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OPPORTUNITIES FOR PROMOTING ORANGE-FLESHED SWEETPOTATO AS A MECHANISM FOR COMBAT VITAMIN-A DEFICIENCY IN SUB-SAHARAN AFRICA

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ABSTRACT

Sweetpotato *(Ipomea batatas)* is one of the most important staple crops in densely populated parts of eastern Africa and is quickly becoming an important supplementary staple in the southern part of the continent. Sweetpotato is vital to small-scale farmers with limited land, labour and capital. One of its greatest values is its ability to be harvested piecemeal for home consumption or income generation. Presently, 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 readily 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, over 50 million children under the age of six stand to benefit from this effort. More precisely, *ex ante* analysis showed that each unit kilogramme increase in per capita production of orange-flesh sweetpotato results in 1% rise in the attainment of requirements up to about 25 kilogrammes per capita. The challenge is to maintain sweetpotato status as a food security crop, and, yet stimulate its transition into a market-oriented commodity for rural income generation. 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 estimated to occupy 1-2% in the lake zone of Tanzania, 5-10% in Central Uganda, 10-15% in western Kenya and 15-20% in Southern Mozambique. Consumers are primarily concerned with taste, texture and dry-matter content, and not with colour *per se*. 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 is to alleviate vitamin A deficiency among children, and pregnant and lactating mothers. VITAA represents an opportunity for the countries to tackle one of 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. 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.

Key Words: *Ipomea batatas*, beta carotene, vitamin A

RÉSUMÉ

La patate douce *(Ipomea batatas)* est une de plus importants aliments de base dans les parties sur-peuplées de l'Afrique de l'est et est devenue un aliment supplémentaire dans la partie sud du continent. La patate douce est vitale pour les petits fermiers avec une terre, labour et les capitaux limités. L'une de ses plus grandes valeurs est son habilité d'être récolté en partie pour la consommation domestique et génération de l'argent. Présentement, les variétés dominantes en Afrique de l'est et du sud sont blanches et graissées contenant une quantité négligeable de carotène-b, des micro-éléments que le corps utilise pour produire la vitamine A. On pense que les variétés orange graissées de la patate douce (PDOG) sont les moins chères, toute l'année elle représente la source de la vitamine A disponible pour les familles pauvres de la région. Les études ont montré que les mères africaines peuvent accepter la variété orange graissée, réfutant la notion que le goût africain est pour les variétés de couleur blanche. Les estimations récentes basées sur les données géo-referenciées montrent que la magnitude de l'impact de remplacer blanche avec les oranges dans six pays d'Afrique de l'est et centrale. En tout, 50 millions des enfants en dessous de six ans pourront bénéficier des efforts. Précisément, l'analyse ex ante montra que l'augmentation de l'unité de masse par capita de production la patate douce orange graissée était accompagnée d'une augmentation de 1% dans les exigences jusqu'à 25 kilogrammes par capita. Le défit est alors de maintenir la patate douce comme aliment de base tout en stimulant la transition vers une économie de marché générant des recettes en milieu rural. La disponibilité de variétés améliorées et la distribution du matériel de semence a qualité élevée fournira une base pour atteindre cet objectif. Il y a eu une augmentation constante dans la superficie et le niveau de consommation de des PDOG. Par exemple, les estimations indiquent que les PDOG occupent une superficie de 1-2%, 5-10%, 10-15%, 15-20% dans la zone du lac Tanganyika, le centre de l'Ouganda, l'ouest du Kenya, et sud du Mozambique, respectivement. Les consommateurs sont plus concernés par le goût, la texture, le contenu en matière grasse et pas avec la couleur comme telle. Sous le parapluie Vitamine A pour l'Afrique (VTAA), 40 agences partenaires du domaine de la santé, nutrition et de l'agriculture ont agrée de travailler ensemble pour étendre l'impact du PDOG dans sept pays dont l'Ethiopie, Mozambique, Ghana, Kenya, Afrique du sud, Tanzanie et l'Ouganda. L'objectif est d'éradiquer la carence de la vitamine A chez les enfants, les femmes enceinte ou allaitées. VTAA représente une opportunité pour les pays de résoudre l'un de plus pressant problèmes de santé en utilisant une technologie existante qui s'est avérée efficace et durable. Les activités incluent, le croisement et la sélection des variétés pour une production élevée du contenu en matière sèche et carotène-bêta, teste des variétés de façon participative pour l'adaptation et l'acceptabilité, durable multiplication des plantules par les communautés de base, éducation nutritive, transformation après récolte pour le marché et pour la consommation domestique, la promotion à travers la socio-commercialisation, et la détermination de l'impact de la nutrition sur la santé. Les stratégies de mise en oeuvre a concentré sur les femmes à cause de leur rôle central sur la production et la commercialisation de la patate douce et autres aliments utilisés en famille.

