RAPID MULTIPLICATION AND DISSEMINATION OF SWEETPOTATO VARIETIES WITH HIGH YIELD AND ß-CAORTENE CONTENT.

DFID CPP-FUNDED PROJECT No. ZA0483/R8040

Implemented by: Buganda Cultural and Development Foundation (BUCADEF)
Managed by: Regional Network for Improvement of Potatoes and Sweetpotatoes in Eastern and Central Africa (PRAPACE)

Final Technical Report

.

UGANDA, March 2004

Executive Summary

The project aimed at reducing food insecurity, poverty and malnutrition among small-scale farmers in eight districts of central Uganda. This was to be achieved through increased multiplication, distribution, production and consumption of sweetpotato varieties that are not only high yielding and virus resistant but also rich in ß-carotene (a precursor to vitamin A).

It was conceived that promoting production, consumption and utilization of such varieties, particularly among children below six years of age and lactating mothers would contribute to alleviating vitamin A deficiency (VAD) in the project area. According to the 2001 Uganda Demographic and Health Survey and the World Health Organization, Vitamin A deficiency is a clinical problem in the country, with incidences of 30% and 50% among children and women, respectively. The project's major objectives were to establish a sustainable, system for multiplication and timely distribution of planting material of improved sweetpotato varieties, enhance capacities of farmers to produce planting material, educate communities about the role of vitamin A, promote the production and consumption vitamin A-rich sweetpotato varieties to alleviate VAD deficiency and establish/strengthen inter-institutional linkages between BUCADEF and other partners with common goals

In all 8-project districts de-centralized informal farmer-based planting material multiplication farms were established. These are operational supplying quality-planting material of improved varieties to farmers on a timely basis. These farms are increasingly operating on a commercial basis surprisingly in a region where sale of sweetpotato vines was supposed to be a social taboo. The business of producing sweetpotato planting material for sale is very profitable fetching much more money (about 10 times more) than from sale of fresh roots, contributing greatly to the sustainability the farms.

The same farms have in the project's lifetime disseminated at least 10 improved varieties to over 6,000 other farmers and sold planting material that can estimatedly plant over 2,000 hectares. In general, including multiplier effects, BUCADEF estimates that over 60% of about 60,000 farmers that the NGO serves in Central Uganda have accessed improved varieties. Consequently, on-farm productivity has at least tripled. It is conservatively estimated that over 34,000 metric tons of improved sweetpotato worth over UK £1,200,000 was produced in the project area during the lifetime of the project. The increased income helped the communities to improve their livelihoods expressed by such concrete evidence as living in better houses, owning more permanent properties such as land, sending more children to schools and improved access to better food.

There are clear indications that the proposed approach of promoting production and consumption of orange-fleshed sweetpotato (OFSP) to alleviate

VAD can work well. The rapid adoption of OFSP in the project areas coupled with the findings of a collaborative study in Kenya that showed that regular intake of at least 100 grams per day of orange-fleshed sweetpotato provides the required daily allowances of vitamin A for children under six, is clear evidence that the food-based approach to overcome VAD is the right approach. Over sixty percent of planting material that secondary and tertiary multiplication farms sold was of the orange-fleshed type. Districts that are most affected VAD were the most responsive in multiplying orange-fleshed varieties that are gaining popularity particularly among children and their mothers, the real target groups. There are testimonies that OFSP improved the sights of children and the elderly and helped the poor living with HIV/AIDS. Factors that negatively influenced adoption rates were unavailability of credit, variations in consumer preferences, unavailability and high prices of planting material, and poor transportation facilities from farm to market and vice versa.

The project was successful in establishing and/strengthening inter-institutional linkages between BUCADEF and networks (PRAPACE, Foodnet), National Agricultural Research organization (NARO), extension services, farmers, processors, international research centres and donors. Also established was strong working relationship with the Vitamin A for Africa (VITAA) initiative that is coordinated by the International Potato Center. It also contributed to bringing together the strategic partners in agriculture, health & nutrition.

The project contributed greatly to getting another DFID-sponsored project in the Crop Post-harvest Project (CPHP), which is currently in progress. The CPHP projects is run by a coalition of 11 partners from various disciplines managed by PRAPACE.

Background

Lack or shortage of improved varieties that are acceptable to farmers and other end users is a primary constraint to sweetpotato production not only in Uganda's central region, but also in the entire eastern and central African region (PRAPACE, 2003). The situation is further aggravated by the lack of formal systems in the country entrusted with the responsibility of producing and distributing quality planting material of vegetatively propagated crops such as sweetpotato (Bashaasha et, al 1995). By improved variety is meant those varieties that are more productive and more resistant to prevalent diseases.

Sweetpotato Virus Disease (SPVD), caused by a combination of sweetpotato chlorotic stunt virus and sweetpotato feathery mottle virus is the main disease limiting sweetpotato production in Uganda occasionally causing root yield losses of up to 100% (Karyeija *et al*., 1998). However, poverty, lack of proper linkages to markets, limited post-harvest processing and utilization are also among other factors that greatly constrain sweetpotato production in the target areas.

In 1999, Uganda's National Agricultural Research Organization (NARO) in collaboration with the International Potato Center (CIP) and PRAPACE released for uptake pathways six sweetpotato varieties with a production potential about four times the national average of local varieties (Turyamureeba et al., 2000). In addition, the new varieties are tolerant to virus diseases the biggest constraint to sweetpotato production in central Uganda. One of the released varieties is orange-fleshed rich in β-carotenoids compounds (over 2mg/100g fwt), that provide vitamin A.

In this project, efforts were geared to disseminating and popularizing the new varieties and at the same time maintaining a constant link between research that continuously generates new technologies and the end-users to increase the impact of the improved interventions on improving the livelihoods of beneficiaries. However, such a transfer is not easy in a country where a formal sector to take charge of production and distribution of the planting material for vegetatively propagated crops is absent (Bashaasha et al., 1995).

With financial and technical support from PRAPACE/CIP and NARO, BUCADEF started an informal farmer-based sweetpotato planting material multiplication project targeting its farmers in 8 districts of central Uganda. One year after the project's inception, 30% of BUCADEF's 3,000 farmers had accessed the latest improved varieties and were multiplying them further on over 170 hectares across the eight districts (PRAPACE, 2000). Twenty percent of the farmers were trained on rapid multiplication of planting material and sweetpotato production and a considerable number of farmers are already selling planting material at a profit. Two farmers in Luweero and Mpigi generated about USD 1,000 each in one year and have distributed planting material to over five hundred fellow farmers. These developments have aroused much interest among the farmers to adhere to the project.

The interest expressed by the farmers, the need to maintain the link between the generators of the improved technology and the end-users and the fact that WHO (1996) categorized Uganda's vitamin A deficiency status in the clinical category, are the factors that led to the initiation of this project.

Project Purpose

The purpose of the project was to develop a cost effective and sustainable system for continuous multiplication and timely distribution of quality sweetpotato planting material in target areas. It was conceived that this would contribute to alleviating food insecurity, poverty and malnutrition among small-scale farmers in central Uganda through increased production of sweetpotato varieties that are high yielding and rich in vitamin A.

In a country devoid of a formal system to take charge of the proper multiplication and dissemination of vegetatively propagated crops such as sweetpotato, setting up informal farmer-based systems to produce quality planting material on a commercial basis would further contribute to improved incomes.

Research Activities

The project aimed at reducing food insecurity, poverty and malnutrition among small-scale sweetpotato farmers in eight central Uganda's districts of Mubende, Luwero, Wakiso, Mpigi, Masaka, Mukono, Kiboga and Rakai.

