banana leaves |
| Raw Sweetpotato roots | Sweetpotato roots are peeled and eaten raw in the garden |
| Inginyo | Inginyo is a dry chip like (more of a chunk) primary product. First roots are crushed into pulp and sun dried. |
| Amukeke | Roots are dried in the sun for 1-2 days. They are then peeled, sliced into thin horizontal strips and sun dried on rocks, polythene bags or courtyards specially smeared with cow dung and then stored. To cook, the dry chips are boiled in salted water until soft. These can be eaten at this stage or mashed and put back on fire to remove excess moisture. |
| Roasted Sweetpotato | Roots are peeled and roasted on an open fire |
| Porridge | Sweetpotato flour is mixed with cold water to form a paste which is then added to boiling water (with/without tamarinds) and boiled until ready |
| Kwon | Boil water, add sweetpotato flour mixed with millet/sorghum flour and stir |
| Ugali | Water is boiled, sweetpotato flour added and the whole mixture is mixed over heat into a soft bread form. |
| Fried Sweetpotato chips | Fresh sweetpotato is sliced and deep fried in cooking oil. Salt is added when ready |
| Processed products (chapatti, mandazi, juice) | Boiled sweetpotato roots are mashed and: i.) added as an ingredient instead of flour ii.) To make juice; boiled sweetpotato roots are mashed, water is added and the whole mixture is strained using a sieve to obtain juice |

The preparation methods used affect the amount of vitamin A that is finally available in a product. Some preparation methods especially for some of the sun-dried products like amukeke, Otere, inginyo lead to the loss of the orange colour of the OFSP, which signifies a reduction in the vitamin A level in the products. On the other hand, a study by van Jaarsveld *et al.* (2004) shows that OFSP prepared in a boiled or mashed form retains on average from 75-90% of its beta-carotene content. These are two of the most common forms of preparation along with steaming which, according to Nestel and Nalubola (2003), is even better than boiling for retaining beta-carotene.

## 5.3 Processing Sweetpotato

In order to increase the commercial value of sweetpotato, diversified uses of this crop have been sought. Farmers process sweetpotato at the household level using mainly traditional methods. Traditional products include Amukeke, inginyo and otere. These products are generally consumed at the household level, however, and may not be attractive to many consumers, particularly in the urban areas. Commercial processing of sweetpotato into other more (non-traditional) commercial products like sweetpotato chips, juice, cakes, flour has been promoted through farmer groups, NGO's and CBO's. Non-traditional products that have been promoted include bread, chapatti, fried chips, sweetpotato flour, mandazi, juice, pancakes, porridge, biscuits cakes and doughnuts. The adaptation of new sweetpotato products and processes has the potential to open up new markets for farmers and processors (Owori and Hagenimana, 2000). Collaborative research carried out in Lira and Soroti districts has demonstrated that there is market for common snack products such as mandazi (doughnut), chapatti, buns and cakes in which sweetpotato flour has been used to substitute wheat flour at a proportion of 30%. (Hagenimana and Owori, 1997; Owori *et al.*, 1997).

On average, only 16% of the sweetpotato farmers processed sweetpotato into either traditional or non-traditional products. It was, however, observed that a bigger percentage of farmers (33% and 29%) of farmers in Eastern and Northern regions respectively, processed sweetpotato as compared to only 5% and none in the Central and Western region respectively. The most common processed products were Otere, sweetpotato flour, Inginyo and Amukeke which are traditional products. These sun-dried products were important especially in the northern and eastern regions.

Sun drying sliced pieces is practiced during the dry season as a means of storing roots and ensuring that sufficient food is available during the lean seasons. The processing of sweetpotato is done basically to increase its shelf life thus improving the food security of the household. This

would probably explain the occurrence of processing activity in the Northern and Eastern regions, which experience drier conditions than the Central and Western regions. These results suggest that the processing of sweetpotato into commercial products is still very limited, however, Owori and Agona (2003) in Rees *et al.* (2003) noted that substitution of wheat flour, either with grated fresh roots or sweetpotato flour, is gaining a foothold in the snack product market in Kenya and Uganda. Therefore promotion of commercial processing of primary products would increase the utilization of sweetpotato flour as an ingredient in snack product processing.

## 5.4 Storage of Sweetpotato

Sweetpotato roots can be stored for several months using different storage methods. Unprocessed roots have a short self-life under tropical conditions. However, farmers using different methods have helped improve the self-life of fresh roots and traditional and non-traditionally processed products (Figure 5.3).

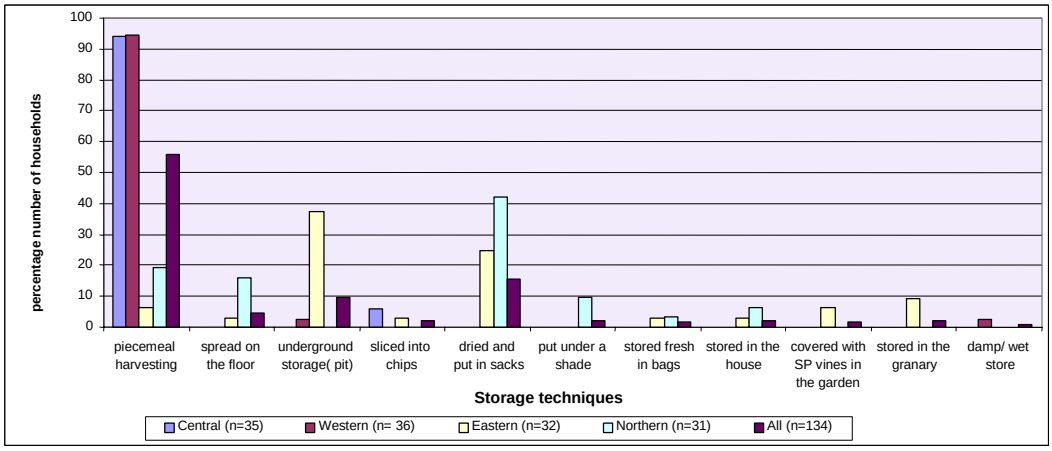



**Figure 5.3**
Storage of roots and traditional processed sweetpotato products.

The most common storage method, piecemeal harvesting, was used by 44.6% of the sweetpotato farmers. This involves harvesting a field little by little. In essence, the crop is simply stored in the ground. Piece meal harvesting also allows farmers to spread out consumption and reduce the peak labor requirements of harvesting. The duration of storage depends on the food needs of the household and weather conditions. This method, though common in the Central and Western regions, was not popular in the Eastern and Northern regions, where weather conditions are drier. Drier conditions, according to farmers, predispose sweetpotato roots to weevil attack.

Drying and storing in sacks was the next most important storage technique practices by approximately 15% of farmers. It was more common in the Eastern and Northern regions. Sun

drying is practiced during the dry season, primarily as a means for preserving roots for longer storage. Sweetpotato roots are processed into dried chips (Inginyo or Amukeke) and stored in this form in sacks in the house, in the shade or spread on the floor.

Another method, practiced by roughly 10% of farmers, is the use of a pit for underground storage. The procedure involves digging a shallow pit that is filled with grass or vines. The harvested roots are put in the pit and covered with grass or sweetpotato leaves and a layer of soil on top. Reasons given for the use of this method were that sweetpotato had been harvested but couldn't be sold, a need to create space for re-utilization of the mother garden and to avoid frequent travel to distant gardens.

In general, what is striking is the low use of storage techniques apart from piecemeal harvesting. This result concurs with a study by Agona (1998) that also found few appropriate storage and conservation methods, especially at smallholder subsistence farm level, that could enhance the self-life of roots after maturation. After piecemeal harvesting, only one other technique reached an average level of 15% across regions. This can be attributed to two factors. First, roots are inherently difficult to store in a tropical environment given their moisture content. Second, given that they are principally a food security crop, they don't generate much in the way of income. Farmers are less willing to invest labor or financial resources in storing a crop that generates little income itself. It is not coincidental that the principal storage technique of piecemeal harvesting simply involves leaving the roots in the ground and therefore involves zero cost.

**Storage of Non-traditionally Processed Sweetpotato Products**

The storage of non-traditionally processed sweetpotato products differs from that of the traditional sweetpotato products. Most of the non-traditionally processed products have a very short self-life (1-3 days) with the exception of sweetpotato flour and machine sliced chips, which had a shelf life of 4 months and 24 months respectively. Products like cookies, Mandazi, Ugali, pancakes, cakes, fried chips, porridge were stored in bowls or glass jars while flour and machine dried chips were stored in bags and granaries.

