Increased promotion and evaluation of high β carotene sweetpotato as part of the food based approaches to combat Vitamin A deficiency in sub-Saharan Africa (SSA)

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Abstract

Sweetpotato is one of the most important staple crops in densely populated parts of eastern Africa and is fast becoming an important supplementary staple in the southern part of the continent. Sweetpotato is vital to destitute, small-scale farmers with limited land, labor and capital. One of its greatest assets is its ability to be harvested piecemeal as needed for home consumption or income generation. At present, the predominant sweetpotato cultivars in eastern and southern Africa are white- fleshed varieties that contain negligible amounts of beta-carotene, a micronutrient that the body uses to produce Vitamin A. Orange-fleshed sweetpotato (OFSP) varieties are believed to represent the least expensive, year-round source of dietary vitamin A available to poor families in the region. Studies have confirmed that African mothers can be motivated to accept orange-fleshed varieties, thus dispelling the notion that African tastes preclude the use of all but white-fleshed cultivars. Recent estimates based on geo-referenced data show the magnitude of the potential impact of replacing white-fleshed varieties with high dry matter orange-fleshed cultivars in six East and Central African countries. Overall, some 50 million children under the age of six stand to benefit. More precisely, *ex ante* analysis showed that each increase of one kilogram in per capita production of orange-flesh sweetpotato results in a one-percent rise in the attainment of requirements up to about 25 kilograms per capita. The challenge is to maintain sweetpotato's status as a food security crop, and, at the same time, stimulate its transition into a market-oriented commodity that local people can use to generate income to improve family welfare. The availability of improved varieties and the distribution of high quality planting materials will provide the foundation needed to achieve this objective. There has been a steady increase in both acreage and consumption levels of OFSP. For example orange-fleshed varieties are currently estimated to occupy 1-2% in the lake zone of Tanzania, 5-10% in Central Uganda, 10-15% in W. Kenya and 15-20% in Southern Mozambique. Studies have further shown that consumers are primarily concerned with taste, texture and dry-matter content, and not with colour *per se.* Children have a special liking for a food that is not only good for them but actually is nutritious. Adults, though cautious are adapting to the new item in their diets. Under the VITAA (Vitamin A for Africa) umbrella, 40 partner agencies from the health, nutrition and agricultural sectors have agreed to work together to extend the impact of orange-fleshed sweetpotato in seven partner countries: Ethiopia, Mozambique, Ghana, Kenya, South Africa, Tanzania and Uganda. The goal of this initiative is to alleviate vitamin A deficiency among young children and pregnant and lactating mothers. VITAA represents an opportunity for the countries to tackle one their most pressing public health problems using an existing technology that has proven to be both effective and sustainable. Activities include: breeding and selecting varieties for high dry matter content and high beta-carotene, participatory testing of varieties for

adaptation and acceptability, community-based sustainable seed multiplication and distribution, nutrition education, post-harvest processing for market and for home consumption, promotion through social marketing, and monitoring of impact on nutrition and health. Principal beneficiaries are young children and their mothers, the two groups most at risk for Vitamin A Deficiency or VAD. Implementation strategies concentrate on women because of their central role in the production and marketing of sweetpotato and other food crops used in the family diet. The signs are that OFSP will rapidly gain a place in the affections of African consumers. This paper therefore analyses the experiences and achievements as well as strategic forecasts in the production and utilization of OFSP in SSA.

