Project Title: Improving the livelihoods of small-scale sweetpotato farmers in Central Uganda through a crop post harvest-based innovation system

R8273 (ZB0342)

INVESTIGATING THE POTENTIAL OF SEA FREIGHTING SWEETPOTATO FROM EAST AFRICA

Technical report

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1 Introduction

In Uganda, sweetpotato (SP) on-farm production has at least tripled as result of many (93% in 3 sampled districts) farmers adopting improved varieties. The major bottleneck now is low market prices and hence low income for the farmers. Farmers are risk-averse and will not produce more SP for a commercial outlet without a guaranteed market. Efforts now are geared to linking SP farmers to markets hence this study of simulating sea freighting of SP under controlled temperature and relative humidity conditions. The study involved the following partners:

- The International Potato Centre (CIP) and the regional network for improvement of potato & sweetpotato in East & Central Africa (PRAPACE) who provided an input on the selection of SP varieties that have been bred for improved agronomic performance and nutritional value, as well as advice on curing & dehulming of SP
- An International shipping company SDV-Transami Uganda (LTD) provided the automated refrigerated freight container at their premises
- The Horticultural Exporters Association (HORTEXA) who mobilized farmers to harvest SP for use in the study
- Makerere University - Department of Food Science & Technology (MAK-FST) who performed selected chemical analyses of the SP roots

The objectives of the study were two fold, to assess the performance of sweetpotato under simulated sea freight conditions and give an estimated cost of sea freighting sweetpotato.

2 Methodology

The sea freight simulated study was undertaken at the premises of the freighting company SDV-Transami at Ntinda/Nakawa, situated on plot M.611, Ntinda Road, Kampala. The following were the varieties packed into the freight container viz.: *Kakamega* (*SPK004*), *Ejumula*, *Kala*, *NASPOT* 1, *NASPOT* 2, #93/29, *Kasujja*, New *Kawogo*, *Nakakande* and *Jowelia*. Measurements of dry matter, weights of roots and beta-carotene content were made before the roots were placed in the freight container and after 50 days, which was the duration assumed sea freighting cargo to Europe.

Eighteen metric tons of SP were purchased from HORTEXA and BUCADEF farmers and packaged into waxed boxes (Figure 1) of ten kg weight. The boxes were packed in a refrigerated freight container held for 50 days at 14^{o}C and 90% relative humidity.

Figure 1 Waxed perforated 10 kg carton used to package sweetpotato roots for the study

Four SP varieties were selected used in the following experiments:

1. Assess the performance of sweetpotato with respect to morphological and physiological changes
2. Assess the changes in dry matter and beta-carotene of the orange fleshed sweetpotatoes

2.1 Laboratory analyses

The following analyses were carried out: dry matter content by drying samples (10 g) in a forced-air oven (Gallenkamp Oven 300 series, UK), at 105°C to constant weight in approximately 20 h. Individual weight measurements of roots (four to six roots) were obtained and a mean weight computed to represent a sample. Beta-carotene content of the SP root samples determined by high-performance liquid chromatography.

3 Findings

3.1 The performance of sweetpotato with respect to morphological and physiological changes

Export of sweetpotato by sea was reported to technically and economically feasible. Fifty days after storage in the refrigerated freight container showed that SP that had been handled properly appeared visually fresh (Figure 2a). However, those samples that had not been well handled showed visible deterioration (Figure 2b).

Figure 2 Sweetpotato samples that were still sound after 50 days in the freight Container; b – sweetpotato that had deteriorated

3.1.1 *Varietal performance*

All SP varieties, including the orange-fleshed variety, *Kakamega* (*SPK004*), have been widely adapted in the East and Central African region. *Ejumula* is to be released in Uganda this year, and has been earmarked for export. All SP varieties, except *Kasujja* are improved SP varieties that are abundantly produced on-farm and are already being exported by air to Europe in combination with other high value non-traditional export crops, such as Vanilla and Hot Pepper.

Kakamega SP stored best of all varieties in that it did not show significant weight loss, rotting and sprouting (Table 1). Sweetpotato varieties that were properly handled, notably cured through dehaulming two weeks prior to harvest showed low levels of weight loss and soft rotting, Pythium (Table 1).