Most of the non-traditionally processed products like mandazi, pancakes, chapatti, cakes and cookies were made from both boiled mashed OFSP roots and OFSP flour. Farmers said products made from OFSP roots kept for a relatively short time. This is a hindrance to the commercialization of OFSP.

**Damage Experienced**

Sweetpotato roots are frequently damaged during storage. A majority of the sweetpotato farmers (52.9%) in all regions experienced damage. On average, 25% of roots are damaged during storage. Damage lowers the sale price of sweetpotatoes as shown in Figure 5.4.

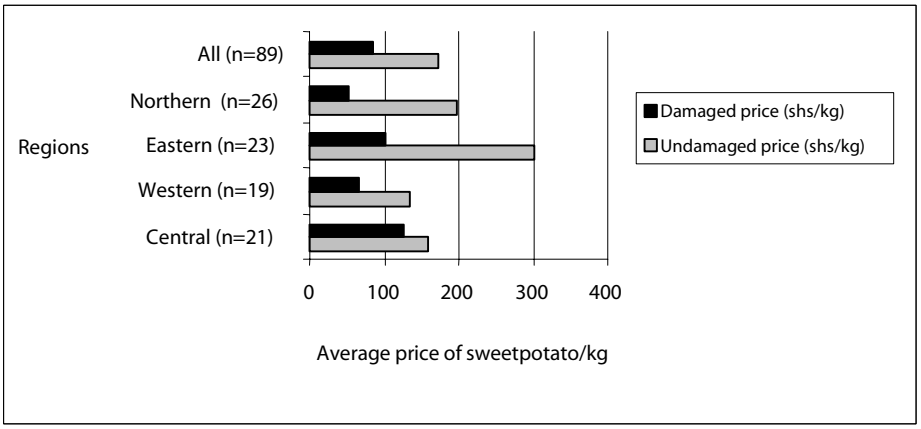



**Figure 5.4** Comparison of prices of damaged and undamaged sweetpotato roots.

There were different causes of damage experienced by sweetpotato farmers but the most predominant was that caused by weevils. Weevil damage was common especially for the manually chipped products like amukeke, otere and inginiyo. Similar findings by Agona (1996) revealed that sweetpotato chips in storage suffered irreversible quantitative and qualitative losses from weevils like *Araecerus f*aculatus*, rhyzopertha dominica, dinoderus minutes, sitophilus zeamais, lasioderma serricorne* and *tribolium confusum*. Farmers who used machine chipping especially in Eastern Uganda reduced weevil attack by improved drying of the chips and reduced surface area for weevil infestation. A shelf life of up to 2 years was experienced.

Vermin (rats, moles and domestic and wild animals) was also another cause of damage both to roots in the garden and to dry stored products. Minimal damage was experienced for non-traditionally processed products since they were sold or consumed within their self-life. Table 5.4 shows the type of damage that was experienced with sweetpotato products and the control measures employed.

Farmers employed a number of control measures to reduce the damage. The most important was the re-drying of the traditionally processed sweetpotato products and the use of biological control methods and natural pesticides (for example the Neem tree leaves and red pepper) to control weevils and vermin. In a study carried out by Owori and Agona (2003) in Rees *et al.,* (2003) it was revealed that farmers' practices of mitigating losses involve regular inspection and re-

drying in the sun and to a lesser extent, opening the granary roof to allow the photophobic insects to escape.

**Table 5.4** Damage experienced with Sweetpotato products and control measures.

| Product | Type of damage experienced | Control measures |
|---|---|---|
| Amukeke | Attacked by weevils | 1. Apply Neem tree leaves between the amukeke<br>2. Boil briefly before drying<br>3. Constant drying and airing of the amukeke<br>4. Use lantana camara<br>5. Cover sacks properly, store in the house and expose to the sun periodically<br>6. Use red pepper<br>7. Store in granary |
| Inginyo | Attacked by weevils | Constant airing and drying<br>Use lantana camara |
| Flour | Solidifies and is attacked by maggots | Constant re-drying and airing |
| Otere | Attacked by weevils; vermin; breaks into small pieces | 1. Constant re-drying<br>2. Use pesticides to control pests<br>3. Control vermin |
| Cookies | No damage experienced | Sold or consumed within self life |
| Ugali | No damage experienced | Sold or consumed within self life |
| Mandazi | No damage experienced | Sold or consumed within self life |
| Pancakes | No damage experienced | Sold or consumed within self life |
| Cakes | No damage experienced | Sold or consumed within self life |
| Machine chips | Vermin attack (rats) | Use of Rat poison, a cat, traps |
| Fried chips | No damage experienced | Sold or consumed within self life |
| Porridge | Bad smell | Prepare small quantities |

## 5.5 Marketing

**Commercialization of Sweetpotato Produce**

Sweetpotato is marketed in two major forms; in the fresh form as roots or as processed products. Table 5.5 indicates the level of commercialization, which was estimated by comparing the number of farmers who sold OFSP and non-OFSP in comparison to those that did not.

**Table 5.5** Sale of sweetpotato by OFSP and Non-OFSP growers

| | OFSP growers n=72 | | Non-OFSP growers n=165 | |
|---|---|---|---|---|
| | **Freq.** | **%** | **Freq.** | **%** |
| **Farmers who sold sweetpotato** | 30 | 41.6 | 84 | 50.9 |
| **Farmers who didn't sell sweetpotato** | 42 | 58.3 | 81 | 49.0 |

The results show that, for those farmers that grow each category of sweetpotato, a substantially higher percentage of farmers (50.9%) sold white and yellow sweetpotato as compared to OFSP (41.6%). When all sweetpotato growers are taken into account, only 18.2% sell OFSP whereas this figure remains at 50.9 percent for non-OFSP. OFSP appears to be at some disadvantage relative to varieties of other colors.

Nevertheless, of the 30 farmers that did grow OFSP, half of these did not note any particular marketing problems. Figure 5.5 shows the nature of problems of the farmers who faced difficulties marketing OFSP.

The most important marketing problem facing OFSP farmers is limited market opportunities. One reason advanced for this finding was that OFSP varieties were relatively new to the populations and many are not aware of its health and nutrition value. Also many consumers mentioned that OFSP had an off or undesirable taste.

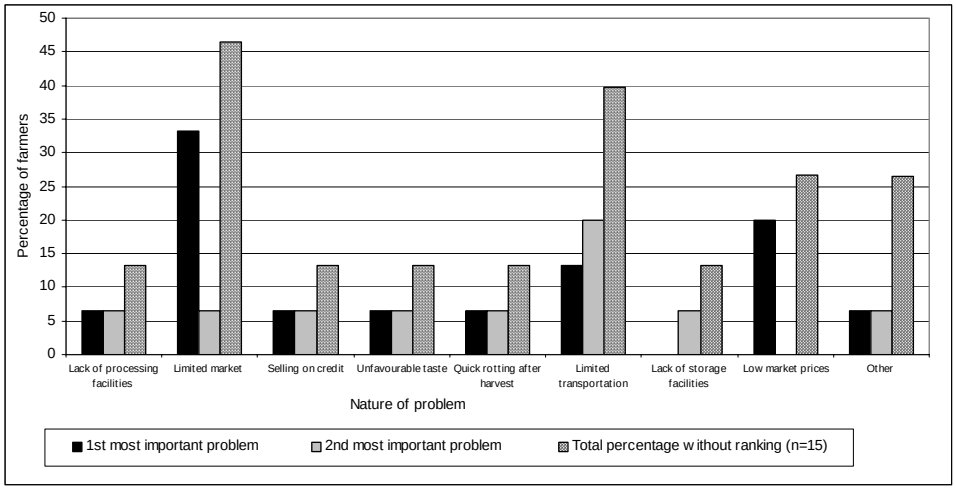



**Figure 5.5**
Most important problems faced in marketing OFSP.

Transportation was found to be the second major constraint that affected OFSP farmers sampled in this study. Sweetpotato is a bulky and highly perishable crop, which necessitates the availability of adequate transportation facilities if it is to get to the market on time. Difficulty in transportation was also attributed to poor road infrastructure. Mwanga *et al.* (1995) underlined that marketing significant level of sweetpotatoes depends on improved road conditions and the availability of transport.

Bashaasha *et al.* (1995) likewise found that the lack of market, high labor costs and unavailability of transport were among the most common marketing problems faced by sweetpotato farmers. Mudiope *et al.* (2000) acknowledged that low prices of fresh sweetpotato was the major constraint to marketing of sweetpotato in eastern Uganda followed by a disorganized market characterized by middlemen haggling for prices, delayed payment and the lack of transport.