1.0 Introduction

Vitamin A deficiency is a serious wide spread nutritional and health problem affecting most people in the developing countries including the East and central Africa. Most of these are among the 90 countries worldwide that are categorized by WHO (1995) as having a public health concerning clinical and sun-clinical vitamin A deficiency. In sub-Saharan Africa (SSA), 3 million children under the age of 5 suffer partial blindness caused by VAD. The total prevalence is estimated at 36 million people in SSA (Mason et al., 2001). The deficiency increases children's risk to common illnesses, impairs growth, development, vision, and immune systems, and in severe cases results in blindness and death (Ruel, 2001). In women, vitamin A deficiency increases risk of dying during pregnancy, as well as giving birth to low weight children, and may increase the spread of HIV/AIDS virus infection. New research findings suggest that vitamin A can have important effects on maternal mortality and protects infants from the effects of maternal to child transmission of HIV/AIDS Virus (Semba et al, 1995).
In Sub-Saharan Africa (SSA), three million children under the age of five suffer total or partial blindness caused by Vitamin A deficiency (VAD) (Ref…..). The total prevalence is estimated at 36.0 million people (Mason et al., 2001 acrobat readerfile) Vitamin A is consumed directly in meat products, and is produced in the body if a person consumes sufficient quantities of a precursor known as ß-carotene. Otherwise, the body cannot produce sufficient Vitamin A. Vitamin A deficiency is particularly a problem among children under five and pregnant and/or lactating women. Serious VAD can lead to blindness; chronic deficiency reduces a child's immune system to fight off malaria and other diseases.

World development and health agencies have responded to the situation by distributing Vitamin capsules and fortifying food. These efforts have reduced on the levels of cases affected by the deficiency. For example, the number of children suffering from blindness related to vitamin A deficiency is reported to have significantly dropped. However, many rural poor families do not adequately and regularly access these supplements due to poor infrastructure available in most remote areas of developing world. In Kenya, extremely low serum retinal levels are found in the arid and semi arid northeast, along the coast, and throughout the densely populated western part of Kenya, which includes Siaya (GoK & UNICEF, 1995). In Uganda about 28% of children and 60% women are vitamin A deficient. The rural and urban poor cannot afford expensive vitamin A rich foods, such as fish oils, liver, milk, eggs and butter that contain vitamin A in its true form (retinol), which can be used by the body directly. One of the alternative options for combating the deficiency is to enhance food-based strategies that aim at modifying people's diets through crops that have rich levels of ß-carotene.

Development and health agencies have reacted to this crisis by distributing Vitamin A capsules and fortifying processed and packaged foods. The results have been impressive. More than 12 million children received Vitamin A supplements in 1997, and the total number of children suffering from blindness related to severe vitamin A deficiency has dropped. Nevertheless, many families, particularly in rural areas, do not have access to capsules or fortified foods. In these areas therefore, Vitamin A chronic deficiency is rife.

CIP and its partner organizations have taken up the food-based options to combat the vitamin A deficiency in the sub-Saharan Africa through promotion of orange-fleshed sweetpotato. The orange-fleshed sweetpotato varieties have high ß-carotene contents and can be a cheaper and a complementary source of vitamin A to the rural and urban poor families. By this, sweetpotato combine a number of advantages that make it a choice crop for sustainable food security, improved nutrition and income generation (Ewell, 1990). It is already the first or second staple for most of the rural poor in the region. It has broad ecological and agronomic adaptabilities, produces high yields per unit area per unit time with minimum inputs and has a high energy efficiency ratio. It is an important food and cash crop in East and Central Africa region where most of sweetpotato are produced on the continent.

The promotion of orange-fleshed sweetpotato is showing great promise as a key element in strategic partnerships to solve the problems of malnutrition and food insecurity in eastern and southern Africa. Sub-Saharan Africa is the only region in the developing world where both the number and proportion of malnourished children has been consistently rising. According to projections in IFPRI's 2020 Vision project, the number of malnourished children is projected to rise from 33 million in 1997 to between 39 and 49 million in 2020, depending on the model used (Rosengrant *et al.*, 2001).
In circumstances where use of capsules and fortified foods to mitigate the situation is not possible, the use of orange-fleshed sweetpotatoes seems feasible. Sub-Saharan Africa produces over 7 million tons of sweetpotato annually, about 5 percent of global production. Recent projections indicate that production will be more than double by 2020, whereas production in other regions is expected to remain stable or take decreasing trends. Sweetpotato is an important household food security crop in eastern and southern Africa, particularly in densely populated, intensively cultivated mid-elevation farming areas. Although the crop is mainly cultivated for domestic consumption, both fresh roots and leaves are increasingly gaining market potential for cash income. Roots are commonly consumed fresh, mostly just boiled or roasted, and the range of common recipes is narrow. Most sweetpotato varieties grown in Africa have white- or yellow-coloured flesh, and supply little or no Vitamin A. Orange-fleshed varieties introduced from other parts of the world or bred locally have been readily accepted in pilot areas in East Africa, and preliminary results have shown that they contain sufficient levels ß-carotene to play an important role in eliminating VAD (Hagenimana *et al.*, 1999b).