The aim was to be achieved through the promotion of production, productivity and nutrition enhancing technologies, specifically through increased multiplication, distribution, production and consumption of sweetpotato varieties that are not only high yielding and virus resistant, but also rich in ß-carotene (a precursor to vitamin A). It was believed that promoting the consumption of orange-fleshed sweetpotato varieties known to be rich in ß-carotene would contribute to alleviating vitamin A deficiency (VAD), particularly among children below six years of age and lactating mothers.

Vitamin A deficiency is one of the most widespread deficiencies in Uganda and according to the World Health Organization, the problem is "clinical" (WHO, 1996). The Uganda Demographic and Health Survey 2001 showed that 30% of the children and 50% of women have vitamin A deficiency**.** (UG, 2001).

The major objectives of the project were to:

- establish a sustainable, cost effective and efficient system for multiplication and timely distribution of planting material of improved sweetpotato varieties and build capacity among the farming community to produce quality planting material.
- educate communities (rural women groups and others) about the role of vitamin A in the diet of both children and adults
- promote adoption, production, consumption and sustenance of vitamin A-rich sweetpotato varieties as a way of alleviating VAD deficiency in target communities.
- establish/strengthen inter-institutional linkages between BUCADEF and networks (PRAPACE), research institutions, particularly the National Agricultural Research organization (NARO), extension services, farmers, international research centres and donors.

Promotional pathways and achievements with regard to the above objectives are described.

1. **The establishment of a sustainable, cost effective and efficient system for multiplication and timely distribution of planting material of improved varieties and building farmers' capacity to produce quality planting material.**

1.1 The pathways for evolving the system are summarized in Figure 1.

Clean nuclear seed stocks were initially multiplied by NARO scientists at Namulonge Agricultural and Animal production Research Institute (NAARI). These fields at NAARI constituted what was referred to as Primary Multiplication Site (PMS). From the PMS planting material was directly given to BUCADEF to establish Secondary Multiplication Sites (SMS) at the organization's official sites or at Local Group Leaders' (LGL) sites or both. In addition, the primary site could also supply planting material for multiplication at the tertiary and individual levels (Fig. 1).

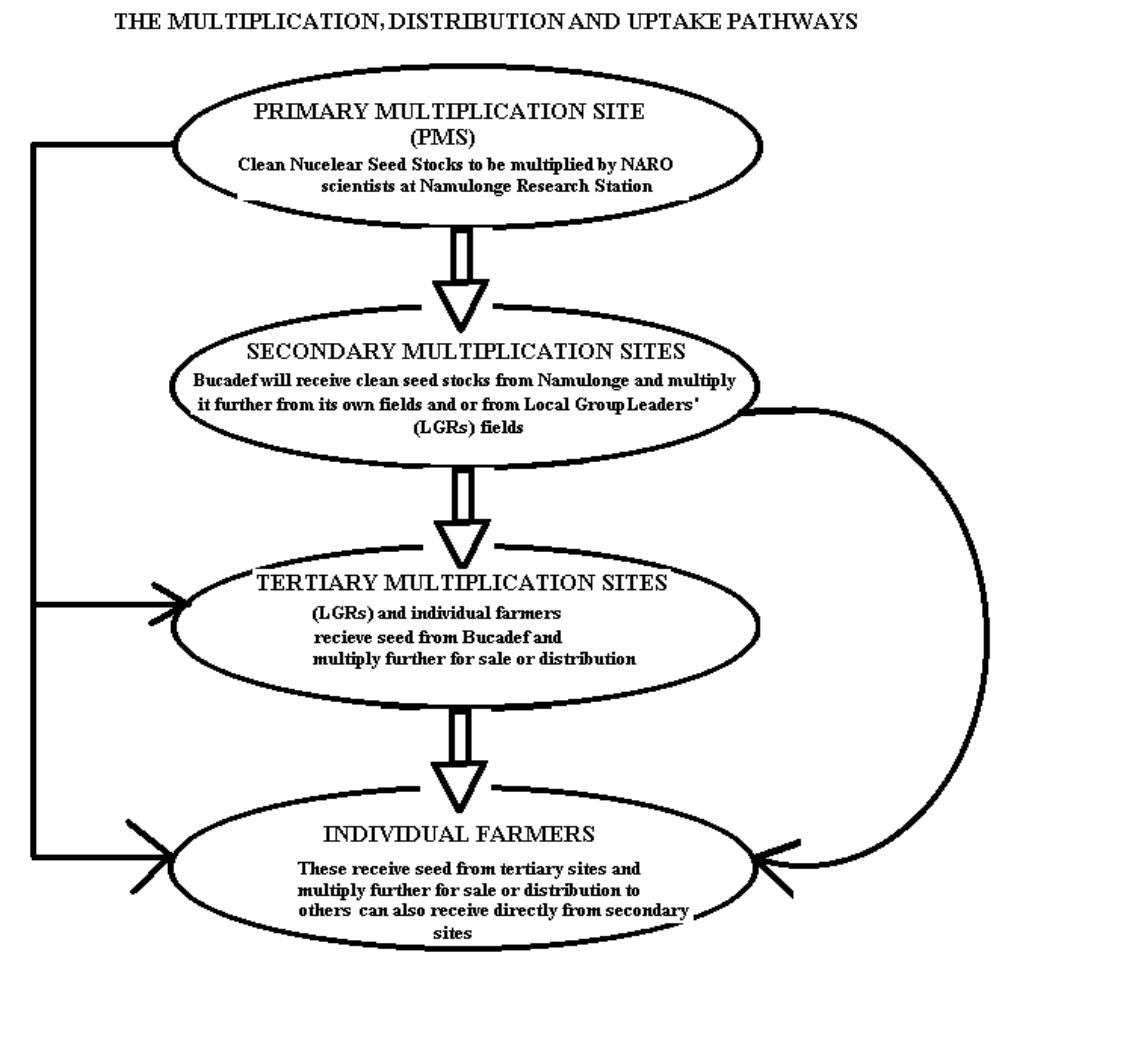

Fig.1. Multiplication, distribution and uptake pathways for planting material

From secondary multiplication sites, planting material was distributed and or sold to farmers multiplying at the tertiary level who in turn supplied individual farmers. The latter may in addition, be directly supplied by multipliers at the secondary level.

On selecting farmers to participate in this project, the interest to multiply planting material on a commercial basis using the improved technologies was the major criterion considered.

In collaboration with PRAPACE and NARO, informal training supplemented by meetings to discuss project issues was adopted. The training emphasized importance of having and managing permanent nurseries for planting material production, importance of producing sweetpotatoes following recommended practices, diseases (particularly SPVD) and their control practices, choosing clean plant parts as planting material (for this minimizes disease spread and increases yield), etc.

Training also covered post-harvest activities to reduce the large post-harvest losses due to the perishability of sweetpotato roots and as a way of increasing market and hence income.

1.2 Achievements

- In each district at least two secondary multiplication sites (SMS) and an equivalent number of tertiary multiplication sites (TMS) all privately owned by various groups of farmers were established and are operational. These have throughout the project shown increasing interest in project activities (Fig. 2).