An analysis of the price levels across the different regions (Table 5.6) revealed some differences in the high, low and average prices for White-fleshed Sweetpotato (WFSP), Yellow-fleshed Sweetpotato (YFSP) and Orange-fleshed sweetpotato (OFSP) respectively.

YFSP had a slightly higher average, high and low price compared to WFSP and OFSP. The reason advanced for these findings was that buyers found the yellow color attractive and nearer to the white-fleshed varieties that they were used to rather than the orange-fleshed varieties to which they were not accustomed. These results imply that the issue of colour preferences needs to be considered in the promotion of OFSP.

**Table 5.6** Average high and low prices of OFSP, YFSP and WFSP roots

| | **Price (Ugshs./kg ) given by farmers in different regions** | | | | |
|---|---|---|---|---|---|
| | **Central** | **Western** | **Eastern** | **Northern** | **ALL** |
| **OFSP** | | | | | |
| Average price (shs/kg) | 140 | 119 | 102 | 107 | 113 |
| High price/kg(shs/kg) | 166 | 181 | 129 | 123 | 151 |
| Low price(shs/kg) | 69 | 84 | 88 | 82 | 83 |
| **YFSP** | | | | | |
| Average price(shs/kg) | 146 | 117 | 135 | 61 | 116 |
| High price(shs/kg) | 205 | 163 | 194 | 82 | 165 |
| Low price(shs/kg) | 102 | 83 | 107 | 61 | 91 |
| **WFSP** | | | | | |
| Average price/kg | 145 | 124 | 124 | 85 | 113 |
| High price/kg | 190 | 166 | 180 | 119 | 156 |
| Low price/kg | 94 | 87 | 102 | 59 | 82 |

**Note: 1 US $ =** 1,800 Uganda Shillings.

**Sale Points and Buyers of OFSP and OFSP Derived Products**

Generally the most important sale points for sweetpotato products were the local markets (Figure 5.6) followed by shops in the trading centers and fellow farmers, in that order. Other points included village processors, hotels and hawkers.

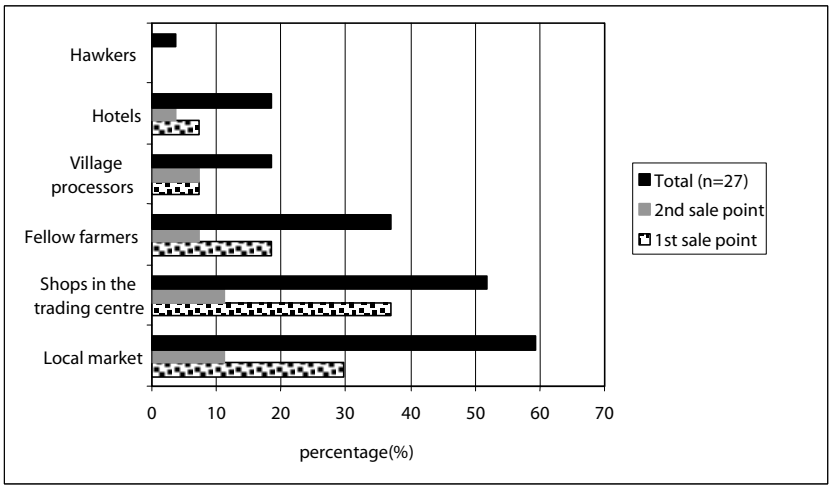



**Figure 5.6** Most important sale points for sweetpotato products.

The buyers of sweetpotato products included traders, individuals and fellow farmers from the local community or village. Figure 5.7 and 5.8 show the different buyers of sweetpotato and its derived products.

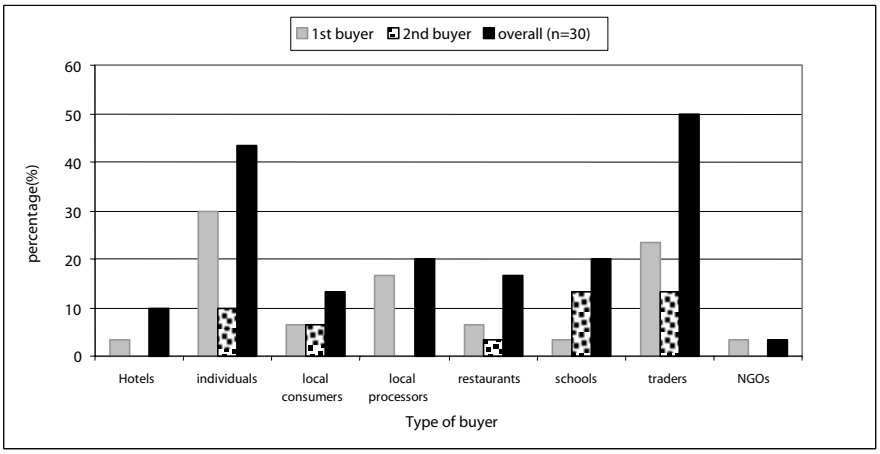
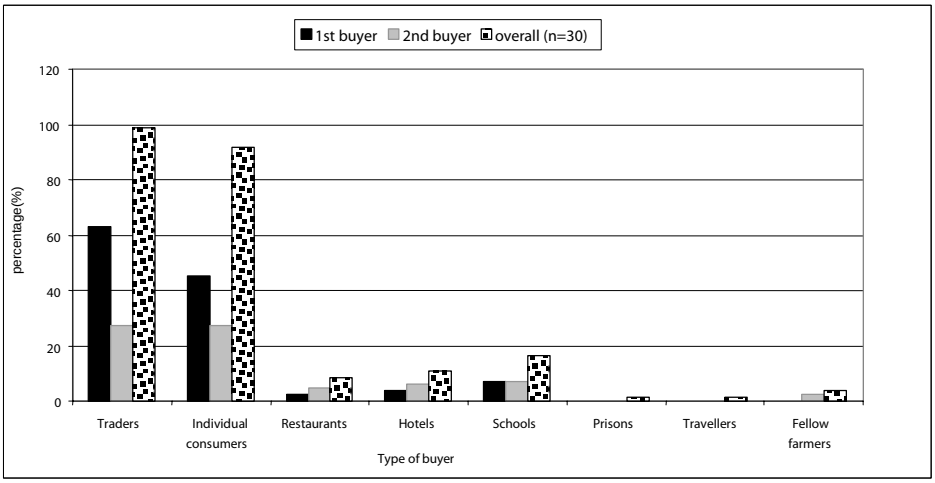



**Figure 5.7** Buyers of OFSP

The most important buyers of both OFSP and non-OFSP were traders (retailers, wholesalers, local brokers and vendors) followed by individual consumers within the local communities.

**Figure 5.8** Buyers of non-OFSP



# 6. CONCLUSIONS AND RECOMMENDATIONS

## 6.1 Introduction

### 6.1.1 The Problem and the Potential

A first set of observations simply reiterates the gravity of the problem of vitamin A deficiency (VAD) and the tremendous potential of orange-fleshed sweetpotato to (OFSP) to help alleviate this serious problem. According to the WHO website (www.who.int/vaccines-diseases/en/vitamina/science/sci02.shtml), VAD is now recognized as a major contributing factor in an estimated 1-3 million child deaths each year, principally in Africa and Southeast Asia. An estimated 250,000 to 500,000 vitamin A-deficient children go blind every year, half of them dying within 12 months of losing their sight. Uganda has one of the highest rates of VAD in Africa. Between 41 and 57% of mothers suffer from VAD and between 22 and 35% of children under 6 suffer from VAD. According to a disability adjusted life years (DALY) analysis for Uganda (Yanggen, 2005) the economic impact in terms of lost human productivity is in a range of 306 to 613 million dollars a year. DALY analysis indicated that OFSP has the potential to decrease the health burden of VAD by 40 to 67%. This health improvement has a potential positive economic impact of 122 to 206 million dollars a year due to increased labor productivity.

The VITAA program has only been in place for about four years. It has been extremely active in promoting OFSP and has made tremendous progress in raising the profile of this crop and its potential for combating the very serious problem of VAD. It has also been key in pushing forward OFSP technologies including improved varieties, post harvest transformation, agronomic management, etc.

This study has shown, however, that only 3.3% of sweetpotato area is planted to OFSP. And given the presence of local land races, the quantity of improved varieties in production due directly or indirectly to VITAA work is likely to be at most half 1-2% of total production. Also, given that these studies were carried out in zones near where interventions had taken place, the figure may be closer to the low side of the 1-2% range nationwide.

Should these low figures lead us to conclude the project is not being successful? Absolutely not. In the few communities where there has been a sustained intervention with OFSP there has been substantial uptake of this crop. But, there has not been much diffusion of the crop beyond the intervention communities.