Mots Clés: *Ipomea batatas*, carotène-bêta, vitamine A

INTRODUCTION

Vitamin A deficiency is a serious nutritional and health problem affecting most developing countries including the sub-Saharan Africa (SSA). SSA countries are among the 90 countries categorised by WHO (1995) as a public health problem in terms of clinical and sun-clinical vitamin A deficiency (VAD). Up to 3 million children in SSA under the age of 5 suffer partial or total blindness caused by VAD. It is also reported that SSA is the only region in the world where the proportion of malnourished children has been consistently rising (Rosengrant *et al.*, 2001). This number is projected to rise from 33 million in 1997 to between 39 and 49 million in 2020. The total VAD prevalence is estimated at 36 million people in SSA (Mason *et al.*, 2001). The deficiency increases children's risk to common illnesses, and impairs children's growth, development, vision, and immune systems; and in severe cases results in blindness and death (Ruel, 2001). In women, vitamin A deficiency increases the risk of death during pregnancy, as well as giving birth to low weight children. It may also increase the spread of HIV/AIDS virus infection. New research findings suggest that vitamin A can profoundly obviate maternal mortality and protect infants against the effects of maternal to child transmission of HIV/AIDS Virus. 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 β-carotene. Otherwise, the body cannot produce sufficient Vitamin A.

World development and health agencies have responded to the situation by distributing Vitamin capsules and fortifying processed and packaged food. These efforts have reduced cases of the deficiency. For example, the number of children suffering from blindness related to vitamin A deficiency is reported to have significantly dropped (IVACG, 2000; Future Harvest, 2004;). However, many rural poor families do not adequately and regularly access these supplements due to poor infrastructure characteristic to remote areas of SSA and where chronic VAD is rife. In Kenya, extremely low serum retinal levels have been reported among populations leaving in the arid and semi-arid northeast, along the coast, and throughout the densely populated western part of Kenya (GoK and UNICEF, 1995). In Uganda about, 28% of children and 60% women are vitamin A deficient (UDHS, 2001). One of the alternative options for combating the deficiency is to enhance food-based strategies that aim at modifying people's diets through crops rich in β-carotene.

The International Potato Centre (CIP) and its partner organizations have focused on the food-based options to combat the VAD in the sub-Saharan Africa through promotion of orange-fleshed sweetpotato. Beta-carotene rich sweetpotatoes (BCR) have emerged as one of the most promising plant sources of vitamin A and stand to be a cheaper and complementary source of vitamin A to the rural and urban poor families. Sweetpotatoes combine a number of advantages that make it a choice crop for sustainable food security, namely, improved nutrition and income generation (Ewell, 1990). Sweetpotato is already widely grown as a secondary food crop throughout Sub-Saharan Africa, and is a primary staple food in Rwanda, Burundi, and Uganda (Bashaasha *et al.*, 1995). Over 7 million tonnes of sweetpotato (about 5% of global production) are produced in Africa annually. Recent projections indicate that production will be more than double by 2020, (Scott *et al.*, 1999) whereas production in other regions is expected to remain stable or decrease. Promoting a marginal change in dietary practices, such as switching varieties is likely to be easier than introducing a complete new food into the diet (Low, 2003). At the same time, the rural and urban poor cannot afford expensive vitamin A rich foods, such as fish oils, liver, milk, eggs and butter.

Sweetpotato as a source of β-carotene. Depending on the variety, 100 g of sweetpotato can provide β-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 β-carotene, this translates to about 2400 μg of β-carotene, an amount easily supplied by about 100 g of orange-flesh sweetpotato. The amount of fresh weight required to yield the daily requirement of β-carotene is even less with deeper coloured orange-fleshed sweetpotatoes (Table 2). Some orange-fleshed varieties tested by CIP have yielded 8000 μg of β-carotene per 100 g 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 (70-100 g) of orange-fleshed sweetpotato (OFSP) is required for daily requirements of pro-vitamin-A for adults compared to 9000 g for the white-fleshed variety (Table 3). Unfortunately, it is the white-fleshed varieties that are commonly grown and consumed by households. Moreover, there is limited awareness about the importance of orange-fleshed varieties in terms of vitamin A.