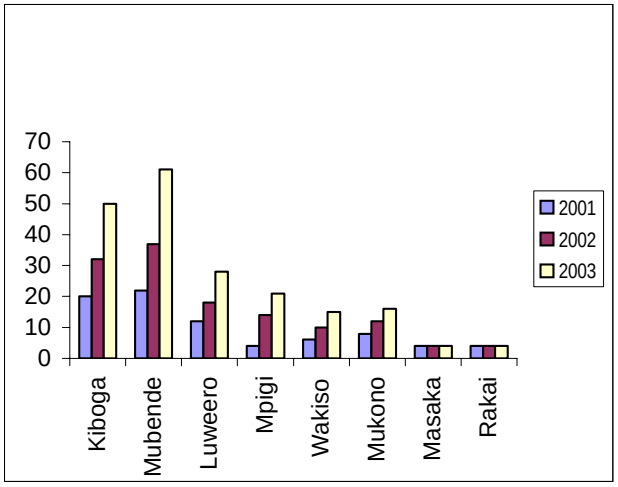

Fig. 2. Trends in number of groups participating in project activities

At both secondary and tertiary levels of multiplication, at least 18 individual farmers have established farms for the multiplication & timely distribution of vines to target districts throughout the year. These are private farms that are running with no external financial support. Record books of the farms indicate that in the course of the project, such farms disseminated at least 10 improved varieties to over 6,000 other farmers and sold planting material that can estimatedly plant over 2,000 hectares (Fig 3).

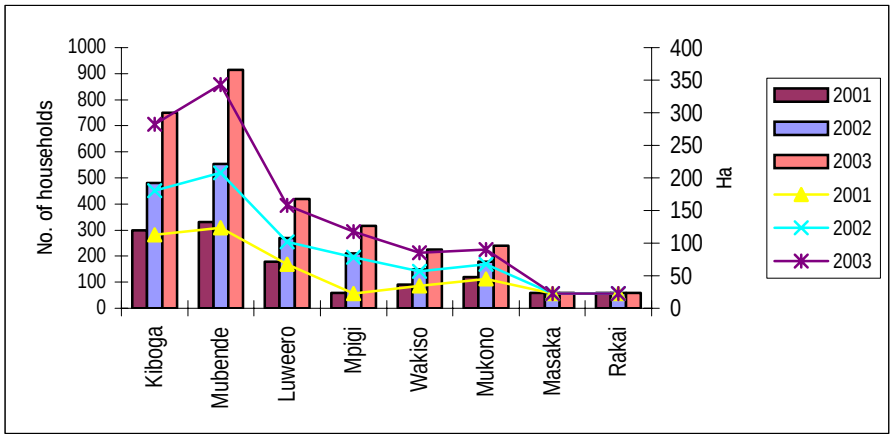

Fig. 3 Number of farmers that accessed improved varieties from multiplication sites and land area estimatedly planted

These are, however, conservative estimates from the multiplication sites alone. In general, including all multiplier effects, BUCADEF estimates that over 60% of about 60,000 farmers that the NGO serves in the 8 districts accessed the released varieties and in many places productivity on-farm has increased at least three-fold. Consequently, the major constraint on-farm is now shifting from lack of quality planting material to lack of access to markets and high post-harvest losses in the range of 25-30%. In contribution to both long and short-term solutions to the problem, efforts are underway to link farmers to markets for fresh roots & dried chips.

- In an effort to enhance the farmers' capacity to produce quality-planting material with minimum support from researchers, farmers were trained. They were trained particularly on rapid multiplication techniques. However prior to training the farmers, BUCADEF's field staff had to be trained in what was termed as "Training of Trainers" so that they would pass the knowledge acquired onto farmers more effectively. By the end of the project, the entire field staff of 22 had been trained (Table 1).

- Farmer Training. Over 6,000 farmers and school children were trained on matters related to agronomy for improved production, nutrition and utilisation. With regard to training of farmers, please refer to section 3.2.1

Table 1. Number of BUCADEF Staff trained in various aspects during the course of the project.

Subject	2001	2002	2003	Total number trained
Rapid Multiplication technique	8	9	5	22
Vitamin A & VAD related aspects	3	15	4	22
Agronomic aspects	14	8	0	22

2. Educating communities (rural women groups and others) about the role of vitamin A in the diet of both children and adults

2.1 Pathways

Nutritionists, health workers and researchers trained potential trainers that is, BUCADEF field staff on nutrition, VAD related aspects, sweetpotato production, marketing and utilization. These in turn passed the knowledge onto farmers.

Also planned in support of this activity was a survey aimed at clearly documenting the vitamin A deficiency status in the target districts and establishing the degree of familiarity of the problem among the local people, health and extension personnel. Quantitative assessment was supposed to be based on the modified Food Frequency methodology (HKI, 1994). Households were to be randomly selected in the survey area(s) and children below 6 years of age listed. A child within this age range would then be randomly selected for interviews.

2.2 Achievements

Apart from training for which results are presented in section 3.2.1, this activity failed to take off fully. It actually required hiring a subject matter specialist preferably from the University. However, there was not sufficient budget to implement this rather complex subject.

3. Promote adoption, production, consumption and sustenance of vitamin A-rich sweetpotato varieties as a way of alleviating VAD deficiency in target communities.

3.1 Pathways

Having multiplied the vitamin A rich varieties, farmer groups were selected to grow them together with their local varieties for comparison preferably in form of on-farm performance assessment trials. The varieties were jointly evaluated

with farmers, researchers and extensionists for agronomic and organoleptic qualities. Prior to planting, however, the groups/farmers were sensitized on the importance of vitamin A, particularly for child health and the role of the new varieties in alleviating vitamin A deficiency.

Farmer education. In collaboration with PRAPACE and NARO, informal training supplemented by meetings to discuss progress issues was undertaken. The training emphasized, having permanent nurseries for planting material production all year round, choosing clean plant parts as planting material to minimise disease spread, importance of producing sweetpotatoes following recommended practices, diseases particularly SPVD and how to control them, and others. Training also addressed post-harvest activities to minimise post-harvest losses of the roots and as a way of increasing market and hence houshold income.

Close collaborations with partners and technology transfer. BUCADEF believes it is important that farmers, researchers and development workers work very closely to get feedback from farmers and consumers to identify needs and also reorient activity directions. The NGO's response to identified needs and problems was always in the form of training, meetings or giving technical backstopping to individual farmers or communities, conducting on-farm demonstrational plots and encouraging farmer-to-farmer technology transfer. Strengthening collaboration with other relevant institutions was greatly emphasized as a strategy for continuity of the project even after expiry of donor funding. This worked really well.

Variety Trials. The six varieties were assessed for adaptation and yield stability with the purpose of coming up with recommendations on suitability of varieties for specific and wide adaptability. The on-farm trials were carried out during March to June (2002A), first season, and the second season from September to December (2002B) at five locations in the five districts of Mpigi (at Nkozi), Wakiso (at NAARI), Masaka, Luweero and Kiboga. In Kiboga, the crop was grown only in 2002A hence giving a total of 9 environments. The six varieties studied were NASPOT 1, NASPOT 5, SPK004, New Kawogo, Ejumula and Kala.

At each location, the varieties were grown in a Randomized Complete Block Design (RCBD), with 3 replications under rain-fed conditions. No fertilizer or herbicide was applied.

The Additive Main Effects and Multiplicative Interaction (AMMI) model MATMODEL 2.0) was used to analyze the data. The AMMI model uses the following equation

$$Y_{ger} = \mu+\alpha_g+\beta_e+\sum\lambda_n\gamma_{gn}\delta_{en}+\rho_{ge}+E_{ger},$$

where Y_{ger} = yield of genotype g in environment e for replicate r; μ = grand mean; α_g = mean deviation of the varieties g (varietymean minus grand mean); and β_e = mean deviation of the environmental mean; λ_n = singular value for Interactive Principal Component Analysis (IPCA) axis n; δ_{en} = the environment e eigenvector value for IPCA axis n; ρ_{ge} = the residual; and E_{ger} = Error.