We believe that this study comes at a propitious time quite early on in the life of the VITAA initiative and right at the beginning of the Harvest Plus initiative. The very ambitious objective of

this study is to present recommendations, now that these initiatives are underway and showing initially promising results, about what it will take to scale up these efforts so they have an important impact across Uganda and neighboring countries.

This particular research initiative has documented OFSP uptake and agronomic management in the field by farmers. It has also examined three thematic areas that we believe are critical to understand in order to make recommendations for promoting the widespread diffusion of OFSP. These include analyses analysis of the preferences for sweetpotato and OFSP, extension strategies used to promote OFSP and post-harvest use of sweetpotato and OFSP.

## 6.2 Vines, Vines and Vines

The issue of vine planting material is the first subsection in the conclusions because it is the key factor upon which all else depends. If vines are not available, the diffusion of OFSP in Uganda will fail. Farmer access to OFSP vine planting material must be the central pillar upon which a program for the promotion of OFSP is built. For this reason a vision for the sweetpotato vine sector receives top billing in the conclusions section.

### 6.2.1 A Vision for the Sweetpotato Vine Planting Material Sector

Most of the world's major crops, such as rice, wheat, maize, and beans are propagated by seeds. Sweetpotato, on the other hand, is propagated with vines. Vine cuttings are taken from a mature plant, they are planted in the ground and, given appropriate agronomic conditions, take root and grow into mature plants and produce sweetpotato roots for human consumption.

The advantage of vine propagation is that improved varieties maintain the characteristics of their parent material over time. This contrasts with hybrid varieties of crops planted by seed that generally lose their improved characteristics. New seeds therefore need to be purchased typically for each cropping season. Vines from sweetpotato plants, however, can in theory be harvested indefinitely for use as planting material. In practice, having a sustainable supply of vine planting material is not so easy.

There are three critical stages necessary to ensure farmers have sustainable access to OFSP vine planting material:

1. Initial provision to communities from external sources
2. Internal multiplication and distribution within the community
3. Inter-seasonal/annual on-farm regeneration

First, OFSP vines need to be distributed to rural communities. This is essentially a function of an external institutional capacity to produce vines and bring them out to communities. The extension system of the Ministry of Agriculture, NAADS, NGOs, CBOs and NARO (National Agricultural Research Organization) have taken a lead in off-farm vine multiplication and provision to communities.

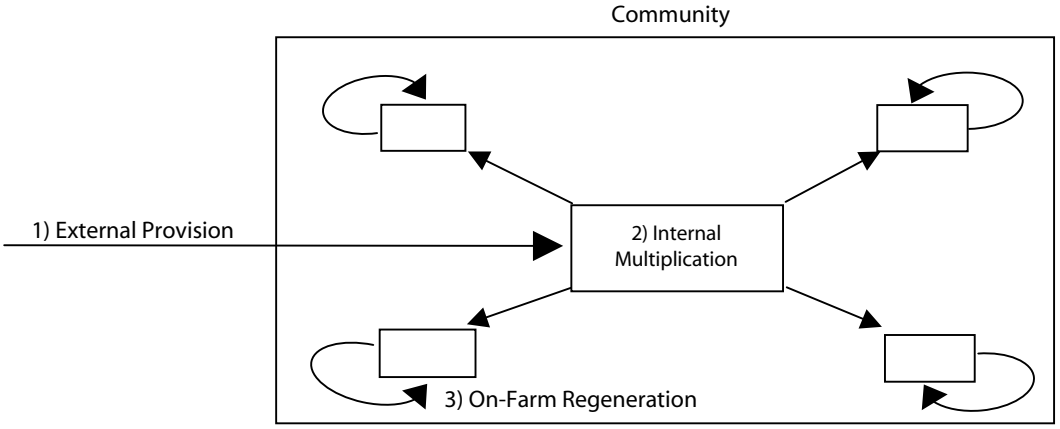



**Figure 6.1** Steps for creating sustainable access to vine planting material.

Second, there is a need to multiply and distribute vines within each individual community. In general, outside institutions will not be able to produce and distribute enough vines so that they are available to a substantial proportion of all the households within a community. It is only feasible in most cases to provide a relatively small amount to communities who must multiply the vines they receive so enough are available to cover the needs of all or most households in the community.

This multiplication and distribution of vines implies the existence of an internal institutional capacity within communities to plant the vines initially provided in nurseries, take care of the plants until maturity, harvest the vines and then establish a mechanism for distributing the vines to individual farmers. An institutional capacity implies that farmers must organize themselves in a collective fashion to carry out the aforementioned tasks. There is no one way that this must be done, but typically community members set up a communal nursery and work collectively to multiply the vines. The communal nursery can also serve as a demonstration plot to teach farmers agronomic techniques for OFSP management. All those who participate in multiplying the vines receive a share of the sweetpotato planting material when the crop is mature that they can then take and plant in their own individual plots.

The key point here is that if vines are distributed to communities without there being an institutional/organizational structure of farmers in place to receive, multiply and distribute vines, then the initial external provision efforts are likely to fail. Often the agriculture extension system and NARO don't have enough of a sustained presence in communities to help facilitate the formation of the needed institutional structures. NGO's and CBO's, on the other hand, generally are able to maintain a greater measure of sustained contact with individual communities to facilitate the multiplication and internal distribution process.

The third critical step is on-farm regeneration. This involves farmers creating their own sustainable supply of OFSP material in order to continue planting season after season. Our contention is that village multiplication plots should be viewed as a necessary intermediate step. However, communal multiplication plots will not be able to produce enough quantity of vines on a sustained basis to achieve the necessary massive diffusion of OFSP that is hoped for. In each community, scores of farmers must be able to sustainably regenerate their own vines if OFSP is to take off in a sustainable manner.

Given the goal of establishing an internal capacity to multiply OFSP vines, a highly complementary component would be to train farmers to multiply disease-free vine planting materials. Diseases are a principal production constraint and disease-free vines can substantially increase yields. Training in this area should be integrated into the overall training needed to establish village-based vine multiplication systems.

Two legitimate questions can be asked at this point. First, what's the fuss? Once farmers get their hands on OFSP vines won't the on-farm regeneration be automatic? Second, what about a commercial vine sector as an alternative to farmer-based vine regeneration? The answer to these questions is important for viewing the way forward for the promotion of OFSP.

Challenges for Sustainable Vine Multiplication and Regeneration within Communities. Why should we be concerned about creating an internal capacity for vine multiplication and regeneration? Won't this happen automatically once OFSP vines are delivered to villages? Vines from white and yellow sweetpotato have had self-sustaining reproduction within communities, so why should OFSP be any different? We've already discussed the need for an initial internal multiplication of vines within communities and the presence of institutional structures in order to carry this out. So for that reason already OFSP vine diffusion is not spontaneous and automatic.

The third step in Figure 6.1, on-farm replication of OFSP vines, presents further hurdles. The principal hurdle involves drought and prolonged dry periods between cropping seasons. Most farmers obtain vines for white- and yellow-fleshed sweetpotato from volunteer plants that sprout from roots left in harvested fields from last season's crop. OFSP, however, is generally much more susceptible to drought and therefore roots left in the field typically do not grow as volunteer plants that serve as a source of vine planting material.

Vine scarcity was mentioned as the number one constraint to the adoption of OFSP. Farmers identified drought as the second most important production constraint for sweetpotato in general and the availability of sweetpotato vine planting material as the third most important production constraint.

Interestingly, OFSP vine scarcity was mentioned with greater frequency as a production constraint in those communities where interventions had been undertaken to promote OFSP. Two factors explain this. First, farmers identified susceptibility to drought as one the principal disadvantages of the OFSP varieties versus non-OFSP varieties. Second, farmers likewise identified susceptibility to drought as one of the principal disadvantages of improved varieties of OFSP in comparison to local landrace varieties of OFSP. In sum, the new varieties of OFSP that have been introduced in intervention communities are more susceptible to drought compared to non-OFSP and local OFSP varieties. This hinders the on-farm replication of these new varieties of OFSP and helps create a bottleneck to the widespread diffusion of OFSP.

There are two principal solutions to this problem of on-farm replication of OFSP vine planting material. The first is to make breeding for drought resistance a principal priority in breeding programs. At the International Potato Center, drought resistance is not an explicit breeding goal, nor is it taken into consideration in the pre-selection of promising clones. This situation needs to change. *If there were one message that was to come out of the research presented here it would be: breed for drought resistance*. Drought resistance is more than just an advantageous agronomic characteristic that can increase production—it is a key linchpin necessary for the widespread diffusion of OFSP via the sustainable propagation of vine planting material.

