Promotion of orange-fleshed sweetpotato to enhance dietary Vitamin A intake: Lessons and Strategies in Eastern and Southern Africa

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Abstract:

Vitamin A deficiency is a serious component of a serious and growing problem of malnutrition in sub-Saharan Africa, particularly among children. The International Potato Centre (CIP) is working together with partner organizations in agriculture, nutrition, and health to fight vitamin A deficiency through the promotion of orange- fleshed sweetpotato varieties as a dietary source of ß-carotene, from which the body synthesizes the vitamin. This approach complements supplementation and fortification, which is out of reach to many people, particularly in rural areas where a majority are unable to afford the costs involved. The approach also has potential for sustainability especially if value addition and product development concerns are addressed. This will facilitate varsility and create new markets for sweetpotato. Orange-fleshed varieties are acceptable to African consumers, especially children. Varieties with a drier, starchier texture have now been selected that are accepted by local consumers in vitamin A deficient areas. The challenge therefore is to stimulate further demand through value addition. The VITAA partnership - Vitamin A for Africa -- aims to build partnerships between farmers, nutritionists, researchers, medical doctors, NGO's, local based communities, extensions and entrepreneurs. The common goal is to promote orange-fleshed sweetpotatoes and other food-based approaches to solving vitamin A deficiency and wider problems of malnutrition.

Keywords: *Beta –Carotene, Partnerships, Vitamin A deficiency.*

Introduction

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 (SSA) 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 SSA, three million children under the age of five suffer total or partial blindness caused by Vitamin A deficiency (VAD). 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

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.

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).

Facts about Vitamin A and beta-carotene

Vitamin A (retinol) versus beta-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 as sweetpotato could lead to vitamin A toxicity. On the centrally 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 beta-carotene. Depending on the variety, 100g of sweetpotato can provide ß-carotene quantities that are sufficient to yield from 0 to 100% of the suggested daily vitamin A requirement (Table 1), which is at least 350 micro grams per day for infants and 400 micrograms per day for young children (1-6 years). Because the body can convert not 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). With deeper colored orange-fleshed sweetpotatoes, the amount of fresh weight required to yield the daily requirement of ß-carotene is even less. 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 the 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 that in rice).

Adaptive research on orange-fleshed sweetpotato varieties

In the mid-1990s, after a pilot project between Kenya Agricultural Research Institute (KARI), together with the International Center for Research on Women (ICRW), CARE International and International Potato Centre (CIP) to establish whether orange-fleshed sweetpotato would appeal to African consumers. Until then it had been largely believed that few were 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's findings banished the myth of consumer unacceptability for OFSP. Both women and children welcomed the taste and texture of the orange flesh. Children in particular loved the sweetness and the orange like juiciness.'

Adaptive research activities have since then been continued in Kenya, and started in more other countries in the region. CIP's regional scientists in collaboration with national programs are testing a number of OFSP materials (both local and introduced) for adaptability and consumer acceptability. At the same time, NGOs and women groups are highly involved 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, that have been multiplied and virus cleaned by CIP at Muguga Plant Quarantine Services in Kenya and distributed to different countries in SSA (Uganda, Tanzania, Zanzibar, Sudan, Zimbabwe, DR Congo, Malawi, Zambia, Egypt and South Africa) during the year 2002. Reports from different countries indicate a number of local and introduced varieties that have been identified and found acceptable to local consumers/farmers. In Uganda, varieties Kakamega (SPK004), Ejumula, and Kala have been widely tested and found acceptable to diverse communities. Whereas Kakamega was introduced from Kenya to Uganda, Kala and ejumula are local varieties. Ejumula has been identified the most preferred OFSP variety in the different parts of the country (Table 6). Children love it largely because of its deep orange appealing colour and sweetness (tables 7 and 8). Adults also prefer it because of the starchiness and appealing (table 8). In the field Ejumula has been observed to mature at an earlier date and has stable average yields, though it is observed at the same time to be less tolerant to drought and highly attacked by weevils (table 9) on late harvesting. Kakamega is the second most preferred OFSP variety by both children and their parents. Adults have in cases preferred it most because it is starchier compared to the rest. Its root flesh is light orange. In the field yields are high but will tend to perform poorly when there are no rains after planting.