Table 1 Effect of dehaulming on sweetpotatoes prior to harvest

Variety	Not dehaulmed			Dehaulmed*		
	% Weight loss	% lost to rotting	% lost to sprouting	% Weight loss	% lost to rotting	% lost to sprouting
Kakamega[@]	4	30	0	2	4	0
# 93/29	8	64	3	10	39	1
Kala	11	57	0	9	21	0
Ejumula	15	87	0	13	32	0
Mean	9.5	59.5		8.5	24	

@: *Kakamega* SP variety also referred to as *SPK004*; *2 weeks before harvesting

At least three types of rotting (Figure 2b) were observed. It was also observed that the rotting was restricted to the tips of the root (Figure 3) especially the portion from where the root was cut from the stem during harvesting. The damage due to rotting was not really extensive for most of the roots, but renders the damaged roots unfit for marketing

Ejumula SP variety deteriorated the most compared to all varieties that were investigated (Table 1). No significant sprouting was observed for all varieties except #93/29 that showed some sprouting had occurred (Figure 4).

Figure 3 Sweetpotatoes that showed rotting at the tips of the roots

Sweetpotato variety, #93/29, that produced considerable amounts of latex showed no damage on the tips (Figure 4), tended to heal better as the latex formed a black tar-like wax that sealed the tip, probably blocking entry of rot-causing pathogens.

Figure 4 Sprouting that occurred in #93/29 sweetpotato variety

The study also showed the importance of curing as this greatly appeared to improve SP quality for export. Samples that were dehaulmed two weeks prior to harvest stored three times better than freshly harvested samples (Figure 5). Dehaulmimg is a post harvest handling practice recommended for SP storage by INERA in D.R.Congo.

Figure 5 Effects of dehaulming sweetpotato

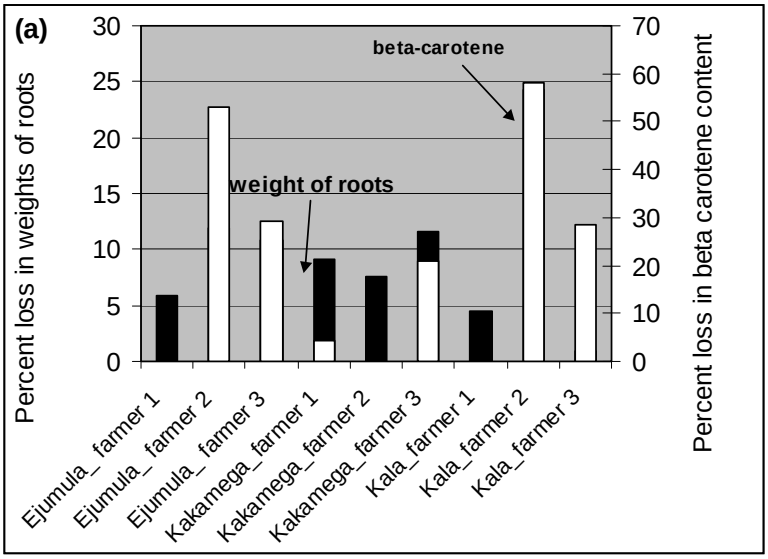
3.2 Acceptability tests of sweetpotato

After 50 days of storage, SP samples were given to two groups of panelists to evaluate the appearance and taste of steamed SP. One group was composed of Africans, Ugandans, and the second constituted Europeans, Belgians. In general, the African panelists ranked the SP as fair to good while the European panelist rated the SP as good to very good, though they noted after-cooking discoloration. The European panel proposed the need for promoting the value of sweetpotato in Europe. The positive evaluation by the European panel was en encouragement since this is the market currently being targeted for exporting sweetpotato.