There is a second important approach to overcoming the bottleneck of OFSP vine planting material. This involves finding appropriate technologies for the propagation of vines. The key issue here is access to water. Many farmers have access to sources of water such as swampy areas and streams during the dry season and can plant vine nurseries. Most, however, do not have access to water. Water is either too far away and it is not feasible to transport for watering a vine

nursery or, as in the case of wells, is in very limited supply during the dry season and is used for priority uses such as drinking, cooking and washing.

One possible solution is for communities to set aside community areas with access to water as spaces where households are assigned individual plots for vine nurseries. This could be next to a steam, a swampy area or a hand pump. One must remember, however, that the time spent walking to and from these plots and watering the nurseries can be substantial. There is therefore a cost associated with this option. Another related option is to use a simple form of irrigation to water an area over the dry season. This could reduce variable costs assuming an irrigation technology were available.

Another option we noted during the fieldwork was the cultivation of OFSP plants during the dry season interspersed throughout a banana-plantain plantation. The OFSP plants benefited from the microclimate underneath plantain plants that retained enough moisture to keep the plants healthy over the dry season. One could add to this that the sweetpotato nursery could be planted under trees near the household area so that water left over from cooking or washing could simply be applied to the OFSP plants.

In general, these solutions for setting up vine nurseries over the dry season would require an important training component from NGO's, CBO's or other institutions working in communities so this would involve a substantial cost for extension activities. In that sense, pursuing the breeding option of developing highly drought resistant varieties could provide the alternative with the greatest potential for rapid diffusion. Pursuing both options concurrently would make the most sense.

Variations on a Theme? The vision of a strategy for vine propagation in figure 6.1 presented a specific set of steps. This is not meant to imply that there may not be other complementary strategies using a variant of the approach outlined in figure 6.1. Alternative approaches, however, must ask the same questions related to the strategy presented above: Is there external provision of vines to the target number of communities? Is there a system in place to ensure the multiplication of vines so enough quantity is available to most households in a community? Is there a technological alternative available to most households for the sustainable regeneration of vines from season to season and year to year?

One variation on the theme presented in figure 6.1 is the use of schools as a production and distribution point for vines. This is a strategy being pursued by the International Potato Center along with diverse collaborators. This strategy is appealing for a variety of reasons.

First, schools are a central gathering point where a large number of individuals (children) from the surrounding communities come together at strategic points with relatively good access. Furthermore, schools are already set up to for educational purposes and working with schools should therefore permit training and education related to OFSP directly to the children at a relatively low cost. Training and education should include agronomic management practices and the nutritional importance of vitamin A and OFSP. Also, at least some of the OFSP produced in school gardens can be fed to the children. This can not only improve their nutritional situation but also help children develop a taste for OFSP so they start to demand it for home production and consumption. The plan is then to distribute the vines to children at appropriate moments when they return home to their communities during school vacations. This would again lower costs by having the children transport the vines to their households and transmit their knowledge on agronomic management and nutritional benefits to their families.

Nevertheless, it is necessary to ask the same questions of this approach. First, do the schools have a source of water to ensure a replication of vines over the dry season? In most cases, this should be an advantage of schools in that most should have access to water from wells or hand pumps that could be used to water vine nurseries. In terms of internal multiplication, school gardens would take the place of community multiplication plots. Each child could be assigned to take care of enough plants to ensure a reasonable supply of vines for his/her family. Multiplication (step 2) in this context would precede the external distribution (step 1) undertaken by children returning home.

The key question is whether inter-seasonal and inter-annual reproduction of OFSP planting material within communities (step 3) is ensured over time. This will be a function of the severity of the dry seasons between cropping seasons, the level of drought resistance of the OFSP varieties provided, farmer's access to water to plant nurseries, and the amount of training provided to children and their families concerning on-farm replication. Our recommendations for this initiative are: i.) to the degree possible provide drought resistant varieties to schools, ii.) train children in on-farm regeneration methods, and iii.) provide some case study follow ups from the inception of this initiative to analyze both the success of the programs at the schools and to go into the villages to document what happens to the vines after they arrive there. Early monitoring

and evaluation of these promising efforts will allow for adjustments that could mean the difference between long-term success and failure.

Constraints Facing the Development of a Commercial Vine Sector. The development of a commercial OFSP vine sector is not realistic for the short-run needs of providing planting material to farmers. The basic reason for this is simple. Sweetpotato, including OFSP, is predominately a subsistence crop. Farmers sell very little of the sweetpotato they produce and they purchase almost none of the sweetpotato they consume.

In addition, farmers use little or no purchased inputs in the production of sweetpotato. First of all, they have little incentive to purchase productivity enhancing inputs if their investment in purchasing these inputs does not generate increased income because of the subsistence nature of the crop and low market prices. Second, farmers often do not have the capacity to purchase inputs because of the extreme poverty prevalent in rural areas of the country and because agriculture overall continues to be predominantly subsistence i.e. it generates minimal disposable income. Bashaasha *et al.* (1995) notes that, at current sweetpotato prices, the use of chemical inputs is generally not economical.

Commercial vine planting material is another form of purchased input. Farmers currently do not purchase vines to any significant degree as a source of planting material. This is unlikely to change in the short term for a simple reason: nearly 80% of Uganda's population remains rural. In order for sweetpotato commercialization to increase substantially, there needs to be an urban demand pull for this product. Urbanization, while clearly an important phenomenon, is not a phenomenon likely to change the commercial dynamics of sweetpotato in the short to medium run.

The purchasing of OFSP vines is also unlikely because there is no indication of a competitive advantage of OFSP versus white or yellow varieties. Field data indicates that there is neither a yield nor a price advantage in general for OFSP. Even if the proportion of commercialization of sweetpotato were greater, buying vines for the production of OFSP instead of other sweetpotato would not be justified in terms of additional revenue generated. The purchase of an input such as fertilizer, on the other hand, would at least increase production and thus offer the potential for greater sales and income from sweetpotato.

The commercial vine sector that does exist predominantly serves the needs of the research and development community who have a public mandate to distribute vines to local farming communities. Efforts to support an incipient commercial vine sector that serves the public sector,

for example via the formation of women's producer groups, are worthwhile in that they can help support initial distribution efforts. Furthermore, using local individuals or producer groups to sell vines to the public sector can help promote OFSP production and consumption in local communities and give a strong initial impetus to diffusion efforts by providing an important source of income. In the long run, these initial efforts will likely form the basis of a commercial sector that serves and increasingly commercialized agricultural sector.

Nevertheless, the public sector purchase of vines constitutes a very small proportion of the total amount of vines needed for planting material in the country and does not reflect a generalized potential to generate incomes in the context of sustained short and medium term growth in a commercial vine sector. Public (including NGO) sector purchases of vines represent and will continue to represent a very small niche market. These efforts should therefore be seen as part of a broader strategy, i.e. they can help "prime the pump" of initial diffusion efforts while the predominant short to medium term focus of extension efforts is on creating an internal capacity within communities for the multiplication and inter-seasonal replication of vine planting material.

## 6.3 Analysis of Farmer Preferences for Sweetpotato Varieties

The reason for analyzing preferences for sweetpotato varieties is to attempt to identify those key characteristics that are most likely to lead farmers to adopt improved varieties. This subsection of the conclusions chapter summarizes the findings concerning preferences. It is hoped that a key audience of these particular findings will be breeders working on varietal improvement so they can take into consideration these farmer preferences.

The principal varietal characteristics currently bred for at CIP are virus resistance and high beta-carotene content (and to a lesser degree high iron and zinc content) using varieties known to have relatively high yields and early maturation. Varieties are also bred to achieve higher dry matter content.

The two highest priority characteristics of sweetpotato identified by farmers are yields and taste. Researchers give high importance to yields during varietal field trials in terms of deciding on what varieties to select for release. Farmers mentioned yield as both a favorable and an unfavorable characteristic of OFSP varieties in roughly 10% of the total responses. Data from this research's survey are more clearly negative. They indicate that OFSP has 23% and 28% lower yields compared to countrywide averages for white- and yellow-fleshed varieties respectively. Furthermore, local land race varieties of OFSP were given higher positive ratings in terms of yields

compared to improved OFSP varieties. In sum, new varieties of OFSP have not to date clearly distinguished themselves in the field in terms of their yield advantage.

This question needs to be looked at more carefully because initial researcher trials with some of the improved OFSP varieties showed promising yield potential. It would be worthwhile to follow up and determine if these varieties are performing well under real world field and farmer management conditions. Participatory on-farm research trials managed by farmers would be particularly useful in this context. In general, it appears there is room for improvement in yields of OFSP varieties and breeding efforts should continue to emphasize yield.