In the recent past, there have been more deliberate research efforts to develop and promote the production and consumption of the OFSP in the region. These efforts have largely concentrated on variety development in terms of good yield performance, resistance to pests and diseases, improved nutrition and proper post harvest handling methods. The available results are encouraging. There are a number of orange-fleshed sweetpotato varieties that have been developed. Some of them like Kakamega have shown stable yield performance in a wide range of environments. Other varieties have specific environment stability. Farmers and other consumers have found them acceptable both at pre-processing and post processing consumption levels. Moreover, the OFSP varieties have been found to be more popular among young children who are the most vulnerable group. The post harvest handling technologies have been developed and there is already high exhibited demand of sweetpotato-based products by both rural and urban-based consumers. The OFSP based weaning recipes have been received well and are liked by children. All these developments seem to bridge closer the gap for sustainable and beneficial production and utilization of the crop. The nutrition education programs in newspapers, radios, TVs and seminars have raised demand for OFSP. This demand can only be met if farmers can be able to produce sustainable large quantities of the sweetpotato to satisfy demand by processors, local consumers etc.

Facts about Vitamin A and ß-carotene

Vitamin A (retinol) versus ß-carotene: Vitamin A is produced only in animals (including humans) whereas ß-carotene is produced in plants. Because the absorption of ß-carotene and its conversion to vitamin A (retinol) in the body is controlled naturally, and because vitamin A itself does not exist in plants, there is little danger that over-ingestion of vitamin A ß-carotene from a plant source such as sweetpotato could lead to vitamin A toxicity. On the contrally over- ingestion of vitamin A supplements derived from animal sources, such as fish oils has been reported. If excessive amounts of ß-carotene are ingested (which is very unlikely), simply reducing the intake will correct the situation immediately with no lasting toxic effects (Booth *et al.*, 2001).

Sweetpotato as a source of ß-carotene. Depending on the variety, 100g of sweetpotato can provide ß-carotene quantities that are sufficient to yield from 0 to 100% of the recommended daily vitamin A requirement (Table 1), which is at least 350 μg per day for infants and 400 μg per day for young children (1-6 years). Because the body cannot convert all ß-carotene, this translates to about 2400 μg of ß-carotene, an amount easily supplied by about 100g of orange-flesh sweetpotato.

From plant storage parts different crops have different levels of Vitamin-A and sweetpotato mainly orange-fleshed are among the few crops that provide higher amount of ß-carotene content (Table 2). The amount of fresh weight required to yield the daily requirement of ß-carotene is even less with deeper colored orange-fleshed sweetpotatoes. Some orange-fleshed varieties tested by CIP have yielded 8000 μg of ß-carotene per 100g of fresh weight. Studies in Kenya and Uganda (Carey *et al.*, 1999) comparing different varieties ranging from white to deep orange-fleshed showed that small quantity (70-100g) of orange-fleshed sweetpotato is required for daily requirements of pro-vitamin-A for adults as compared to 9000g required from white-fleshed variety (Table 3).

Unfortunately, it is the white-fleshed varieties that are commonly grown and consumed by several households and there is limited awareness about the importance of orange-fleshed varieties with regard to provision of vitamin A. It is not clear why the white-fleshed varieties are popularly used as compared to the orange-fleshed. The challenge, however, is to develop and popularize orange-fleshed varieties among small-scale farmers. Several orange-fleshed varieties have been identified by CIP and partners. Some have been tested on-farm and accepted in Kenya, Uganda, Tanzania and Mozambique (Carey *et al.,* 1999, Oyunga *et al.,* 2000, Wanjekeche *et al.,* 2000, Pequenino *et al.,* 2000). In Kenya the popular varieties include: SPK 004, *Kemb* 10, *Mogamba,* and *Sowola*. For these countries, orange-flesh sweetpotato can be used to "supplement programs". Based on the idea that food-based approaches are the most sustainable and therefore the best option for building future nutritional food security program worldwide, CIP intends to work with the health and nutrition sectors to maximize the potential of food crops such as sweetpotato (especially orange-fleshed varieties) in boosting access to Vitamin A. Although several other food crops can be used as a source of ß-carotene sweepotato seem to be the best candidate crop.