While the trials were growing in the field, multi-disciplinary teams comprising nutritionists, agricultural researchers and local administrators continued training farmers and school children in the production to consumption continuum of sweetpotato.

3.2 Achievements

3.2.1 Training

Over 6,000 farmers and school children were trained on matters related to nutrition, vitamin A, its deficiency and the use of orange-fleshed Sweetpotato to alleviate the deficiency and on agronomy for improved production (Table 2). Heads of schools were particularly instrumental in this effort and as a result, of the total number trained about 65% were school children. More participation of students was recorded in the drier parts of Kiboga and Mubende districts where health problems related to Vitamin A deficiency are more frequently reported.

Table 2. Number of farmers and school children trained on Vitamin A & VAD related aspects during the lifetime of the project

Districts	2001	2002	2003	Total
Kiboga	300	480	750	1530
Mubende	330	555	915	1800
Luwero	180	270	420	870
Mukono	120	180	240	540
Wakiso	90	150	225	465
Mpigi	60	210	315	585
Masaka	60	60	60	180
Rakai	60	60	60	180
TOTAL	1200	1,965	2,985	6150

3.2.2. Variety evaluation

Root yields of sweetpotatoes were highly significantly ($P<0.001$) affected by varieties (Table 3) and locations (Table 4). When averaged across locations and seasons, varieties NASPOT 1, NASPOT 5 and SPK004 yielded highest, while Kala yielded lowest (Table 3). When averaged across varieties, Nkozi followed by Luweero resulted in the highest root yield in 2002A, While NAARI and Luweero performed best in 2002B (Table 4). Generally, root yields were higher in 2002A than in 2002B.

Table 3. Mean yield (t. ha^{-1}) of sweetpotato genotypes evaluated at five locations for 2 seasons

Variety	**Yield**	
	2002A	**2002B**
New Kawogo	19.2	9
SPK004	19.5	13
Kala	16.5	8.9
NASPOT1	20.9	13
NASPO 5	21.9	12
Ejumula	18.0	8.7
Mean	19.3	10.8
LSD (0.05)	2.98	2.20

Table 4: Mean yield (t. ha^{-1}) of sweetpotato genotypes evaluated at five locations for 2 seasons

Location	**Yield**	
	2002A	**2002B**
NAARI	16.9	16.9
Nkozi	33.8	5.8
Masaka	7.9	4.0
Luweero	17.5	15.5
Kiboga	-	8.8
Mean	19.03	10.2
LSD (0.05)	2.72	1.77

Three varieties (referred to as genotypes in the biplot): NASPOT 1, SPK004 and New Kawogo seemed not to interact much with the environments and hence were stable with NASPOT 1 being the most stable across environments (Table 5 and Fig. 4)). These there genotypes can adapt to a wide range of environments. Genotype NASPOT 1 was the most acceptable among adults, especially the male because of its taste. Although the farmers' check, New Kawogo, was fairly stable, it was not very productive. NASPOT 5 and Ejumula were very unstable and generally poorly adapted to environments.

Table 5. Ranking of the genotypes based on AMMI estimates for storage root yields (t. ha $^{-1}$) of 6 sweetpotato genotypes grown in 5 locations in 5 districts over two seasons in central Uganda.

Environment	New Kawogo	SPK004	Kala	NASPOT 1	NASPOT 5	Ejumula
NAARI, 2002A	4	3	5	2	6	1
Nkozi 2000A	5	2	6	1	3	4
Masaka 2000A	5	2	6	1	4	3
Luweero 2000A	5	2	6	1	3	4

NAARI, 2002B	3	2	5	4	1	6
Nkozi 2002B	4	3	6	1	2	5
Masaka 2002B	4	3	6	1	2	5
Luweero 2002B	4	3	5	2	1	6
Kiboga 2002B*	4	2	6	1	3	5

*In Kiboga district, planting was done only during 2002B

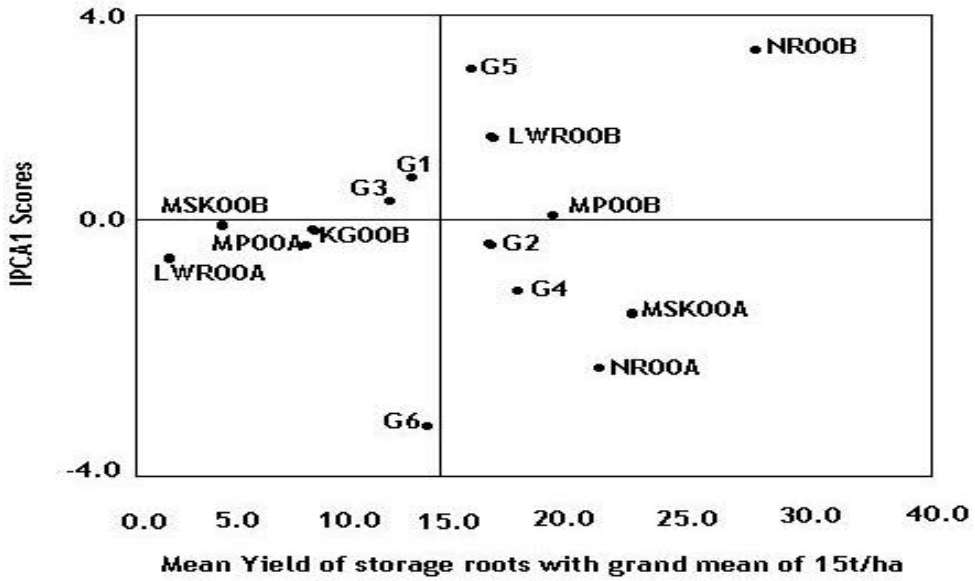

Figure 4: Biplot of the unadjusted means of root yields (t.ha^{-1}) and the first AMMI interaction (IPCA) scores for 6 varieties designated in the biplot as genotypes (G) grown at 5 locations for 2 seasons (9 environments).

Locations: KG: Kiboga, LWR: Luweero, MP: Mpigi, MSK: Masaka, NR: NAARI; genotypes G1: New Kawogo, G2: SPK004, G3: Kala, G4:NASPOT 1, G5: GASPOT 5, G6: Ejumula.

Table 5 and Figure 4 also showed that:

- among the orange-fleshed sweetpotatoes namely SPK004, Ejumula and Kala, SPK004 performed best. It showed the highest productivity and stability across environments and therefore its production is recommendable in all project areas.
- in sharp contrast, NASPOT 5 was the most unstable OFSP with potentially high productivity but very much dependent on the environment. Its production could therefore be discontinued except in limited environments, where it performs well. This is a very good example of specific adaptation.
- Kala, Ejumula were generally low yielding genotypes though relatively stable in Nkozi, Masaka, Luweero and Kiboga, where they could be

recommended for production. In Luweero district, for example, 78% of interviewed children preferred these two orange-fleshed varieties compared to 17% who preferred white-fleshed.

- The location NAARI in Mpigi district was the most favourable environment recommendable for screening genotypes for stability. At NAARI, there is a high pressure of virus diseases, making it the most suitable location for screening for virus resistance. Nkozi and Luweero were moderately favourable, while the locations in Masaka and Kiboga were less favourable.

Multiplication of OFSP. Through BUCADEF's extension staff, all 8 districts were requested to emphasise multiplying OFSP and the response was encouraging. During 2003A season, a quick survey among the multiplication farms showed that emphasis was already put on the multiplication of OFSP. Over sixty percent of planting material that secondary and tertiary multiplication farms were multiplying for sale was OFSP (fig 5).