Potential impact of varietal replacement of white-flesh with orange-flesh sweetpotatoes. There is great potential for reduction of VAD through replacement of white-fleshed varieties with orange-fleshed varieties. Over 80% of the risk population (Table 4) in such countries as Uganda, Rwanda, and Burundi are estimated to have attained full impact benefit (Low, 2003). These countries have sufficiently high production density of sweetpotato (FAO, 1999; Ewell, 2002). In other countries, 10 million or about 10% of the population at risk would receive the full benefit of increased vitamin A intake, and an additional 40 million children would receive partial benefits from substituting white fleshed with carotene rich varieties.

VITAA partnership. VITAA stands for vitamin A for Africa. The experiences that sowed the seeds of VITAA came in the mid 1990's when the Kenya Agricultural Research Institute (KARI), the International Center for Research on Women (ICRW), CARE International and CIP worked jointly in a pilot project to test whether orange-fleshed sweetpotato would appeal to African consumers. Until then, it had been assumed that very few were willing to switch from traditional

TABLE 1. United Nations published valuesof 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. 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)/ gender	Recommended daily vitamin A (µg retinol equivalent)	Amount (g.) of fresh storage root required to supply the required pro-vitamin 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)
*Sweetpotato variety

TABLE 3. Sources of β-carotene from different crops in sub Saharan Africa

Crop	β-carotene equivalent per 100 g of edible portion	Total vitamin A activity (RE)
Carrot (boiled)	3890 - 2,000	648 - 3500
cassava	5 - 35	1 - 6
Finger millet	25	4
Maize		
White	0	0
Yellow	360	60
Irish potato	2 - 20	trace - 3
Rice (parboiled)	0	0
Sweetpotato white	35	6
Sweetpotato yellow-orange	300-4620	50 - 770
Banana (matooke)	60 - 130	10 - 21
Plantain (Gonja)	345	58

RE: Retinol Equivalent; Source: UN Press, 1992

white-fleshed varieties, which are less sweet tasting and high in starch and dry matter content. This has banished the myth of consumer acceptability for orange fleshed sweetpotato (OFSP). VITAA reflects interest in switching to food-based approach in combating VAD. The interest culminated into a meeting held in May 2001 to formally launch the partnership and during which Ethiopia, Kenya, South Africa, Tanzania and Uganda were represented. Since then, each country has developed a plan of action and instituted a national committee to oversee the implementation. The partnership has since grown and spans disciplinary and institutional barriers. The experts are largely from areas of agriculture, nutrition and health. The partnership is seeking to:

(i) increase the availability and acceptability of orange-flesh sweetpotatoes in sub-Saharan Africa;

(ii) complement development agencies' supplementation/ fortification efforts;

(iii) increase the capacity of national agriculture, health and nutrition experts to incorporate sweetpotatoes in their national dietary recommendations;

(iv) stimulate and promote micro-enterprise development using products from orange-flesh sweetpotato; and

(v) teach household managers (women and children) the nutritional value and effects of consuming orange-fleshed sweetpotatoes and encourage them to analyse their household nutrition.

RESEARCH AND DEPLOYMENT OF OFSP IN SSA

Adaptability and acceptability studies of OFSP. Since mid-1990s, CIP in collaboration with national sweetpotato programmes, mainly in eastern and central Africa, have embarked on a vigorous research to adapt and test the acceptability of various introduced and local OFSP varieties. The initial efforts saw the introduction of a number of orange-fleshed varieties largely from outside Africa, majority of which had low to medium dry matter content. Although children fully liked the taste and appearance of some of these varieties, adults expressed reservations on the varieties because of their low dry matter (Ewell, 2002). High dry matter is one of the important attributes that affect adults consumer preference in most of the SSA. This necessitated the breeders to develop

TABLE 4. Impact of full substitution of white-flesh sweetpotato varieties with orange-flesh varieties in selected countries of Sub-Saharan Africa

Country	Average increase[a]	No impact	Partial impact[b]	Full impact[c]	Population at risk[d]
	RDA (%)	Population at risk (%)			(Number of children in millions)
Kenya	9.1	8.9	72.6 (14.5)	18.5	4.47
Ethiopia	1.2	65.8	32.4 (5.0)	1.8	8.89
Uganda	18.9	0	15.5 (17.1)	84.5	3.30
Tanzania	13.0	9.9	41.6 (13.8)	48.5	4.96
Rwanda	20.5	0	4.6 (26.1)	95.4	0.87
South Africa	1.0	63.2	36.1 (5.0)	0.7	5.98
Burundi	19.9	0	9.6 (22.4)	90.4	1.01

[a]Assuming a maximum availability of five months
[b]Average % increases for those children receiving partial benefits are given in parentheses
[c]Full impact is equivalent to a 40% increase in %RDA
[d]Aged 6 months to 6 years
RDA = Retinol Daily Allowance