In Kenya four introduced varieties (Zapallo, 420094, SPK004, and 420019) have been identified for high yields and another two varieties (Sponge and 420005) were selected for good root characteristics (Table 10). At the same time local varieties KK118, Nyaguta, Kuny, Odinga and Sponge (Table 11) have been identified and have already been virus cleaned for distribution to other countries in the region. In Tanzania, varieties Zapallo, Japon Tresmesino, Tainung 64, were widely accepted by consumers and produced higher yields. In South Africa, varieties W-19 and Excel have been for high dry matter and high beta-carotene content.

Increased markets of orange- fleshed varieties (both roots and vines) as well as multiplication and distribution of planting materials have continued by individual farmers and community based organizations. During 2001, and estimated 18 million vine cuttings mainly of orange-fleshed varieties were distributed to farmers in Western Kenya by KARI stations in collaboration with local CBO's/ NGO's. During 2002 a total estimate of 10 million vine cuttings are reported to have been distributed in the major sweepotato growing areas of Uganda, Kenya and Tanzania (Table 12). To-date it t is currently estimated that orange fleshed varieties occupy 1-2% in the lake zone of Tanzania, 5-10% in Central Uganda and 10-15% in W. Kenya. These estimates are known to be an under estimate as there is a lot of informal exchange of planting material among farmers that is unaccounted for.

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 has been 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 Medical, 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.

- The unpleasant odour associated with orange-fleshed varieties normally leads to poor reception of the varieties by adults. Other people suffer from the fact that they have been used to white-flesh types and the orange-flesh types seem strange. However the bias is short lived and is came as farmers eat more of the orange-fleshed sweetpotato.

- Yield is another important attribute used by African farmers to accept or reject varieties. The average yields characteristic of orange types of sweetpotato has also limited their wide scale uptake.

Variety deployment of high beta-carotene and dry matter content

The next generation of improved OFSP clones (Table 13) has reached in the region and is under preliminary adaptability trials in Kenya, Tanzania, Uganda, South Africa and Mozambique. These are countries with established tissue culture facilities and will in future serve as sources for other neighbouring countries in the region through the expanding regional networks (SARRNET and PRAPACE). 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.' 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 14.

VITAA (Vitamin- A for Africa) Partnerships

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 have developed 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.

References

Booth, S. L., T. Johns, and H. V. Kunlein. 2001. Natural food sources of Vitamin A and provitamin A. In: http://www.unu.edu/unupress/food/8F14le/8F141E05.htm

Carey, E.E., Hagenimana, V., K'osambo, L., Oyunga, M.A., Benesi, I., Smit, N., Ocitti p'Obwoya, C., Turyamureeba, G., Ndolo, P.J., and Low, J. 1999. Using orange-fleshed sweetpotato varieties to combat vitamin A deficiency and enhance market opportunities for smallholder farmers in sub-Saharan Africa, pp.157-168. In: *Food Security and Crop Diversification in SADC Countries: The Role of Cassava and Sweetpotato,* M.O. Akoroda and J.M. Teri (eds.). Proceedings of the scientific workshop of the Southern African Root Crops Research Network (SARRNET) held at Pamodzi Hotel, 17-19 August, 1998, Lusaka, Zambia. 476p.

CHDC (Child Health and Development Center). 2001. Assessment of orange–fleshed sweetpotato varieties by consumers in Luwero District., Uganda. CHDC, Mulago hospital-MOST Program. Uganda.

Hagenimana, V. 2001. Final technical report, Project R7036 (ZB0099).An enterprise approach to commodity system improvement: Sweetpotato in Uganda and Kenya.

Hagenimana, V., Oyunga, M.A., Low, J., Njoroge, S.M., Gichuki, S., and Kabira, J. 1999b. The effects of women farmers' adoption of orange-fleshed sweetpotatoes: Raising vitamin A intake in Kenya. ICRW/OMNI Research Program, Research Report Series 3. International Center for Research on Women, Washington, DC, 24p.