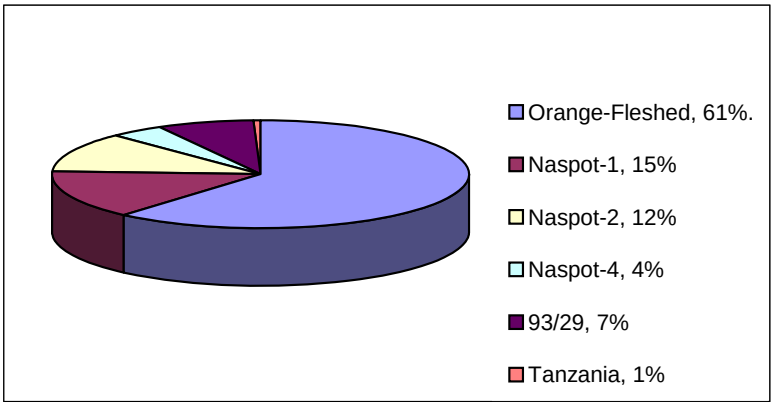

Fig. 5: Relative proportions of varieties multiplied during 2003A season

Relatively speaking, the highest dedication to grow OFSP came from Kiboga, Mubende and Wakiso districts where VAD health related problems are most frequently reported (Fig. 6). Over 75% of planting material multiplied in the three districts was actually OFSP (Fig 7).

- Farmers have in the course of the project increasingly gained easy access to improved varieties and other technologies from researchers through farmer participatory activities.

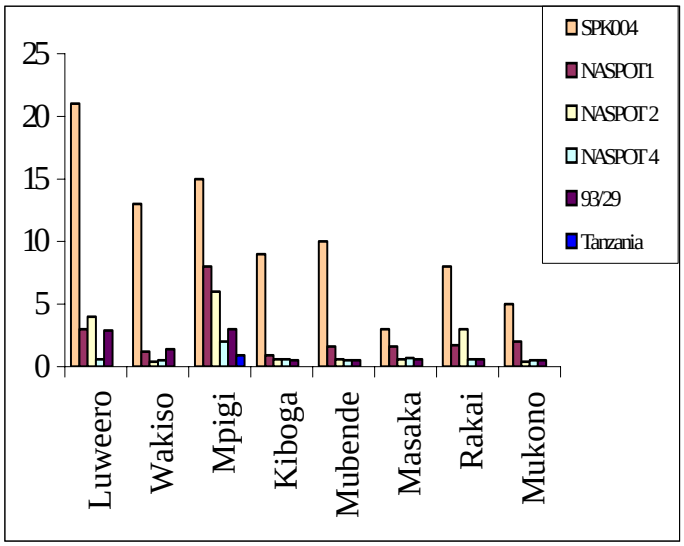

Fig. 6. Relative amounts (acreage equivalents) of different varieties sold from multiplication sites during 2003A season

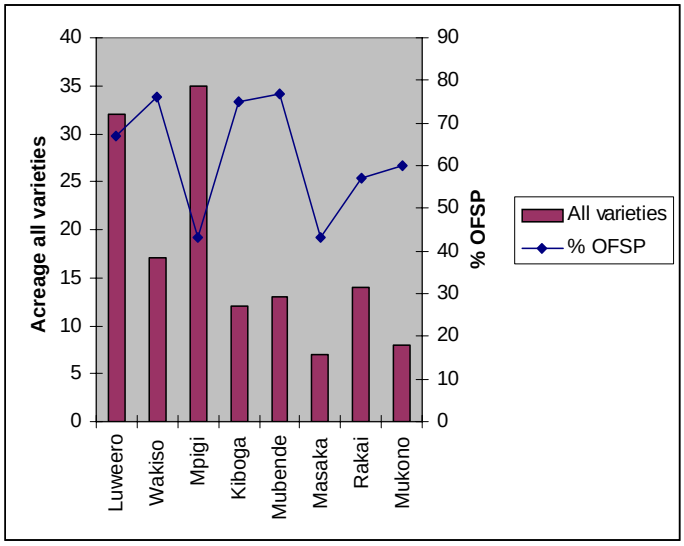

Fig. 7. Relative proportion (%) of OFSP related to total amount (acreage equivalents) of planting material produced in the different districts

4.1 Assessing adoption and impact of the intervening technologies

4.1 Methodology

Data were collected from both secondary and primary sources in April 2003. The major sources of secondary data were published and unpublished reports collected from District Agricultural Offices, Non-Governmental Organizations and from FOODNET, a market information provider network.

For primary data, Participatory Rural Appraisal (PRA) and a formal survey were used to assess adoption of the intervening technologies and their impact on the livelihoods of rural smallholder sweetpotato producers. The survey was carried out by BUCADEF's field staff under the supervision of one subject matter specialist. Before the survey, however, discussions were made with key informants such as development agents, farmers and district agricultural officials to get additional secondary information.

4.1.1 Study sites

The study was conducted in all eight districts (Luwero, Kiboga, Masaka, Mubende, Mukono, Mpigi, Rakai and Wakiso) targeted by the project. Specifically targeted were those areas where sweetpotato is one of the major

crops and improved technologies had been demonstrated and disseminated since the launch of the project in 2001.

Twenty randomly selected households per district were interviewed using structured questionnaires, making the total sample size 160 households.

The statistical package "SPSS 10.0 for windows" was used for analysis. Only descriptive statistics such as percentage and means were employed.

4.2 Adoption and impact (results of survey)

4.2.1 Production of clean planting material

- In all 8 target districts informal farmer-based seed systems now exist for the provision of quality planting material in a timely manner all the year round. There is still no formal system in Uganda and in east Africa as a whole, to take charge of the proper multiplication and dissemination of vegetatively propagated crops such as sweetpotato.
- Multiplication and distribution of improved sweetpotato planting material is increasingly becoming commercial in the region, where sale of sweetpotato vines was otherwise supposed to be a taboo. In fact, apart from being very seasonal, the business of producing sweetpotato planting material is very profitable (Table 6) fetching much more money than from sale of fresh roots.

Table 6. Gross margin analysis (per hectare/season[1]) for sale of planting material of improved sweetpotato varieties in Central Uganda

ITEM	
Yield per hectare (No. of vines) On-farm gate price per vine (Ug. Shs)	2,360,000 5.3[2]
Gross value (income)	12,508,000
Items	Costs (Ug. Shs)
1. Land preparation - Two times - Ridging/heaping mounds 2. Planting material (60 bundles of 600 vines) - Transporting planting material 3. Labour requirements - Planting 10 Man days (MD) @ Ug. Shs. 6,000 - Weeding 3 times 10 MD @ Ug.Shs. 12,000 - Harvesting, packing and loading onto customer's vehicle 500 Ug.Shs for every bundle of 600 vines	200,000 100,000 300,000 50,000 60,000 120,000 1,966,667

	2,796,667
Sub-total	
Miscellaneous costs @ 3% of sub-total	83,900
Total operational costs	2,880,567
Gross margin per hectare	9,627,433
Interest 20% @ of working capital	576,113
Gross margin including interest (Ug. Shs/ha)	9,051,320
Gross margin including interest (UK £/ha)	3,620

[1] There are usually 2 sweetpotato growing seasons in a year.