Source: Low *et al.* 2001

varieties with improved dry matter content. To date, a number of varieties with high dry matter and high beta-carotene have been introduced and distributed in the region (Table 5) for adaptability and consumer acceptance studies. Reports indicate a number of local and introduced varieties that have been identified and are acceptable to local farmers in Africa. In Uganda, varieties Kakamega, Ejumula, and Kala have been found acceptable to communities (Tables 6-11). Whereas the first variety was introduced from Kenya, the latter two are local varieties. Ejumula is adapted to wide local conditions and has been the most preferred variety by both adults and children in different locations of Uganda. It is very sweet with high dry matter and a deep orange flesh, an attribute that makes it appealing to most children. Kakamega is the second most preferred variety by both children and their parents. It is also widely adapted to local conditions and yields well. There have been incidences where adults have shown preference for Kakamega than Ejumula, which is consistently liked by children. The new generation of introductions from Lima is being tested in various agro-ecologies of Uganda (Table 4).

In Kenya, four introduced varieties (Zapallo, 420094, SPK004, and 420019) have been identified for high yields and another two (Sponge and 420005) were selected for good root characteristics (Tables 12). At the same time, local varieties KK118, Nyaguta, Kuny, Odinga and Sponge (Table 13) have been identified and have already been virus cleaned for distribution in the region.

In Tanzania, varieties Zapallo, Japon Tresmesino, and Tainung 64, were widely accepted by consumers and produced high yields. On the other hand, in South Africa, varieties W-19 and Excel have been for high dry matter and high beta-carotene content.

Multiplication and distribution of OFSP. The integration of orange-fleshed sweetpotato into the consumer habits of Africans has started and is

TABLE 5. Sweet potato germplasm distributed by CIP to several African and European countries from PQS Muguga, Kenya

Country of destination	Type of clones	
	OFSP	Others
DR Congo	5	0
Zimbabwe	10	7
Tanzania	25	10
Sudan	7	15
Egypt	2	13
Uganda	20	8
Zanzibar	21	5
Malawi	8	0
Mozambique	21	0
Zambia	10	2
South Africa	24	0

PQS = Plant Quarantine Station

TABLE 6. Farmer pair wise ranking of sweetpotato varieties over 2 seasons in Luwero, Uganda

Zone	Variety ranking		
	Ejumula	Kakamega SPK004	Kala
April 2002			
Bajjo	2	1	3
Kalule	1	3	2
Kibisi	3	1	2
Kikasa	2	1	3
Mayirikiti	1	2	3
Rank sums	9	8	13
August 2002			
Bajjo	1	3	2
Kalule	1	2	3
Kibisi	1	3	2
Kikasa	2	1	3
Mayirikiti	1	3	2
Rank sums	6	12	12

steadily raising. This has been possible through establishing partnerships among local non-Governmental Organisations (NGOs), Community Based Organisations (CBOs) and/or local government institutions working with grass root farmers in different parts of the countries. The strategy has involved establishing farmer based seed systems, which ensure a sustained and continued wider distribution of popular orange-fleshed sweetpotato varieties. National

TABLE 7. Ranks of cooked sweetpotato varieties over 2 seasons in Luwero, Uganda (2001/ 2002)

Zone	Varietiy ranking					
	Ejumula		Kakamega (SPK004)		Kala	
	Adults	Child	Adults	Child	Adults	Child
April 2002						
Bajjo	2	2	1	3	3	1
Kalule	3	1	2	3	1	2
Kibisi	1	1	3	2	2	3
Kikasa	1	1	2	3	3	2
Mayirikiti	1	2	2	2	3	3
Rank sums	9	7	10	13	12	11
August 2002						
Bajjo	1	1	3	3	2	2
Kalule	1	-	2	-	3	-
Kibisi	1	1	2	2	3	3
Kikasa	3	1	1	2	2	3
Mayirikiti	1	1	2	2	3	3
Rank sums	7	4	10	9	13	11

TABLE 8. Ranking of OFSP varieties for field and post harvest performance in Central districts of Uganda

District	Orange variety rank					
	Ejumula		Kakamega		Kala	
	Field	Post harvest	Field	Post harvest	Field	Post harvest
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	7	7	10	12	13	9