3.3 Changes in dry matter, weight of roots and beta-carotene of the orange-fleshed sweetpotatoes.

Dry matter content and weights of the roots were typical values for sweetpotato. With respect to beta-carotene content, these varieties contain higher beta-carotene content than the white fleshed indigenous varieties. They are new varieties have been released by breeders in NAARI and CIP, bred specifically for high beta-carotene content in addition to improved agronomic performance. Generally *Ejumula* variety contains the highest beta-carotene content (4-8.8 mg / 100 g), followed by *Kakamega*, *SPK004,* (4.5.5.5 mg / 100 g) and *Kala* containing the lowest (<1.0 mg / 100 g) on dry solids basis.

After 50 days in storage in the freight container, there were variations in the percent loss of all the parameters measured with respect to variety, and individual samples per variety. The percent weight loss of the roots was not more than 12%. This indicated that the roots might still have the required weight of sweetpotato roots by the export market. With respect to beta-carotene, percent losses of up to 60% were observed for only one sample of *Kala* SP variety (Figure 6a). *Kakamega* SP variety showed the lowest percent loss in beta-carotene of less than 20% (Figure 6 a).



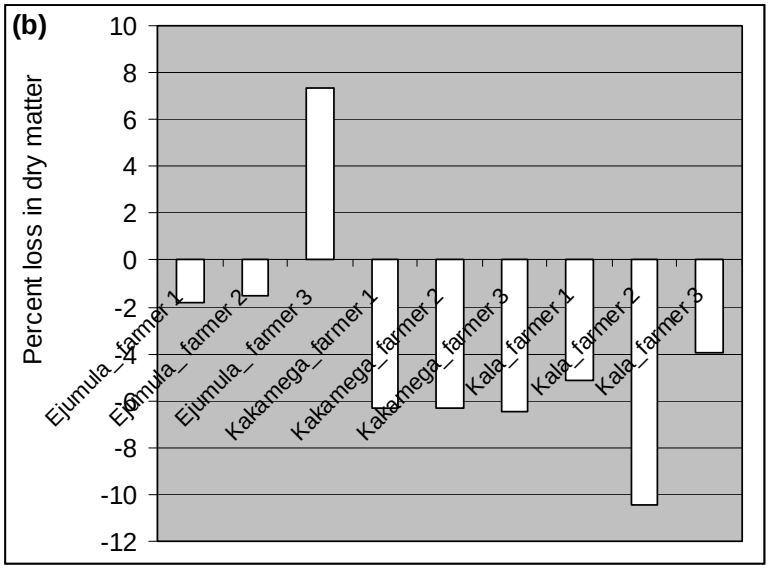


Figure 6 *Percent loss / change in values of parameters measured. (a – weight of roots and beta-carotene content; b – dry matter content)*

The dry matter content of sweetpotato roots after 50 days increased for the majority of the root samples measured. This suggested that the SP samples absorbed moisture presumably due to the humid environment of 90% relative humidity, except for one sample (*Ejumula*_farmer 3) that showed a loss of 7% (Figure 7b).

4 Indications of the gross margin analysis for exporting sweetpotato

A farmer producing SP roots for the export market can fetch US$ 489-2500 / ha planted of any of the improved varieties that yield 7 to over 20 tons per hectare of fresh roots. While for the domestic market, the farmer instead fetches US$ 54 - 1194 / ha (Table 2).

An exporter sea freighting SP would get US$ 394-6,902 probably selling at a competitive price of US$ 1.01 per hectare. In order for the exporter to airfreight SP, this would require the exporter to have to double the selling price for the enterprise to be profitable. That is at US$ 2.25 per hectare, to earn US$ 1,612-8,523. In Belgium one kilogram of SP shipped from South Africa costs between 1.50 and 2.25 Euro while in London a kilogram of SP from Brazil costs 3 pounds.

5 Way Forward

- A network of farmers has been mobilized and prepared to start exporting in March 2004. These farmers are currently producing for the domestic market supplying mainly universities and hospitals. The production trend of sweetpotato by the farmers is shown Figure 8. A specific group of twenty farmers are being groomed to export to the identified markets.

- The study showed that SP varieties that produce latex at the tips of the roots showed no damage, and there is need for this to be investigated.

- Fine tuning trials are to be carried out on storage root curing. The cold room for use in the storage studies is to take place at the HORTEXA field premises.