Low, J., T. Walker, and R. Hijmans. 2001. The potential impact of orange-fleshed sweetpotato on Vitamin-A intake in su-Saharan Africa. . Paper presented at a Regional Workshop on Food Based Approaches to Human Nutritional Deficiencies: The VITAA Project, Vitamin A and Orange-fleshed sweetpotato in sub-Saharan Africa. May 9-11, 2001. Nairobi, Kenya

Oyunga, M.A., N. M. N'gan'ga & J. A. Olayo. 2000. Sweetpotato processing for improved Vitamin A intake: Gender implications and potential for sustainable technology adoption in Siaya District, Kenya. *Proceedings of the 5th Triennial Congress of the African Potato Association* Kampala, Uganda. May 29–June 2, 2000. pp. 491-495.

Pequenino, E. F., J. Ricardo, and M. I. Andrane. Preference of orange- fleshed sweetpotato and seasonality of vitamin A consumption in rural areas of Mozambique. *Proceedings of the 5th Triennial Congress of the African Potato Association* Kampala, Uganda. May 29–June 2, 2000. pp. 497-502.

Rosengrant, M.W. M.S. Paisner, S. Meijer, and J. Witcover. 2001. 2020 global food outlook: Trends, alternatives, and choices. Washington D.C. International Food Policy Research Institute (IFPRI), p.7.

Wanjekeche, E., C. Lusweti, V. Hagenimana, V. Wakasa, E. Misto, and I. Lopel. 2000. Performance and acceptability of orange sweetpotato in the marginal areas of west Pokot District Kenya. *Proceedings of the 5th Triennial Congress of the African Potato Association* Kampala, Uganda. May 29–June 2, 2000. pp. 143-147.

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

TA- Total vitamin A activity, Adopted from: Booth *et al.* (2001)

Table 3. Amounts of fresh storage roots (g.) of sweetpotato required supplying 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. Potential Vitamin- A values of 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		dry matter (23.8%)	has low consumer acceptability

(56632)	TAIWAN	tolerant to acidic conditions	
Kafr-El-Zayat (440091)	-	virus (resistant - FMV)	unstable except where night temperatures are normally 15^{o}C to 20^{o}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: Ranking of OFSP varieties for field and post harvest performance by farmers in Central districts of Uganda, August 2002

District	**Orange-fleshed varieties**					
	Ejumula		**Kakamega**		**Kala**	
	Field	**Post harvest**	***Field***	**Post harvest**	***Field***	**Post harvest**
Luwero	1	1	2	2	2	3
Kiboga 1	1	2	2	1	3	1
Kiboga 2	2	1	1	2	3	3
Wakiso	2	2	3	3	1	1
Mpigi	1	1	2	3	3	2
Rakai	1	1	2	3	3	2
Rank sums	**8**	**8**	**12**	**14**	**15**	**12**
Overall rank	**1**	**1**	**2**	**3**	**3**	**2**

Table 7: Ranks of cooked OFSP varieties generated out of pair wise raking exercises by children over 2 seasons in Luwero, Uganda , 2002

Zone	**Ranks of different varieties**		
	Ejumula	**Kakamega (SPK004)**	**Kala**
April 2002			
Bajjo	2	3	1
Kalule	1	3	2
Kibisi	1	2	3
Kikasa	1	3	2
Mayirikiti	2	2	3
Rank sums	**7**	**13**	**11**
Overall rank	**1**	**3**	**2**
August 2002			
Bajjo	1	3	2
Kalule	-	-	-
Kibisi	1	2	3
Kikasa	1	2	3
Mayirikiti	1	2	3
Rank sums	**4**	**9**	**11**
Overall rank	**1**	**2**	**3**

Table 8: Reasons for highly ranking Ejumula at field and post harvest levels in Luwero district, Uganda (2002)

Reasons for acceptance (field)	**Freq uenc**	**Adults at post harvest**	**Freq uenc**	**Children at post harvest**	**Frequenc y**

	y		y		
Good yields	5	Good appearance	6	Good colour/appearance	9
Less attacked by pests	2	Sugary	3	Not fibrous	5
Good foliage coverage	1	Good flavour	7	Good flavour	5
Skin appearance	5	Not fibrous	7	Good taste	4
Good root size	3	Starchy	7	Starchy	3
Good root shape	1	Tastes good	5	Sugary	5
Good root flesh appearance	1				

Table 9: Estimated means of rate of establishment, vine and root yield at harvest, marketable root harvest and percent weevil infestation in Luwero, Uganda 2002.