Orange-fleshed sweetpotato compared to "golden rice." Golden rice is rice that has been genetically transformed, using genes from daffodil (and a bacterium) so that ß-carotene is synthesized in the rice grains (ß-carotene is found naturally in rice leaves, but not in the grains). In contrast, sweetpotatoes biosynthesize ß-carotene naturally. Golden rice and orange-flesh sweetpotatoes are both valuable in terms of nutrition, because of their high level of ß-carotene, however, the amount of ß-carotene is higher in orange-flesh sweetpotato than golden rice as shown in the study by Low *et al.* (2001) (Table 4). In addition other research findings indicate that the convertible content on rice is about half that of sweetpotato. It is therefore believed at International Potato Centre (CIP) that orange-flesh sweetpotato offer a quicker and more feasible solution to vitamin A deficiency in Africa than golden rice, because sweetpotato cultivation and consumption is traditionally part of the culture while this is not the case for rice. Also in Africa, sweetpotatoes are currently the cheapest year-round source of vitamin A. Rice may be a more feasible solution to Vitamin A deficiency in Asia, where rice production and consumption is part and parcel of tradition.

Addition health benefits. If infants, young children, and adults are encouraged to eat more orange-flesh sweetpotato to protect themselves against blindness, they will also benefit from other health-enhancing features such as provision of adequate amounts of calories and Vitamins B and C (ascorbic acid) as well as adequate amounts of other micro nutrients such as iron (the iron content in sweetpotato, although not high compared to most food crops, is twice than in rice).

Adaptive research on orange-fleshed varieties

The experience that sowed the seeds of VITAA came in the mid-1990s, when the Kenya Agricultural Research Institute (KARI), the International Center for Research on Women (ICRW), the NGO CARE International and CIP came together in a pilot project to find out whether orange-fleshed sweetpotato would appeal to African consumers. Until then it had been assumed that few would be willing to switch from the traditional white-fleshed varieties, which are high in starch and energy and have good cooking qualities because of their high dry matter content. To our delight, the project banished the myth of consumer unacceptability, both women and children welcomed the taste and texture of the orange flesh. Children in particular loved the sweetness and the orange like juiciness.'

Now the partnership is capitalizing on the opportunity revealed by these findings. Adaptive research activities are being advanced in Kenya and Uganda, where KARI and the National Agricultural Research Organization (NARO) scientists are working with CIP's regional staff to screen several orange-fleshed varieties clones in order to access their suitability to different environments. In addition, NGOs and women's groups in both countries are participating in on-farm trials, exposing a growing number of producers and consumers to their first experience of the varieties. Table 5 shows the list of orange-flesh varieties and their characteristics, which are currently being multiplied and virus cleaned by CIP at Muguga Plant Quarantine Services in Kenya for distribution to different countries in SSA upon request.

Children in Luwero district Uganda, loved the taste, texture, and color of *Ejumula*, which is a deep orange variety, while adults preferred the lighter orange *Kakamega* variety, which is less sweet and has much appealing flavour (Tables 6 and 7). Farmers also found that the new orange-fleshed varieties grow well, producing acceptable yields of tubers and moderately resistant to stresses such as drought and insect pests (CHDC, 2001). Results of the assessments indicate that all varieties tested had a great potential for acceptability. The low coefficients of variations obtained from the farmers' assessment data serve to reveal the fact that not much variation existed between rankings for the various attributes both within and between zones. The fact that orange-fleshed varieties were liked by the respondents and ranked high especially by the children implies that varieties that are rich in vitamin A can be easily adopted among the farming communities in Luwero and probably the entire country as a whole. This will help in dealing with the problem of vitamin-A deficiency. Children preferred very sugary varieties with less dry textures, whereas adults preferred less sugary and drier textured varieties. Children indicated that *Ejumula* had a very attractive color, sweeter and less fibrous whereas for the adults, the most preferred variety was '*Kakamega*' (SPK004) mainly because it was flourier and not sugary like the latter. Field attributes for example resistance to pests, drought tolerance and time to maturity were ranked high by the farmers. Similarly, all varieties were ranked above moderate for the tuber yield attributes. The coefficients of variations for the various field attributes assessed on-farm were generally low indicating that farmers' views were unanimous when assessing the varieties. Adults and children considered aspects of fibre content, smell, taste and hard/softness. Adults only mentioned the culinary aspects. In all five villages two varieties *Ejumula* (deep orange) and *Kakamega* (light orange/cream) were singled as the most preferred varieties.