[2]This price quotation was very conservative based on conditions of excessive supply. Otherwise usually each vine costs Ug. Shs 8.3

- Consequently, the practice has significantly improved income and livelihoods of many (Plate 1). On average two farmers per district have adopted the production and sale of planting material as their major source of income. The roots resulting from such a practice are used as a major source of food and additional income for households

Plate 1. Other specific impact indicators identified were improvements in acquisition of fixed assets. One Mr. Rajab Ssetyabula's family in Luweero district was able to generate income that enabled it to shift from a grass thatched hut to a bigger iron- roofed house that was baptized "NASPOT" generic name given to improved SP varieties released from NAARI.

- SPK004, orange-fleshed variety, is now widely distributed in central Uganda, among other important factors, because its dissemination was launched by "Nabagereka" or the Queen of Buganda Kingdom. The kingdom, comprising

- of all the districts of central Uganda has the "Kabaka" or the King as the head of over six million subjects, the Baganda, who very much cherish their culture and the institution. Recommendations given the blessing of this cultural institution are usually readily taken up. Some re-baptized this variety as "Nabagereka".

- When asked to point out just one particular aspect that farmers liked most about the informal farmer-based seed system, 48% of respondents said that it had helped to reduce the chronic shortages of planting material. Sixty-two percent pointed out that the system had saved them the hustle of travelling long distances to research stations just to collect a few vines. However, 56% of interviewed farmers complained that the price of UK £ 2/ bundle of 600 vines is very expensive. Such a bundle can plant 180 M^2.

- Lack of improved varieties is no longer the main constraint to sweetpotato production in the target districts. Farmers can now even participate in variety evaluation, which they could not before because of lack of sufficient quantities of quality planting material. The number of improved varieties in circulation among farmers has more than doubled from the six that the project began with in 2001. Five of the varieties in circulation are orange-fleshed with the potential to provide vitamin A.

4.2.2 Varieties

- Results of the survey indicated that improved varieties have increased on-farm yields by around three-fold and better production returns, consequently attracting many farmers to adopt them. Production of local varieties especially Dhimbuka and Kyebandula is still widespread only for food security purposes, particularly in the districts of Luweero, Mubende and Kiboga. It is evident from Table 7 that production of traditional varieties is not economical. Ninety percent of interviewed farmers who still grow local varieties reported that they produce them because of their taste and good in-ground storability.

Table 7. A comparison of gross margin analysis (per hectare/season[1]) for a farmer in Central Uganda growing improved sweetpotato against traditional varieties

ITEM	**Type of variety**			
	Traditional (local)		**Improved**	
	Low yields	**High yields**	**Low yields**	**High yields**
Yield per hectare (kg)	2,000	5,000	10,000	25,000
On-farm gate price per kg (Ug. Shs)	50	50	150	160
Gross value (income)	**100,000**	**250,000**	**1,600,000**	**4,000,000**
Items				
1. Land preparation				
– Two rounds	200,000			
	100,000	200,000	200,000	200,000

– Ridging/heaping mounds	300,000	100,000	100,000	100,000
2. Planting material (60 bundles of 600 vines)	50,000	300,000	300,000	300,000
– Transporting planting material		50,000	50,000	50,000
3. Labor requirements	60,000			
– Planting 10 Man days (MD) @ Ug. Shs. 6,000	120,000	60,000	60,000	60,000
– Weeding 3 times 10 MD @ Ug.Shs. 12,000	150,000	120,000	120,000	120,000
– Harvesting, sorting, grading & packing 10 MD @ Ug.Shs. 15-30,000		450,000	300,000	900,000
	350,000			
Transport produce to nearest market @ (Ug.Shs. 50,000/ton)		1,050,000	350,000	1,050,000
	1,330,000			
Sub-total	39,900	2,330,000	1,480,000	2,780,000
Miscellaneous costs @ 3% of sub-total	1,369,000	69,900	44,400	83,400
Total variable costs	-1,269,000	2,399,900	1,524,400	2,863,400
Gross margin per hectare		-2, 149,900	75,600	1,136,600
Interest 20% @ of working capital			304,880	572,680
Gross margin including interest (Ug. Shs/ha)				563,920
Gross margin including interest (UK £/ha)				226

[1] There are usually two sweetpotato growing seasons in a year.

- About 90% of respondent farmers had adopted two improved varieties NASPOT 1 (non orange-fleshed) and SPK004 (Orange-fleshed) mainly on the basis of their high productivity and culinary acceptability. It was also found that farmers are adopting improved varieties due to their considerable economic benefits for both local and export markets. Varieties Naspot 2 and New Kawogo have red- skinned and oblong-shaped roots that are suitable for export market. Mpigi, Wakiso and to some extent Masaka districts are almost exclusively the sole districts that produce sweetpotato for the export market. Sweetpotato currently is airlifted not as the main cargo, but as a 'filler' to meet tonnage quotas on the plane, while exporting the less bulky, higher value crops such as hot pepper, vanilla, etc. The volume of sweetpotato airlifted in 2003 was 320 Tons as compared to 210 tons in 2002, showing a 52% increase (Fig. 8)

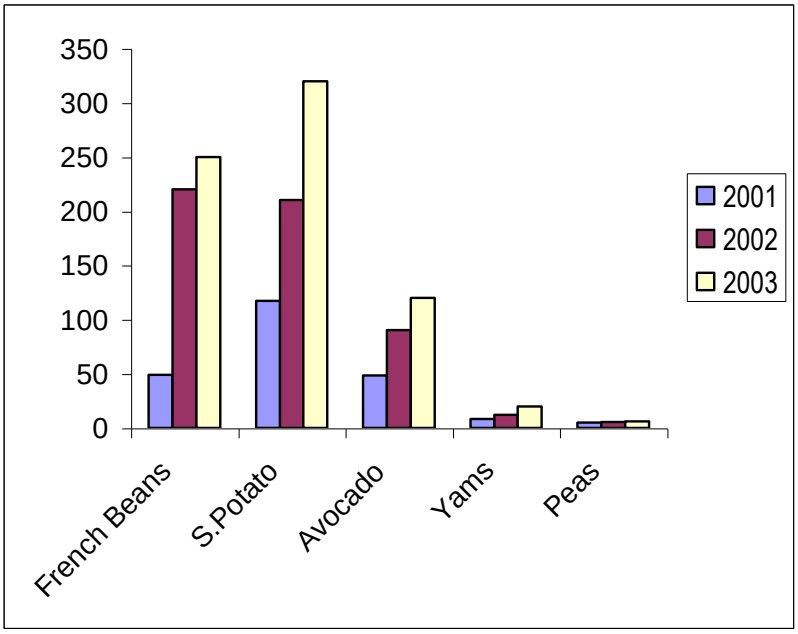

Fig. 8. Quantities of sweetpotato t/ha air freighted from Uganda during 2001-2003.