Variety	**% Estab.t**	**Vine yield (t/ha)**	**Total root yield (t/ha)**	**Marketable roots (t/ha)**	**Weevil infested roots (%)**
Ejumula	86.3 ± 2.6	4.9 ± 0.8	5.2 ± 1.1	3.5 ± 2.3	40.3 ± 10.6
SPK004	89.6 ± 1.6	9.2 ± 1.3	3.9 ± 0.8	2.6 ± 2.1	21.6 ± 5.2
Kala	90.4 ± 2.7	8.2 ± 1.3	5.0 ± 1.1	4.1 ± 2.7	42.7 ± 6.7

Table 10: Evaluation of cooked roots of orange-fleshed sweetpotato varieties in Advanced Yield Trial harvested at ARI- Kakamega, Kenya (2002)

Variety	**Appearance**	**Taste**	**Flavour**	**Starchiness**	**Fibrousness**
SPK004	2.4	2.4	2.4	2.5	2.6
Sponge	2.0	2.0	2.0	2.3	2.4
Zapallo	2.4	2.0	2.1	2.0	2.3
420005	2.2	2.1	2.0	2.1	1.9
420006	2.3	1.8	1.9	2.0	2.1
420019	1.7	2.0	2.0	2.1	2.2
440091	1.7	1.8	2.0	2.9	2.1
420094	2.3	1.7	1.7	1.8	2.0
LSD (0.05)	**0.24**	**0.23**	**0.22**	**0.23**	**0.23**
CV%	**31.0**	**32.2**	**31.1**	**29.9**	**29.3**

Scale 1= Bad, 2= Moderate, and 3= Good

Table 11: Performance of local orange-fleshed sweet potato varieties in Preliminary Yield Trial at ARI- Kakmega, Kenya. 2001/2002

Variety	Total root yield (T/Ha)	Foliage yield (T/Ha)	General evaluation	DM%	Virus score (1-5)
KK118	21.1	30.7	4.0	32.0	2.3
Nyaguta	10.5	50.4	3.0	32.4	1.3
Kuny	15.6	27.6	2.7	33.9	2.7
Odinga	15.8	29.0	3.3	34.4	2.0
Nyasna	22.4	25.9	3.7	29.7	2.3
SPK004	17.5	29.4	3.7	32.2	1.7
Simama	4.9	54.5	2.3	33.3	2.0
Sponge	17.6	46.9	3.7	31.6	1.7
KK207	3.8	42.5	2.3	34.4	2.0
Mean	14.4	37.4	3.3	32.7	2.0
CV%	38.3	35.1	16.0	9.0	31.7
LSD	9.3	16.3	0.9	5.1	1.1

General evaluation scores 1: Very bad, 2: Bad, 3: Moderate, 4: Good, and 5: Very good
Virus scores 1: Very bad, 2: Bad, 3: Moderate, 4: Good, and 5: Very good

Table 12: Planting Material multiplication and distribution by research institutes and partners in CIP targeted East African countries in year 2002

Country	**Varieties distributed**	**Number of cuttings distributed**	**Estimated area (ha) covered**	**Estimated number of beneficiaries (farmers)**	**Collaborating partners**
Kenya (Western region)	Zapallo (23%) SPK004 (36%) SPK013 (9%) Salyboro (21%) Others (11%)	2,093,100	69.8	172	FARM AFRICA KARI – Kakamega REFSO Local CBOs
Uganda (Central and Eastern regions)	SPK004 (89%) NASPOTs (8%) Others (4%)	5,261,974	175	600	BUCADEF/PRAPACE SOCADIDO JAF NAARI AFRICARE
Tanzania (Zanzibar, Eastern and Lake zones)	SPN/O (75%) Vumilia (12%) Maruno (8%) Polista (3%) Others (2%)	3,600,000	120	290	TAHEA, CARE, World Vision, CCT, DTC, ARD – Maruku & Ukiruguru, Winrock International
Total		**10,955,074**	**364.8**	**1062**	