In addition to the above, farmers in Kenya, Tanzania and Uganda have evaluated orange-fleshed varieties and other preferred varieties. They include SPK004, *Mogamba, Zapallo* (for children), *Salyboro, Pumpkin,* SPK 013, and *Kemb*10 (yellow-fleshed). Increased markets of orange- fleshed varieties (both roots and vines) and multiplication and distribution of planting materials have continued by individual farmers and community based organizations. In Western Kenya, about 18 million cuttings mainly of orange-fleshed varieties have been distributed to farmers from KARI stations and local CBO's/ NGO's.

Farmers' observations to-date

- Varieties *Salyboro*, SPK 013, SPK004 and *Mugande* are preferred for marketing because of good root shape, big root size and early maturity (3-4 months). Also SPK 013 produces high foliage yield for livestock feed.

- Varieties *Pumpkin* and *Tainung* are watery and susceptible to drought. These are not preferred although both have extended storability (can keep up to one month after harvesting) as compared to others. Farmers attribute this to their watery nature hence reduced water loss. These observations corroborate with findings from the studies in Kenya and Tanzania by the National Root Crops Research Program 1995- 1999.

- Diabetic persons in their villages currently use varieties Pumpkin and SPK 004. It was indicated by the farmers in Western Kenya that diabetic patients claimed to be eating these varieties without any problem whereas in the past they couldn't do so with their local varieties. This however, requires further investigations by Health and Nutritional scientists.

- Farmers observed that majority of the orange-flesh varieties were moderately resistant to pest attack as compared to local varieties that succumbed easily to severe outbreaks of caterpillars.

Constraints limiting the expanded production of orange-fleshed varieties

- Lack of markets to dispose the planting materials and capital to expand the production of sweetpotato for processing the high quality flours.

- Low dry matter contents of available orange-fleshed varieties limit the increased utilization at household level mainly by adults. Similarly for the communities that have initiated the processing into flours, it has been observed that very small quantities of flours are obtained when low dry matter varieties are used. High acceptance is still limited to children because adults prefer dry textured roots.

- Majority of introduced varieties from USA and other countries outside Africa easily succumb to virus disease infections hence establishment and adaptability in high-pressure zones is generally poor. Many potential high yielding varieties have been lost in this way.

Distribution of varieties and way forward

Soon the next generation of improved clones will reach farmers' fields. The new varieties break the link between flesh color and dry matter, offering growers the best of both worlds -- a relatively high vitamin A content in a background with good starch and dry matter.' The new clones will be sent to Genetic Technologies Ltd., a Nairobi-based private-sector laboratory specializing in tissue culture, which will speed the multiplication of high-quality planting materials. These will then be distributed through the expanding network of VITAA collaborators in East Africa. As in the pilot study, the emphasis will be on working through the strong community and women groups' characteristic of Kenya and other countries in the region. These groups offer the best chances of changing the dietary habits of rural families. And they can also form the micro-enterprises needed to process orange-fleshed sweetpotato products and market them to urban consumers, many of whom are also deficient in vitamin A. More work is being undertaken in East and Central African countries with support from PRAPACE, a regional network for sweetpotato and potato research (Lemaga *et al.,* 2001). The list of activities on the testing and promotion of orange-fleshed varieties supported by PRAPACE is shown in Table 8.