Taste as a consumer characteristic, on the other hand, is not given explicit attention in breeding efforts. Taste is mentioned as both one of the principal advantages and disadvantages of OFSP. In general, OFSP tends to be sweeter than most other varieties of sweetpotato and sweetness is the principal preferred taste characteristic of sweetpotato.

Many individuals dislike OFSP because of what they describe as an "off" taste. Tastes do evolve over time and we hypothesize that part of the negative perception of OFSP is simply because it is different and individuals could very well become accustomed to the different taste over time. Children, for example, who don't have long established preferences generally strongly favor OFSP, an important result given that, along with mothers, they are the principal target group for OFSP. Given both the importance of taste for sweetpotato and the ambiguities surrounding taste preferences for OFSP, it only makes sense to involve sweetpotato consumers in identifying varieties with preferred sensory characteristics.

Perhaps the next most important preference was not what was high on the list, but rather what came in last on the list: nutritional value. Indeed, if we only include non-intervention communities that are representative of the country as a whole given the tiny proportion of intervention communities nationwide, this would not even have registered as a valued characteristic. Furthermore, men, who are primarily responsible for making cropping decisions, never mentioned nutritional value as a priority characteristic. There are two key aspects to this problem: i.) recognition of nutritional problems as priority health concerns and ii.) knowledge of the potential of OFSP to solve nutritional problems.

Nutritional problems in general and Vitamin A deficiency (VAD) related ailments in particular are not recognized by rural individuals as priority health problems. Only seven percent of households mentioned any type of nutritional problem as a priority health problem for children in their

communities. Furthermore, not one survey respondent mentioned VAD or a VAD-caused illness as a priority health problem in their community. Statistics and health studies indicate the gravity of VAD but this is not perceived by individuals living in rural communities. A study by Low *et al.* (1997) in Kenya likewise found a general lack of knowledge of VAD in sweetpotato producing communities.

The implications of this are two-fold. First, in the short and medium-term, nutritional concerns cannot be depended upon to push the adoption of OFSP so therefore OFSP must be competitive with white and yellow varieties in terms of agronomic, consumer and economic characteristics if it is to be successful. It must compete favorably in terms yields, taste, price, etc. in order to achieve good rates of adoption.

Second, nutritional education campaigns must be an integral part of the promotion of OFSP. To date there generally has been a nutritional component to most interventions. The key point, however, is that the challenge of nutritional education may be greater than imagined given the lack of perception of VAD-related problems on the part of intended beneficiaries. It is not enough for rural individuals to be informed of VAD and the potential of OFSP as a cure. In order to achieve a significant degree of behavior change among the rural population, individuals need to be convinced there is a payoff that will truly affect their quality of life. This is likely to take time and will need some degree of empirical evidence to convince a critical mass of people. In the mean time, it is vital that OFSP varieties are competitive with the currently dominant varieties.

Given the need for intensive nutritional education to promote OFSP, it is troubling that no respondent in our survey of households in rural communities mentioned an institution from the health sector as having been a source of information about OFSP. There is a long tradition of separation between different sectors in developing countries (and developed countries for the matter) and the health and agriculture sectors in Uganda are no exception. OFSP is clearly an example of where there is a complementary role for each. There is, in fact, a fairly extensive network of rural-based health clinics throughout Uganda. Community health workers need to receive training so they become a principal source of the message promoting OFSP. Pushing the envelope even further, rural health clinics could have a small garden plot of OFSP and provide vines to those households that come to visit as part of their "prescription" for at-risk individuals.

Early maturity came out as the third most important characteristic farmers look for in a sweetpotato variety. This characteristic, however, receives relatively lower prioritization in breeding programs. Early maturity may be more important than research and development

agencies realize for the following reasons. First, rural households often suffer from food shortages in the "hungry season" that reaches its highest point before the harvest of the new crop. The ability to harvest a sweetpotato crop early could substantially shorten this hungry season.

Furthermore, piece-meal harvesting is a very common practice with sweetpotato. Even individual sweetpotato plants can be harvested piece-meal as it is possible to dig out the biggest roots and the plant is not significantly damaged and continues to grow with the remaining roots reaching a mature size. Early maturity allows farmers to stretch out the piece meal harvesting over a longer period of time. Increasing harvest duration gives farmers access to fresh roots for a longer period of time and longer in-ground storage lessens post-harvest storage problems.

Furthermore, early maturity along with piece-meal harvesting is also useful because it allows farmers to spread out over time labor intensive harvesting that involves digging up roots from the ground. This practice also allows farmers to sell small quantities at a time. Finally, early maturity allows farmers to harvest the produce before insect and disease infestations become severe. In sum, the specific nature of the sweetpotato production system makes early maturity a particularly important characteristic that merits more emphasis by breeding programs.

The next two characteristics preferred by farmers are disease/pest and drought resistance. Farmers were often not able to distinguish between different types of diseases and pests so these were grouped together as a general category. Evidence generally indicates that weevils and viruses top this list. Nevertheless, viruses are just one component of the disease/pest problem identified by farmers. There is, however, a predominant focus on virus resistance in agronomic breeding efforts. Given the diversity of farmer's preferred characteristics and the fact that pest and disease resistance is not the predominant priority characteristic mentioned by farmers, a breeding program giving greater emphasis to a wider range of objectives may be justified. We realize that are limits to the number of goals that breeders can simultaneously work on at once, but a greater attention to the other preferences expressed by farmers could help improve breeding results in terms of the ultimate goal of varietal adoption. Drought certainly should be emphasized as priority breeding objective for the reasons discussed at length in the previous section of this chapter.

## 6.4 Analysis of Extension Strategies

Extension strategies are critical to the diffusion of OFSP. Extension is the link between research on high beta-carotene OFSP varieties and the farmer. This chapter has already touched on some

important issues concerning extension strategies related to vine planting material. This subsection builds on and complements that previous discussion.

There is some good news related to extension efforts: in communities that have received sustained interventions to promoted OFSP, there has been significant uptake of these varieties. On average, OFSP has gone from 3.2% of total production to 22.4% of total production in intervention communities. The frequency of farmers that produce OFSP increased from 21.7 to 64.3%. Likewise, the frequency of farm households stating that they consume OFSP jumped from 25 to 69%. In addition, there was a huge jump in the number of respondents who identified nutritional benefits as one of the principal advantage of OFSP.

Intervention efforts are clearly having an impact in the communities they serve. They do not, however, appear to be having an important spillover effect on nearby communities. Our discussion of the previous section of vine propagation proposed some concrete solutions to the spillover issue. A look at some specific results of the analysis of OFSP extension strategies provides some further insight into promotional efforts.

The four most common sources of information about OFSP were from NGO's, other farmers, NARO and the state agricultural extension service. Farmers rated these latter two as the least effective whereas the former two were rated as the most effective. That community members should rate NARO and extension services low should not be so surprising in that they are more involved in the upstream research and external provision of vines to communities. They play an important role but one that is often less visible to farmers.

NGO's and other farmers are able to help with steps 2 and 3 of figure 6.1 that are internal to the community: vine multiplication and inter-seasonal regeneration. NGO's are generally the institutions that have the most sustained presence within communities and are mentioned as being heavily involved in setting up community multiplication plots. Other farmers are the source most able to provide information about vine multiplication and regeneration based on first hand experiences.

The effectiveness rankings that farmers gave to specific extension strategies also reflected this internal-external dichotomy. The least effective strategies involved off-farm trainings and workshops. Those rated as the most effective involved the planting of demonstration and multiplication plots within communities. These plots not only provide first hand observational and practical experience with OFSP management under local conditions, they also helped ensure

a capacity for an internal multiplication of vines so they can be widely distributed among households within the community. The two most important constraints to adoption identified by farmers were indeed the lack of vine planting material followed by a lack of knowledge of OFSP.

One of the most common criticisms of extension by farmers was the delivery of vines without training on how to use them. Farmers even mentioned instances where vines were delivered during the dry season when it was impossible to plant them so they withered and went to waste. The key point is that external provision activities need to be coordinated with internal multiplication and regeneration activities. This may imply a certain division of labor, for example, NARO and extension may focus on the external provision and they in turn coordinate with NGO's and CBO's to train farmer groups to ensure the internal multiplication and regeneration of vines.