( ) percentage distibution of each variety

Table 13: High dry matter, high beta carotene sweetpotato clones introduced from , CIP for the SSA- region, 2002

Code	Accession Number	Dry matter content (%)	Fresh yield (t/ha)	DM yield (t/ha)	Skin color	Flesh color
1	199069.7	30.0	36.6	11.0	Creamy	Light orange
2	199001.16	30.2	31.3	10.6	Dark copper	Light orange
3	199005.9	30.3	33.2	10.1	Pink	Light orange
4	199024.8	30.5	35.2	10.7	Red	Light orange
5	199038.9	30.8	37.7	11.6	Pink	Light orange
6	199003.2	31.0	35.3	12.3	Light purple	Light orange
7	199029.3	31.1	32.9	10.2	Red	Light orange
8	199067.1	31.1	33.6	10.3	Creamy	Light orange
9	199030.4	31.1	34.4	10.7	Light purple	Light orange
10	199014.7	31.2	38.2	12.0	Red	Light orange
11	199021.7	31.3	38.3	11.9	Light purple	Light orange
12	199025.17	31.3	40.4	12.6	Light copper	Light orange
13	199035.7	31.7	41.3	13.1	Creamy	Light orange
14	199027.8	32.2	33.6	10.8	Red	Light orange
15	199034.5	32.4	31.5	10.2	Light purple	Light orange
16	199014.2	32.5	33.0	10.7	Red	Light orange
17	199001.4	33.0	30.1	11.2	Creamy	Light orange
18	199034.7	33.1	39.5	13.1	Red	Light orange
19	199016.3	33.3	33.0	11.0	Light copper	Light orange
20	199073.2	35.3	30.1	10.6	Creamy	Light orange
21	199029.2	35.5	44.2	15.7	Red	Light orange
22	199037.1	35.6	38.9	13.9	Creamy	Light orange
23	199003.5	35.6	42.4	17.0	Yellow	Light orange
24	199069.1	37.0	37.5	13.9	Creamy	Light orange
25	199020.2	37.5	34.8	13.0	Pink	Light orange
26	199057.4	37.9	45.8	17.5	Light purple	Light orange
27	199004.9	38.3	34.5	13.3	Red	Light orange
28	199004.2	38.6	32.8	14.3	Pink	Light orange
29	199033.7	31.1	31.6	9.8	Red	Orange
30	199020.1	31.2	32.8	10.3	Light purple	Orange
31	199034.16	31.5	36.3	11.4	Yellow	Orange
32	199034.13	31.6	30.7	9.7	Light purple	Orange
33	199035.2	32.1	37.3	11.9	Light copper	Orange
34	199062.1	32.5	52.0	16.9	Light copper	Orange
35	199021.5	33.0	30.3	10.0	Pink	Orange
36	199033.4	34.6	37.8	13.0	Red	Orange
37	199021.3	34.9	34.4	12.0	Light copper	Orange
38	199040.6	30.0	45.1	13.5	Pink	Orange
39	199015.12	31.2	34.3	10.7	Red	Orange
40	199034.12	32.5	38.1	12.3	Light purple	Orange
41	199004.3	32.6	34.0	12.5	Red	Orange
42	199024.6	33.0	37.3	12.3	Light purple	Orange
	Mean	**32.9**	**36.2**	**12.1**		

Table 14. List of some projects on promotion of orange fleshed sweetpotato supported by PRAPACE network in East and Central African region from 2000

Title of the project	Objectives	Outputs	Country	Period
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	Uganda	1998-1999
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	Kenya	1998-1999
	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	Kenya	1998-1999
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	Uganda	1998-1999
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	Burundi	1998-2,000
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. Congo	1998-2000
	Evaluation de l’effet des différentes méthodes de cuisson sur la teneur en provitamine A des feuilles et tubercule			

Source: Lemaga *et al*. (2001)