Building on these experiences, CIP, International Center for Research on Women (ICRW), Kenya Agricultural Research Institute (KARI), Makerere University-Uganda, National Agricultural Research Organization (NARO) –Uganda, Agricultural Research Center-Roodeplat, South Africa, Division of Agricultural Research- Ministry of Agriculture and Food Security- Tanzania, Tanzania Food Nutrition Center and the Ethiopian Agricultural Research Organization are developing a five year regional project to take advantage of sweetpotato's nutritional value. The project code named VITAA (Vitamin A for Africa) is focusing on the following accomplishments:

- increase the availability and acceptability of orange-flesh sweetpotatoes in sub-Saharan Africa.

- complement development agencies' supplementation/ fortification efforts.

- increase the capacity of national agriculture, health and nutrition experts to incorporate sweetpotatoes in their national dietary recommendations.

- stimulate and promote micro enterprise development using products from orange-flesh sweetpotato.

- teach house hold managers (women and children) the nutritional value and effects of consuming orange-flesh sweetpotatoes and encourage them to analyze their house hold nutrition.

Above all, the major goal of this project is to ensure healthy rural populations through food-based approaches to nutrition, focused on vitamin A. The purpose is to have children and adults consume orange-fleshed sweetpotato in levels that lead to reduced vitamin A deficiency.

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Table 1: United Nations published values recommended dietary intakes for Vitamin A (retinol Equivalent)

Human age / reproductive status	Basal (µg retinol equivalent)	Safe (µg retinol equivalent)
Infants	180	350
1-6 years	200	400
6-15 years	250-350	400-600
Males	300-400	500-600
Females	270-330	500
Pregnancy	100	100
Lactation	180	350

Source: Booth *et al.* (2001)

Table 2. United Nations Published values for vitamin A activity in plant storage organs

	Description	CE	TA
Bitter gourd	Raw	17,040	2,840
	Cooked	13.260	2,210
Carrot	Raw	3,890-21,000	648-3,500
	Dried	36,000-135,000	6,000-22,500
	Pickled	123-1,063	20-177
	Juice	2,620	437
Cassava	Raw	5-35	1 –6
Finger millet	Flour	25	4
Maize	yellow, raw	360	60
	yellow, dried	125	20
	White, dried	0	0
Potato	White, raw	2-20	Trace-3
Rice	Parboiled	0	0
Squash	Raw	82	14
Sweet potato	White, raw	35	6
	Yellow-orange, raw	300-4,620	50-770

Adopted from: Booth *et al.* (2001)

Table 3. Amounts of fresh storage roots (g.) of sweetpotato required to supply the recommended daily allowances of vitamin A to different human age and gender groups

Human age group (years)	Recommended daily vitamin A requirement (µg retinol equivalent)	Amount (g.) of fresh storage root required to supply the required provitamin A content

		TIS 2534 (White)	Kemb10 (Pale yellow)	SPK 004 (Cream)	Japones (Orange)
1 to 3	400	3636	265	78	35
4 to 6	500	4545	331	97	43
7 to 10	700	6364	463	136	61
Females over 10	800	7273	530	155	69
Males over 10	1000	9091	662	194	87

Source: Carey *et al.* (1999)

Table 4. PotentialVitamin- A values f golden rice versus sweetpotato (orange-fleshed)

	Mcg b-c	Mcg Retinol Equivalent (RE)	% Required Dietary Allowance (RDA)
Golden rice tm 100g	160	10-20	5.1
Orange-flesh sweetpotato100g	7500	625- 1250	> 100

Source: Low *et al.* (2001).

Table 5: Pathogen-tested orange fleshed varieties distributed to Tanzania, Kenya, Uganda and Zanzibar for evaluation under VITAA Project, 2001

Name (CIP No.)	***Source***	***Characteristics***	***Remarks***
Zapallo (420027)	Peru	tolerant to weevils; susceptible to virus; late maturing; dry matter (25%); yield (23 t/ha).	perform well in a number of African environment, currently undergoing regional evaluation and promotion.
Salyboro (187017.1)	C.I.P	salt tolerance; dry matter (27%), yield (25.2 t/ha) virus (moderate)	performs well in different ecological zones. Can be utilized in formulation of various recipes.
Tainung (440215-. 65)	Taiwan	virus (susceptible) yield (35 t/ha) dry matter (27.2%) drought (susceptible)	consumer acceptability very high; very unstable performance in different regions.