- A farmer producing for the export market using suitable varieties could get between UK £400 to 2000/ha, which is about 2 to 8 times higher than returns from selling on the local markets. So far, nine improved varieties have been found suitable for export. The varieties can produce 7 to over 20 tons per hectare of fresh roots depending on management.
- All the above described food security and economic advantages have contributed to a marked increase in sweetpotato production (Fig. 9)

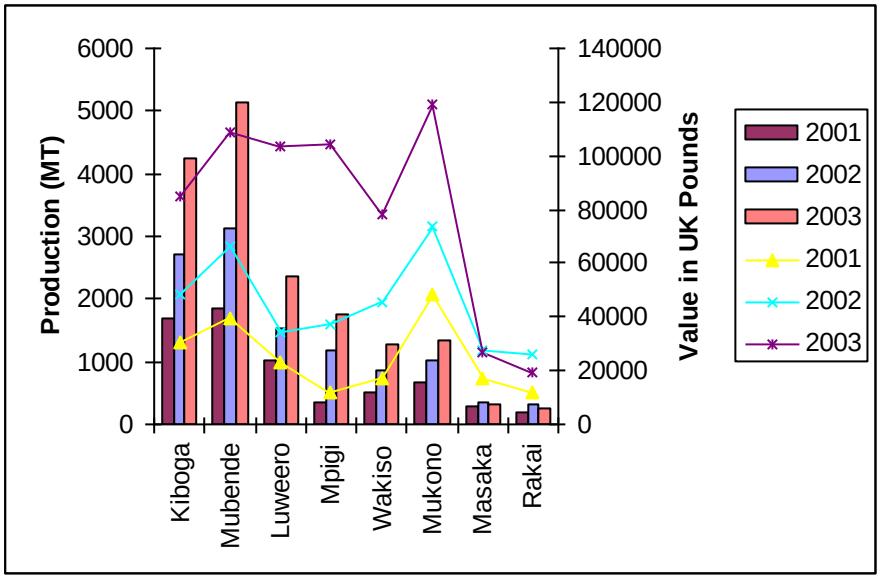

Fig. 9. Trends in sweetpotato production potential values for the years 2001-2003

- It is estimated that over 34,000 tons of improved sweetpotato worth over UK £1,200,000 was produced in the project area during the lifetime of the project. However, this is very much underestimated for it accounted for only 2% of the total production figure given in the Ministry of Agriculture data for the region. The fact that the new varieties Naspot 1 and SPK004 are reportedly accountable for over 90% of the total production in the major producing districts of Mpigi and Wakiso is good evidence of underestimation.
- In 50% of the target districts of Luwero, Kiboga, Rakai and Mubende, sampled farmers experienced low rates of poverty reduction compared to farmers in Wakiso, Mpigi, Mukono and Masaka due to poor market access in the former districts, as they are off the road.
- Marketing channels. From the producers, sweet potato passes through five intermediate stages prior to reaching the consumer. This is rather long and greatly reduces the profitability of the enterprise.

The study identified poor linkages to market outlets, storage, processing techniques, market information, shortage of capital, lack of control of unlicensed traders, and high transportation costs as the current major limitations to the sweetppotato sub-sector. The study also identified important factors that affected adoption of new technologies/innovations (Table 8)

Table 8. Factors that affected adoption of sweetpotato production technologies

Factor	**Remarks**
1. Unavailability of credit	90% responded not having access to credit services to improve production. Otherwise required collateral is far beyond the means of many.
2. Variations in consumer preferences	In the commercial districts (Mpigi and Wakiso), 63% preferred local varieties for home food due to reportedly better taste. For the market, 85% of respondents preferred the improved variety NASPOT 1 that they renamed it to 'Bwengye'
3. Unavailability and high prices of planting material	High and unaffordable cost of planting material was also reported by the non-adopters. Still not many farmers are involved in selling of quality planting material. There was still exceedingly higher demand than supply consequently, the price of UK. 2£ per bundle of 600 vines was high and unaffordable to many smallholder farmers.
5. Poor transportation facilities from farm to market and vice versa.	Accessibility to farmers' villages for market also has a considerable influence on the adoption of improved sweetpotato and related technologies. The farmers in Luwero, Kiboga, Rakai and Mubende are poorly connected to lucrative markets in major cities like Kampala and export market.

4.2.3 Orange-Fleshed varieties and Vitamin A Deficiency (VAD) alleviation

- Orange-fleshed sweetpotato is becoming more and more popular, particularly among children below 6 (Plate 2) and their mothers who actually comprise the real group it is targeted for.

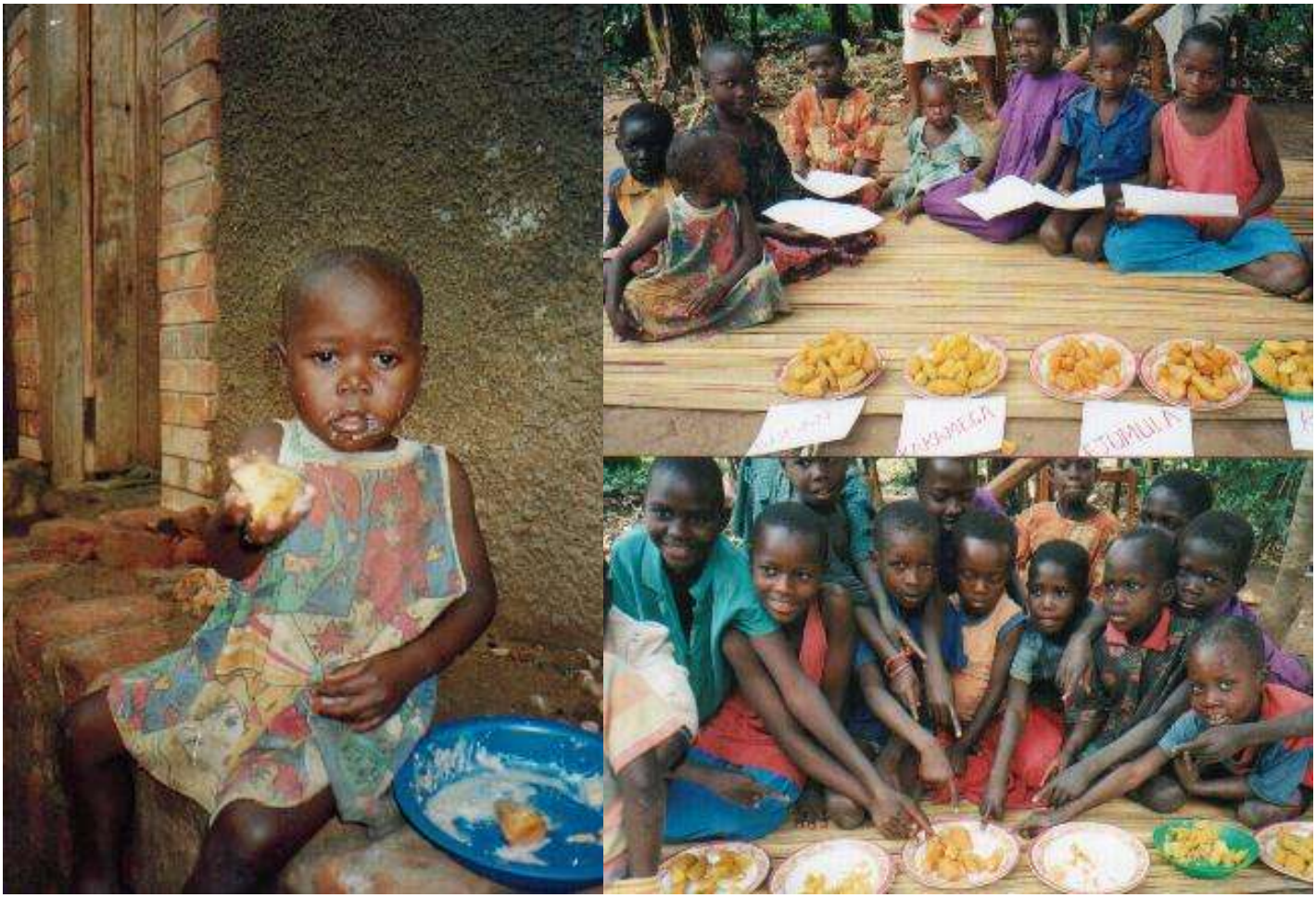

Plate 2. In Luweero district, 78% of the interviewed children preferred OFSP and 17% preferred white-fleshed.