- The study also showed great need to stress the importance of post harvest handling, particularly the process of curing as this greatly affects the quality for export.

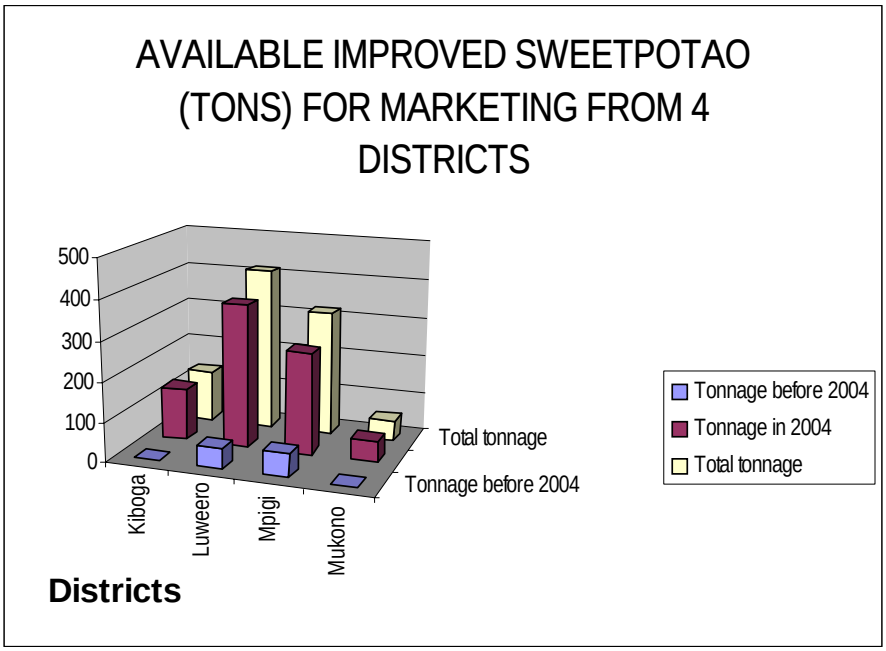


Figure 7 Production capacity of sweetpotato in 4 districts of Central Uganda

- Mobilising producers into SP-for-Export Producer-Groups (SPEPGs).
  This will require that groups have a clear legal structure and a well described internal procedure. Farmers will then be trained in aspects of commercial production that conform to the *EUREGAP* and PRAPACE's compiled Package of Integrated Pest Management (PPIPM). Funds for this activity have been solicited from The Horticultural Intervention Initiative of the Government of Uganda.

5.1 EUREGAP

EUREGAP was introduced in 1997 as an initiative of retailers participating in a working group called the Euro-Retailer Produce Working Group (EUREP). The objective of the working group is to agree on standards and procedures for the development of Good Agricultural Practice (GAP). The two abbreviations constitute the word *Euregap*. Euregap is a private initiative and has no links to European Union-directives.

Why *Euregap*? Retailers and distributors have developed various quality standards. Producers were therefore faced with these different standards. *Euregap* is focused on uniformity of applied standards.

In the recent past, food safety scares had a big influence on the purchasing behaviour of the consumers (BSE; mad cow disease, salmonella and Dioxin scandals; foreign

particles in canned food, pesticide residues in fruits etc.). The introduction of GM-food influences also the consumer behaviour. Consumers now like to know where and how the food is produced and need the assurance that the food is safe. *Euregap* is therefore focused on traceability and food safety.

5.2 Major persistent problems

- SP is not accorded high priority by the Ministry of Agriculture, Animal Industries and Fisheries implying reduced investment compared to other crops.
- There is still lack of clearly differentiated market segments for quality SP of commercial varieties, and also consumers are not conversant with importance of grading.
- Farmers typically grow a mixture of varieties with the sector still largely being farmer-driven from a food security perspective, and not consumer-driven with a commercial perspective.