Jonathan (420014)	U.S.A	weevil (susceptible) virus (moderate resistant) dry matter (28.4%), moderately resistant	resistant to nematodes(meloidogyne) late maturing
Jewel (440031)	USA	weevil (susceptible) dry matter (30 %); virus (moderately resistant) yield (21t/ha);	stable performance ; can be used to make several recipes.
Kandee (440140)	USA	virus (resistant- FMV); yield (20 t/ha) dry matter (27%)	normally form long elleptic shaped storage roots.
Centennial (440112)	USA	virus (susceptible) yield (15t/ha) dry matter (24%)	yet to undergo national and regional trials in Sub- Saharan Africa.
Excel (440016)	USA	late maturing dry matter (26%)	does poorly in areas that are dry; high consumer acceptance. currently undergoing national and regional trials.
TIB-4 (440060)	IITA	virus (susceptible) dry matter (34%) weevil (moderate)	unstable performance can be processed into various recipes due to its high dry matter content.
Japon Tresmesino (42009)	Peru	early maturing	consumer acceptability is very high stable performance
VSP 4 (440288)	Philippines	weevils (susceptible) dry matter (moist)	
Jewel (566638)	U.S.A	early maturing virus (susceptible) weevils (susceptible) yield (very high)	unstable performance.
Julian (440141)	USA	dry matter (25%) late maturing	
BP-SP-2 (440293)	Philippines	weevil (susceptible) late maturing	
Nemanete	PERU	dry matter (29.6%) very sensitive to saline soils	the variety is yet to be tested under varied ecological zone in Kenya
TAINUNG 64 (56632)	TAIWAN	dry matter (23.8%) tolerant to acidic conditions	has low consumer acceptability
Kafr-El-Zayat (440091)	-	virus (resistant - FMV)	unstable except where night temperatures are normally 15°C to 20°C
LA10 SHU (44 440157)	CHINA	dry matter (26.5%)	has not been subjected to trials in Kenya
NC 317 (440090)	USA	dry matter(26.1%)	not sensitive to acidic soil conditions
W-154 (440006)	-	virus (resistant-FMV)	Adapted to warm tropical climate

Table 6: ***Post-harvest assessment by Adults of orange-fleshed sweetpotato cooked roots for different varieties in five villages of Luwero district, Uganda (October, 2001)***

Village	Variety	Attribute									
		Taste	**CV (%)**	**Appearance**	**CV %)**	**Starchiness**	**CV (%)**	**Fibrousnesses**	**CV %)**	**General acceptability**	**CV %)**
Kibisi (N = 15)	Kala	2.8	6.3	2.9	7.9	2.4	4.3	2.9	6.8	2.9	9.6
	Ejumula	2.2	4.9	2.3	4.9	2.4	4.8	2.2	3.2	2.3	4.0
	Kakamega	2.5	2.7	2.6	3.9	2.9	3.6	2.9	7.9	2.5	4.2
Kikasa (N = 14)	Kala	2.4	3.7	2.5	4.0	2.4	3.7	2.8	9.7	2.5	7.4
	Ejumula	2.4	2.5	2.5	2.8	2.7	6.3	3.0	3.1	2.5	2.3
	Kakamega	2.9	7.0	2.9	9.7	2.8	9.1	2.5	7.4	2.8	9.7
Kalule (N = 15)	Ejumula	2.7	5.8	2.6	5.1	2.7	5.8	2.4	3.8	2.6	5.1
	Kakamega	2.4	4.8	2.9	8.1	2.7	4.1	2.4	6.0	2.6	5.1
Bajjo (N = 11)	Emujula	2.7	5.9	2.9	12.5	2.7	5.5	3.0	2.6	2.7	5.5
	Kakamega	2.2	4.2	2.8	6.5	2.9	3.9	2.5	4.9	2.3	3.9
	Bwanjule	2.7	5.5	2.6	4.3	2.3	4.9	2.8	7.4	2.4	3.5
Mayilikiti (N = 14)	Kala	2.3	4.9	2.9	7.9	2.9	10.5	2.7	5.7	2.6	11.4
	Ejumula	2.7	5.8	3.0	0.0	2.4	4.7	3.0	0.0	3.0	12.1
	Kakamega	3.0	4.2	2.9	10.9	3.4	7.9	2.8	6.5	3.0	3.7