- The wide distribution/adoption of the orange-fleshed sweetpotato, coupled with findings of a collaborative study in Kenya that showed that regular intake of at least 100 grams per day of orange-fleshed sweetpotato roots provides the required daily allowances of vitamin A for children under five years of age (Hagenimana, 1999), is an indication that Vitamin A deficiency could be successfully combated using sweetpotato.
- Value addition to sweetpotato is mainly based on using Orange-Fleshed Sweetpotato (OFSP). Moreover, attractive and sizeable packaging of OFSP is making sweetpotato a more competitive crop particularly among the urban consumers, who usually take sweetpotato to be 'food for the rural poor'.

- The Viatmin A study part of the project contributed to bringing together various strategic partners in agriculture, health & nutrition. Moreover, links were made with the Vitamin A for Africa (VITAA) Initiative implemented by the International Potato Center in several countries in eastern and central Africa.
- OFSP is increasingly helping the poor living with HIV/AIDS.

Bukedde.... Lwakubiri • March 9, 2004 17

Haji Lwegaba lumonde wa Nabagereka amuzuddemu ekyama

Amukolamu eddagala eriweweeza siriimu

Bya Madinah Sebyala

An herbalist, Haji Lwegaba, is collaborating with BUCADEF, PRAPACE and the International Potato Center in using orange-fleshed sweetpotato to treat HIV/AIDS- related symptoms ranging from weakened human immune system to skin-related ailments. In an article above that appeared in a daily newspaper on 9th March 2004 in a local language 'Luganda'a, Haji Lwegaba, Nicknamed Dr., was calling on people living with HIV/AIDS to eat OFSP to prolong their lives by boosting their immune systems. He himself openly proclaims being HIV positive and has managed to live in good health for over 20 years through proper feeding without taking anti retro-virals. He reported great success in using OFSP on his patients who usually are the poor that cannot afford anti retro-virals. He has a number of OFSP flour-based products, which sell like hot cakes in many of his clinics, both mobile and stationary, all over Uganda. He tells very proudly that he has made a big business out of what many HIV-infected people believe is the greatest tragedy and lack meaning of their lives. He is one of the first farmers that BUCADEF approached to produce OFSP.

Outputs

There were 5 project outputs as listed below and brief comments are made at the end on the extent they were realized.

1. More land planted to quality cuttings of improved varieties and higher productivity achieved. Current productivity of local cultivars is on average 6 tons/hectare while the new varieties can produce 15 to 35 tons depending on management
2. A cost effective and sustainable system for continuous multiplication and timely availing of planting material developed
3 More orange-fleshed sweetpotato produced, consumed by households and VAD related health problems reduced
4 Households' food security and nutrition improved and income increased
5 Linkages strengthened between partners like networks (PRAPACE), national and international research institutions (NARO and CIP), donors, extension services, farmers, health workers and nutritionists

Comments

Activities contributing to outputs 1, 2 and 4 are described in sections 1.1 and 4. They were all realized and achievements are described in section 1.2, 2.2, 3.2 and 4.2..

Planned in support of output 3, was a survey aimed at clearly documenting the vitamin A deficiency status before and after project interventions in the project area. This however, was not fully done as the subject matter specialist, who was to lead the study finally ended up being more expensive than we could afford. The study was under-budgeted not because we lacked the foresight, but because the specialist was not straightforward from the start. This indeed caused a setback to the project and is the major reason behind the delay in this project report because the same specialist was also to carry out adoption and impact studies.

We nevertheless made some achievements as reported in sections 2.1, 2.2, 3.1 and 3.2.
On the other hand, more was achieved than targeted in relation to output 4 in the area of post-harvest (value adding) that focused on producing dried chips. Dried chips were processed to flour to produce very successful and nutritious products such as Nutri-porridge. This improved the marketability of sweetpotatoes and reduced post-harvest losses resulting in more food for the household. The project was conducted with a contribution from PRAPACE, the managing partner of this project and one of the strategic collaborators with BUCADEF.

Output 5. It was initially planned to achieve effective technology transfer in close collaboration with as many strategic partners as possible. BUCADEF believes that it is important that farmers, researchers and development workers work very closely to address feedback from farmers and consumers. The NGO's response to feedback and needs assessments has always been in the form of training, meetings or giving technical backstopping to individual farmers or communities conducting on-farm demonstrational plots and encouraging farmer-to-farmer technology transfer. Strengthening collaboration with other relevant institutions was greatly emphasized as a strategy for continuity of the project even after expiry of donor funding. This seems to be working really well. Achievements are reported in sections 1.2 and 3.2. The achievements here are beyond what was anticipated initially.

Contribution of outputs to developmental impact

Outputs 1, 2 and 4 will contribute towards DFID's development goal of eradicating extreme poverty and hunger. The output's contribution to the goal has been realised through increased Sweetpotato yields per unit land area (increased productivity) by use of improved technologies such as varieties and improved health of planting material. Increased productivity increases food per unit area that can be consumed and also sold to increase household income. The increased income improves the livelihoods of communities expressed by such concrete evidence such as living in better houses, owning more permanent properties such as land, sending more children to schools, and improved access to better food. Impacts of activities on development in the target districts are reported in sections 4.2.1 and 4.2.3.

Output 3 will contribute towards DFID's development goals of reducing child mortality, improved maternal health and combating HIV/AIDS and other diseases. All these were addressed through the project's activities of promoting production, consumption and utilization of Vitamin A potent orange-fleshed sweetpotato to reduce Vitamin A Deficiency. The activities have had impact as reported in section 4.2.3. Some parents happily reported that the sights of their children had improved after feeding them OFSP for only about two to three months. According to a well-known herbalist, who is HIV-positive says that OFSP helped the patients boost their immunity and improve the appearance of their skins.

Output 5 will contribute towards DFID's goal of developing a global partnership for development. Collaborative ties with DFID's CPP program and PRAPACE for example enabled BUCADEF access the grant that supported the outgoing project that has directly impacted several thousands of households. Inter-institutional partnerships were established and/or the existing ones further strengthened. Strong linkages exist between BUCADEF and networks (PRAPACE, Foodnet), National Agricultural Research organization (NARO), extension services, farmers, processors, nutritionists, health specialists,

international research centres and donors. Also established was strong working relationship with the Vitamin A for Africa (VITAA) Initiative that is coordinated by the International Potato Center. Moreover, the constraints identified in the same project are already being addressed in another on-going project that is funded by DFID's CPHP program. The new project brought together 11 coalitions, representing various institutions to work together for common goal.

References:

Bashaasha, B., Mwanga, R. O. M., Ocitti p'Obwoya , C. And Ewell, P.T 1995. Sweet potato in the farming and food systems of Uganda. A farm survey report. CIP/NARO, Uganda

Government of Uganda (UG). 2001. The Uganda demographic and health survey, 2000-2001

Hagenimana, V., Carey, E.E., Gichuki, S.T., Oyunga, M.A., And Imungi, J.K. (1999). Carotenoid contents in fresh, dried and processed sweetpotato products. Ecol. Food Nutr. 37: 455-473

PRAPACE 2000, 15th annual report to ASARECA, 1999-2000.

PRAPACE. 2003. A summary of PRAPACE activities for the period 1998- 2003

Turyamureeba G., Nsumba J. 2000. Development of sweetpotato varieties for virus resistance, high dry matter, vitamin A and production. Paper presented during the African Potato Association workshop, 29 May to 2 June, the international conference center-Kampala, Uganda.