Table 2 Gross margin analysis (per hectare) for a farmer in Central Uganda[1] growing improved sweetpotato varieties for domestic and export markets

ITEM	**Type of markets**			
	Domestic[2]		**Export[3]**	
	Low yields	**High yields**	**Low yields**	**High yields**
Yield per hectare (kg)[5]	7,000	21,000	7,000	21,000
Price per kg (Ug. Shs)	250	250	400	400
Gross output	**1,750,000**	**5,250,000**	**2,800,000**	**8,400,000**
Variable costs (Ug. Shs[4])				
1. Land preparation				
- Two rounds	200,000	200,000	200,000	200,000
- Ridging/heaping mounds	100,000	100,000	100,000	100,000
2. Planting material (60 bundles of 600 vines)	300,000	300,000	300,000	300,000
- Transporting planting material	50,000	50,000	50,000	50,000
3. Labor requirements				
- Planting 10 Man days (MD) @ Ug. Shs. 6,000	60,000	60,000	60,000	60,000
- Weeding 3 times 10 MD @ Ug.Shs. 12,000	120,000	120,000	120,000	120,000
- Harvesting, sorting, grading & packing 10 MD @ Ug.Shs. 15-30,000	150,000	450,000	300,000	900,000
Transport produce to Export Company/inland container port in Kampala @ (Ug.Shs. 50,000/ton)	350,000	1,050,000	350,000	1,050,000
Sub-total	1,330,000	2,330,000	1,480,000	2,780,000
Miscellaneous costs @ 3% of sub-total	39,900	69,900	44,400	83,400
Total variable costs	1,369,000	2,399,900	1,524,400	2,863,400
Gross margin per hectare	381,000	2,850,100	1,275,600	5,536,600
Interest 20% @ of working capital	273,800	479,980	304,880	572,680
Gross margin including interest (Ug. Shs/ha)	107,200	2,370,120	970,720	4,963,920
Gross margin including interest (US$/ha)	54	1,194	489	2,500

[1]Source, the sweetpotato Coalition project targeting Kiboga, Luweero and Mpigi districts

[2] Institutions of learning, hospitals, local and super marktes etc.
[3] Sweetpotato exported by air and sea freighting
[4] Ugandan shillings

Table 3 Gross margin analysis (per productivity from hectare) for an exporter in Kampala exporting improved sweetpotato varieties by air and sea freighting to markets in Europe

ITEM	**Mode of freighting**			
	Air		**Sea**	
	Low yields	**High yields**	**Low yields**	**High yileds**
Yield per hectare (kg)[5]	7,000	21,000	7,000	21,000
Price per kg (Ug. Shs) or US$2.25 for air and US$1.01	4,500	4,500	2,000	2,000
Gross output	**31,500,000**	**94,500,000**	**11,900,000**	**42,000,000**
Variable costs (Ug. Shs[4])				
1. Purchase of sweetpotato from farmers @ Ug.Shs 400/Kg	2,800,000	2,800,000	2,800,000	2,800,000
2. Purchase of packaging materials (720/2,120 waxed collugated boxes @ 2,000 Ug. Shs)	1,440,000	4,240,000	1,440,000	1,440,000
3. Travel & subsistence allowances for quality control officers monitoring quality at harvest on-farm	20,000	20,000	20,000	20,000
- Travel allowance for one officer	100,000	100,000	100,000	100,000
- Subsistence allowance for 2 nights				
Transport produce to Export market in refrigerated container to a port like Amsterdam in Northern Europe @ (Ug.Shs. 662,000/ton by sea and 2,648,000/ton by air)	18,536,000	55,608,000	4,634,000	18,536,000
	22,896,000	62,768,000	8,994,000	22,896,000
	686,880	1,883,040	269,820	686,880

Sub-total	23,582,880	64,651,040	9,263,820	23,582,880
Miscellaneous costs @ 3% of sub-total	7,917,120	29,848,960	2,636,180	18,417,120
Total variable costs	4,716,576	12,930,208	1,852,764	4,716,576
Gross margin per hectare	3,200,544	16,918,752	783,416	13,700,544
Interest 20% @ of working capital	1,612	8,523	394	6,902
Gross margin including interest (Ug. Shs/ha)				
Gross margin including interest (US$/ha)				

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