Another observation concerning OFSP promotion involves gender relations. Many OFSP interventions, particularly those that focus on nutrition, target only women. There is clearly some basis for this in that women are the household members responsible for family nutrition and food preparation. However, it should be remembered the very frequently men are the household members responsible for making production decisions. In the question about preferred characteristics of sweetpotatoes (of any color) women ranked nutritional value as the fourth most important characteristic in terms of the frequency of this response. Men's response rate for nutrition was zero. Clearly men need to be involved to some degree to ensure that production decisions made by men take into account nutritional advantages.

## 6.5 Post-Harvest Utilization of OFSP

Post-harvest utilization issues deal with the consumption, processing, storage and sale of OFSP. The good news from the post-harvest analysis of OFSP involves who is consuming it and how it is consumed. The two most vulnerable groups in terms of VAD are also those that consume the most sweetpotato and OFSP. 89% and 69% of children are the most frequent consumers of OFSP and non-OFSP respectively and 70% and 69% of women are either the first of second most frequent consumers of OFSP and non-OFSP respectively. Given that over 90% of households in Uganda consume sweetpotato, the potential to reach these vulnerable groups with OFSP is extremely high. If a substantial proportion of overall sweetpotato production is constituted by orange varieties and there is reasonable regional distribution, then it is safe to assume a high percentage of individuals in the target vulnerable groups will be consuming OFSP. In addition, the principal means of preparing sweetpotato are boiling and steaming, both of which have been shown to have very high rates of retention of beta-carotene.

The bad news is that there is very little post-harvest processing of OFSP. Only about 16% of farmers engage in this activity and almost all is of a traditional sort for storage as opposed to value-added transformation. The storage transformation technologies principally involve chipping and drying or chipping, drying and milling into flour. This is principally done in the drier regions. The drier regions have a unimodal rainy season and therefore a greater need to store production over the extended dry season. The longer dry season also facilitates the drying and subsequent storage. The bad news about drying is that it causes a relatively high rate of reduction in beta-carotene levels. Hence there is a need for exploring simple processing techniques and screening varieties for retention capacity.

Only 5.5% of households that produce OFSP engage in value added transformation of OFSP into products such as juice, bread, donuts, pancakes, cookies and cakes. The only individuals that engaged in this type of transformation were those from intervention villages. The subsection on the (lack of) potential for a commercial vine sector discussed the very limited market opportunities for fresh sweetpotato. This is even truer for processed products in a very poor country that cost more for urban consumers. There simply is not currently a large enough urban (or rural) market for these transformed products to encourage an important number of farmers to engage in these activities. Where there are niche markets available, there is nothing wrong with promoting these products as an income generating strategy. However, the goal of VITAA and Harvest Plus is to get a majority of farmers to cultivate a significant proportion of their sweetpotato area in orange-fleshed varieties and even the sum of these niche markets will not have a significant impact on achieving that goal.

Farmers rank markets as the main constraint to the commercialization of OFSP. This is not surprising given that roughly 80% of the population is rural and only 20% is urban and because sweetpotato is principally a subsistence crop. Rural households themselves only purchase 5% of the OFSP and 3.8% of the non-OFSP they consume. Right now only 3.8% of sweetpotato sold in urban markets is OFSP. This coincides closely to our estimate of the amount of OFSP as a percentage of overall sweetpotato area in production indicating that the market share is roughly proportional to the share in production. There does not appear to be any consumer preference for OFSP varieties in terms of the amount purchased and OFSP price is equivalent to that of other colored varieties.

The best hope for improving the commercialization of OFSP is to try increase the market share of OFSP versus non-OFSP sold in urban markets. The 3.8% market share provides ample margin. Market share is principally a function of consumer demand, which, at this point, is largely

indifferent. Given that urban rates of VAD are nearly as high as rural rates of VAD, the promotion of OFSP should not be limited only to the rural sector, but include urban consumers as well.

The inclusion of urban consumers in OFSP promotional efforts will have a double benefit in that it will not only benefit the health of urban consumers who eat OFSP, it will also spur the production of OFSP in rural communities for sale to urban markets. Rural production will create an important spillover effect to rural households who almost always eat a substantial proportion of their own sweetpotato production.

This approach has a greater aggregate potential than, for example, the promotion of value added OFSP products in the short and medium term. However, to be clear, even the urban market for fresh produce has significant limits as expressed above. The principal strategy at this point in time must be on increasing the amount of OFSP as a percentage of overall sweetpotato that is produced and consumed internally within rural communities.

## 6.6 Final Conclusions

As previously stated, the very ambitious goal of this research is to make recommendations concerning the necessary conditions and proposed strategies for the widespread diffusion of OFSP in Uganda with implication for other countries in the region. We hope our analysis of vine planting material multiplication strategies, varietal preferences, extensions strategies and post-harvest use of sweetpotato in general and OFSP in particular has given at least some modest insights towards that goal.

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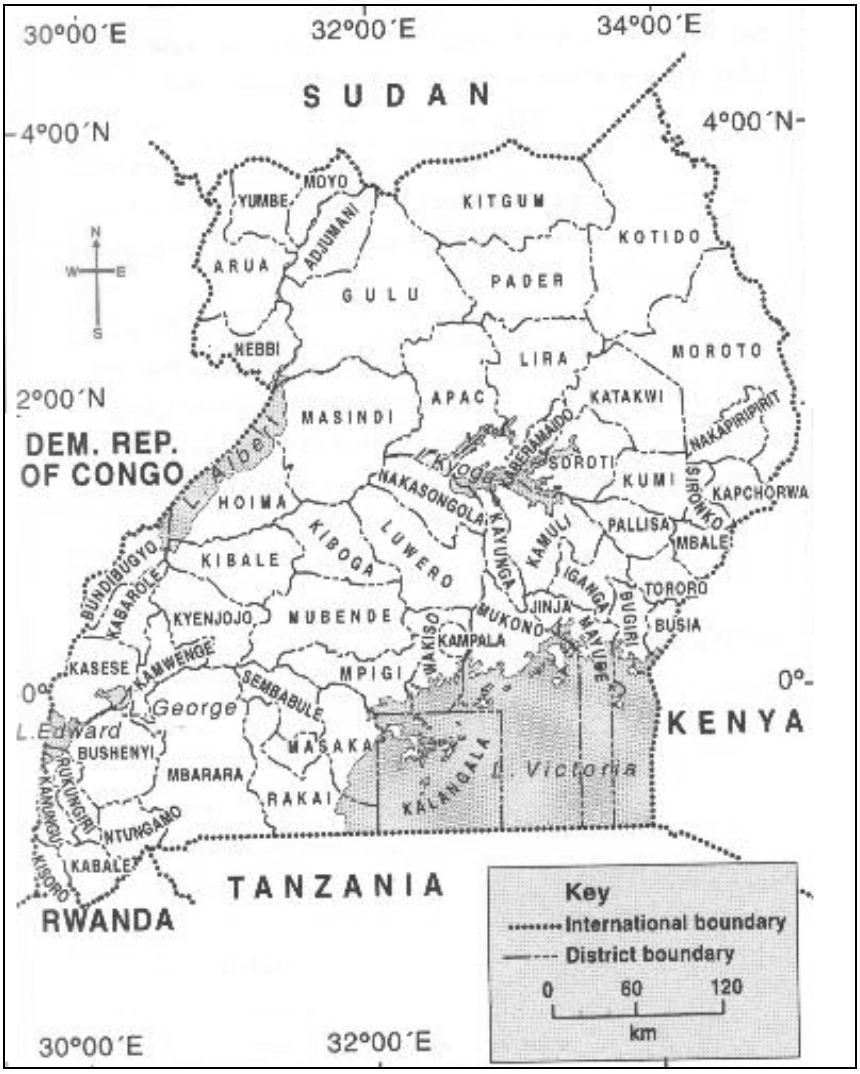
## APPENDIX 1. MAP OF UGANDA SHOWING ALL THE DISTRICTS