Subjective ranking of 1 = very bad, 2 = moderate and 3 = very good
Source: CHDC (2001)

Table 7: Post-harvest assessment by children of orange-fleshed sweetpotato cooked roots for different varieties in five villages of Luwero district, Uganda (October, 2001)

Village	Variety	Attribute									
Kibisi (N = 7)		Taste	CV (%)	Appearance	CV (%)	Starchiness	CV (%)	Fibrousness	CV (%)	General acceptability	CV (%)
	Kala	2.7	7.5	2.9	7.6	2.3	3.0	3.0	0.0	2.6	4.8
	Ejumula	3.0	6.0	2.9	5.7	2.3	4.7	2.1	3.1	2.9	7.0
	Kakamega	2.7	3.6	2.1	7.6	2.3	4.7	2.9	7.6	2.7	3.0
Kalule (N = 3)	Ejumula	2.8	3.9	2.7	4.6	2.3	4.0	2.3	3.9	2.7	4.6
	Kakamega	2.3	3.9	3.0	0.0	1.7	2.9	2.3	3.9	3.0	4.6
Bajjo (N = 7)	Emujula	2.9	7.6	3.0	0.0	2.5	4.8	3.0	6.0	3.0	0.0
	Kakamega	2.1	5.7	2.9	7.6	2.1	5.7	2.6	4.8	2.4	4.5
	Bwanjule	3.0	0.0	3.0	0.0	2.3	4.7	2.9	7.6	2.7	5.6
Mayilikiti (N = 4)	Kala	2.5	4.3	3.0	0.0	3.0	0.0	2.5	4.4	2.8	5.5
	Ejumula	3.2	5.5	2.8	5.5	2.0	0.0	2.8	5.5	3.0	0.0
	Kakamega	3.0	0.0	3.0	0.0	2.8	5.5	2.5	4.3	3.0	

Subjective ranking: 1 = very bad, 2= moderate, 3 = very good
Source: CHDC (2001)

Table 8. List of projects on Vitamin A sponsored by PRAPACE network

Title of the project	Objectives	Outputs	Count
Using orange-fleshed sweetpotato for combating vitamin A deficiency in selected communities	On-farm evaluation of orange-fleshed sweetpotatoes and their resulting products and sensitization of women groups about vitamin A	Development and adoption of appropriate strategy for sustained production and distribution of Vitamin A rich sweetpotatoes	Ugan
Sweetpotato processing for improved nutrition and food security	Use of orange-fleshed sweetpotato flour as composite in fermented porridge;	Development and dissemination of sweetpotato composite flours	Keny
	Incorporation of sweetpotato (flour) into popular snack and staple foods	Availability of sweetpotato processed products to local and urban markets	
Introduction and utilization of orange-fleshed sweetpotato as a weaning food in marginal areas	Development of weaning food based on sweetpotato	Acceptability of orange-fleshed sweetpotato products in marginal areas	Keny
Control of Vitamin A deficiency in children using yellow and orange-fleshed sweetpotato	Formulation of diets from different sources and incorporate sweetpotato as a source of vitamin A	Diets rich in Vitamin A formulated and tested	Ugan
L'emploi de la patate douce comme moyen de lutte contre la carence en Vitamine A chez les communautés cibles	Promouvoir et apprendre aux populations cibles comment developper des produits a base de patate douce riches en Vitamine A	Adoption des variétés de patate douce a chair orange et leurs produits	Burun
Utilisation de la patate douce (feuilles et tubercules) a chaire orange dans la lutte contre l'avitam	Améliorer l'alimentation en Vitamin A des communautés cibles;	Disponibiliser des variétés a feuilles consomables et tubercules a chaire orange et leurs mets	R.D. Co
	Evaluation de l'effet des différentes méthodes de cuisson sur la teneur en provitamine A des feuilles et tubercule		

Source: Lemaga *et al*. (2001)