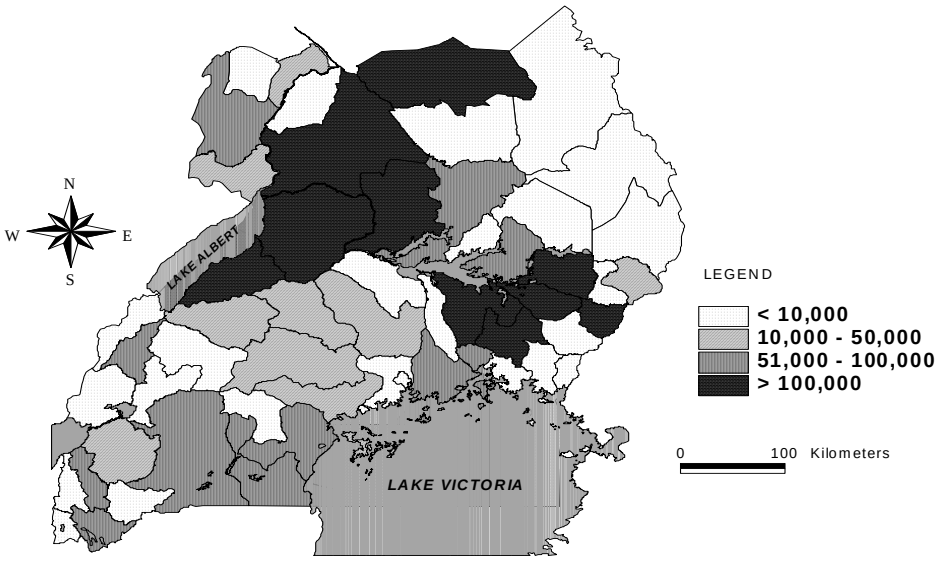


## APPENDIX 2. UGANDA'S AGRICULTURAL SYSTEMS AND MAJOR CROPS

| Farming system | Districts | Major crops grown |
|---|---|---|
| Teso System | Soroti, Kumi, Katakwi | Cotton, Finger Millet, Sorghum, Groundnut, Simsim, Sweetpotato And Cassava |
| Banana/ Coffee System | Bundibugyo, Parts of Hoima, Kabarole, Mubende, Luwero, Mukono, Masaka, Iganga, Jinja, Mpigi and Kamapala | Robusta Coffee, Banana, Maize, Beans, Sweetpotatoes, Cassava, Horticultural Crops, Tea And Groundnut |
| Banana/Finger Millet/Cotton System | Parts of Masindi, Luwero, Mukono, Kamuli, Pallisa, Tororo | Cotton, Robusta, Coffee, Beans And Maize |
| Northern System | Gulu, Lira, Kitgum and Apac | Cotton, Tobacco, Simsim, Finger Millet, Sorghum, Cassava And Sunflower |
| West Nile System | Moyo, Arua and Nebbi | Tobacco, Cotton, Arabica Coffee, Simsim, Millet, Sorghum, Cassava And Groundnut |
| Montane System | Kabale, Rukungiri, Kisoro, Bushenyi, Kasese, Parts of Kabarole, Mbarara, Mbale and Kapchorwa | Arabica Coffee, Banana, Cotton, Maize, Beans, Wheat, Millet, Rice, Potatoes And Sweetpotato |
| Pastrol System | Rakai, Parts of Mbarara and Masaka, Kotido and Moroto | Millet, Cassava, Sorghum, Beans And Maize |

**Source:** MAAIF and MFED (2000).

## APPENDIX 3. SWEETPOTATO PRODUCTION IN MAJOR SWEETPOTATO GROWING DISTRICTS




| Region | District | Average annual Production (1992-2003) (tons) | Average Area under production (ha) | Yield (t/ha) |
|---|---|---|---|---|
| **Central** | Rakai | 76,16.4 | 17,813.0 | 4.3 |
| | Mukono | 72,648.6 | 17,424.5 | 4.2 |
| **Eastern** | Iganga | 121,716 | 29,029.8 | 4.2 |
| | Kamuli | 92,78.6 | 22,037 | 4.2 |
| | Kumi | 99,391 | 25,091 | 4.0 |
| | Mbale | 147,421 | 34974 | 4.2 |
| | Palisa | 98,935.9 | 11,999 | 8.3 |
| **Northern** | Apac | 113,345.5 | 26,988 | 4.2 |
| | Kitgum | 102,537 | 49,856 | 2.1 |
| | Gulu | 99,672 | 24,294 | 4.1 |
| | Lira | 55,471 | 14,938 | 3.7 |
| **Western** | Hoima | 113,509.9 | 24,855.3 | 4.6 |
| | Masindi | 107,509.8 | 25786.4 | 4.2 |

**Source**. MAAIF data (2004)

## APPENDIX 4. SELECTION CRITERIA FOR STUDY AREAS

Selection of study areas was based on a score that was derived as follows:

**Score** = Total VAD prevalence of women and children per region/ highest VAD prevalence of women and children + per capita sweetpotato production per district/highest per capita Sweetpotato production

**Ranking: priority areas were chosen based on the total score**

1st tercile = High priority study area

2nd tercile = Medium priority study area

3rd tercile = Lowest priority study area

**Selection of study area by ranking based on prevalence of vitamin A Deficiency (VAD) and sweetpotato production**

| DISTRICT | SCORE | RANKING BY TERCILE |
|---|---|---|
| Hoima | 2.00 | 1st tercile |
| Kumi | 1.77 | |
| Masindi | 1.70 | |
| Soroti | 1.63 | |
| Kabarole | 1.58 | |
| Mbale | 1.57 | |
| Pallisa | 1.52 | |
| Jinja | 1.50 | |
| Kabale | 1.48 | |
| Luwero | 1.47 | |
| Iganga | 1.47 | |
| Rukungiri | 1.47 | |
| Rakai | 1.44 | |
| Apac | 1.41 | |
| Kamuli | 1.35 | |
| Kapchorwa | 1.29 | |
| Moyo | 1.29 | |
| Mukono | 1.22 | |

| | | |
|---|---|---|
| Mpigi | 1.20 | 2nd tercile |
| Mbarara | 1.20 | |
| Tororo | 1.18 | |
| Arua | 1.18 | |
| Nebbi | 1.18 | |
| Lira | 1.17 | |
| Bushenyi | 1.15 | |
| Kibaale | 1.11 | |
| Wakiso | 1.10 | |
| Kisoro | 1.06 | |
| Mubende | 1.04 | |
| Bundibugyo | 1.04 | |
| Masaka | 1.01 | |
| Kasese | 1.00 | |
| Ntungamo | 1.00 | |
| Kamwenge | 1.00 | |
| Kanungu | 1.00 | |
| Kyenjojo | 1.00 | |
| Moroto | 0.97 | 3rd tercile |
| Bugiri | 0.95 | |
| Busia | 0.95 | |
| Katakwi | 0.95 | |
| Kaberamido | 0.95 | |
| Mayuge | 0.95 | |
| Sironko | 0.95 | |
| Kampala | 0.94 | |
| Nakasongola | 0.94 | |
| Sembabule | 0.94 | |
| Kayunga | 0.94 | |
| Adjumani | 0.92 | |
| Gulu | 0.92 | |
| Kitugum | 0.92 | |
| Kotido | 0.92 | |
| Nakapiripirit | 0.92 | |
| Pader | 0.92 | |
| Yumbe | 0.92 | |

**Notes:** Kalangala district was removed because it was an outlier and would therefore bias the ranking.

**Sources of data:**
Derived from sweetpotato production statistics by District (MAAIF 2004)
Uganda Demographic Health Survey (2001)

# Acronyms and Abbreviations

| | |
|---|---|
| **ADRA** | Adventist Development and Relief Agency |
| **BUCADEF** | Buganda Cultural Development Foundation |
| **CBOs** | Community Based Organizations |
| **CEDO** | Community Enterprise Development Organisation |
| **CIP** | International Potato Center |
| **COWO** | Concerned Women |
| **DHS** | Demographic Health Survey |
| **FAOSTAT** | Food and Agricultural Organization Statistics |
| **HODIFA** | Hoima District Farmer's Association |
| **IC** | Intervention Community |
| **JAF** | James Arwata Foundation |
| **MOST** | The USAID Micronutrient Program |
| **MADDO** | Masaka District Development Organization |
| **NAADS** | National Agricultural Advisory Service |
| **NARO** | National Agricultural Research Organization |
| **NGOs** | Non-Government Organizations |
| **NIC** | Non-Intervention Community |
| **OFSP** | Orange-Fleshed Sweetpotato |
| **PRAPACE** | Regional Potato and Sweetpotato Improvement Network in Eastern and Central Africa |
| **RADFA** | Rakai District Farmer's Association |
| **SOCADIDO** | Soroti Catholic Diocese Development Organization |
| **VAD** | Vitamin A Deficiency |
| **VEDCO** | Volunteer Efforts for Development Concerns |
| **WFSP** | White-Fleshed Sweetpotato |
| **YFSP** | Yellow-Fleshed Sweetpotato |

The International Potato Center (CIP) seeks to reduce poverty and achieve food security on a sustained basis in developing countries through scientific research and related activities on potato, sweetpotato, and other root and tuber crops, and on the improved management of natural resources in the Andes and other mountain areas.

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**International Potato Center**

Apartado 1558 Lima 12, Perú • Tel 51 1 349 6017 • Fax 51 1 349 5326 • email cip@cgiar.org