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

Variety	Establishment (%)	Vine yield (t ha^{-1})	Total root yield (t ha^{-1})	Marketable roots (t ha^{-1})	Weevil infested roots(%)
Ejumula	86.3 ± 2.6	4.9 ± 0.8	5.2 ± 1.1	3.5 ± 2.3	40.3 ± 10.6
Kakamega	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

sweetpotato programmes have supported farmers in the multiplication of planting materials for sale to other farmers. The efforts are more pronounced in the east African region where selection of orange sweetpotato types started much earlier than in the rest of SSA region. For example, orange fleshed varieties are estimated to occupy 1-2% in the lake zone of Tanzania, 5-10% in Central Uganda and 10-15% in western Kenya. In 2002 alone, over 10 millions of vine cuttings

TABLE 10. General acceptability score[1] means by farmers for 3 OFSP in central districts of Uganda

Location	Ejumula		Kakamega		Kala	
	Field	Post harvest	Field	Post harvest	Field	Post harvest
Kiboga (n =25)	3.8 ±0.2	3.1 ± 0.3	3.6 ± 0.2	4.1 ± 0.2	3.4± 0.2	4.2± 0.2
Rakai (n = 5)	4.9± 0.1	4.8 ±0.2	4.3 ± 0.3	5.0 ± 0.0	3.6 ± 0.4	4.2 ± 0.2
Mpigi (n = 10)	4.0± 0.5	4.7 ± 0.5	2.8 ± 0.6	4.3 ± 0.3	3.7 ± 0.6	4.0 ± 0.2
Wakiso (n = 13)	2.8 ± 0.5	4.8 ± 0.1	2.6 ± 0.3	4.3 ± 0.3	2.5 ± 0.5	4.6± 0.2
Variety means	3.9	4.4	3.3	4.4	3.3	4.3

[1]Scores 1 = very bad, 2 = bad, 3 = moderate, 4 = good, and 5 = very good

TABLE 11. Reasons advanced for ranking Ejumula high at field and post harvest in Luwero district, Uganda

At field level	Freq[1]	Adults at post harvest	Freq[1]	Children at post harvest	Freq[1]
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				

[1]Frequency of mention of a given reason during the evaluations that were conducted during two seasons

TABLE 12. Evaluation of cooked roots of orange-fleshed sweetpotato varieties in advanced yield trial harvested at KARI- Kakamega, Kenya

Variety	Appearance	Taste	Flavour	Starchiness	Fibrousness
SPK004	2.4	2.4	2.4	2.5	2.4
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 14) of improved and local DFSP varieties were distributed in east African region, covering over 360 hectares of fields. These figures are underestimated since a lot more planting materials could have exchanged hands among farmers unrecorded.

Adoption of OFSP to mitigate disaster. Sweetpotato is able to reach maturity earlier than most other crops and is hardy enough to thrive under rugged conditions. In 2002 over 850,000 vine cuttings of Kakamega, a popular and well-adapted orange-fleshed variety, were distributed to farmers in the war-affected districts of Apac and Lira as a nucleus seed. This is an amount of seed plant an estimated 30 hectares. The multiplier effect experienced from the first cycle of multiplication was significant to the extent that most of the affected and neighbouring districts have received planting material (Table 14).

TABLE 13. Performance of local orange-fleshed sweet potato varieties at RRC-Kakamega Kenya

Variety	Total root yield t ha^{-1})	Foliage yield (t ha^{-1})	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 14. Planting Material multiplication and distribution by research institutes and partners in CIP targeted East African countries during 2002

Country	Varieties distributed	No. of cuttings distributed	Estimated area (ha) planted	Estimated farmers that benefitted	Collaborating partners
Kenya (Western region)	Zapallo (23%) SPK004 (36%) SPK013 (9%) Salyboro (21%) Others (11%)	2,090,100	69.8	172	AFRICA Now KARI - Kakamega REFSO Local CBOs
Uganda (Central and Eastern regions)	SPK004 (89%) NASPOTs (8%) Others (4%)	5,261,974	175.0	600	BUCADEF, PRAPACE SOCADIDO, JAF, NAARI
Tanzania (Zanzibar, Eastern and Lake zone)	SPN/O (75%) Vumilia (12%) Maruno (8%) Polista (3%) Others (2%)	3,600,000	120	290	TAHEA, CARE, World Vision ARD - Maruku ARD - Ukiruguru, & Winrock International

(%) Percentage of the total no. of cuttings distributed

Farmers have also supplied roots to other families in the camps of displaced persons. This has been possible through the partnership with JAF, a local NGO working in the two districts.

In Mozambique, OFSP have been considered for the flood and drought affected areas. By 14 months of the project implementation, over 154 hectares of multiplication centres for 10 different genotypes (Table 15), were established in 78 selected districts in 9 of the 10 provinces of the country.

OFSP in baby weaning foods. Children under the age of 5 form the majority of the vulnerable groups and, therefore, the major target of VITAA partnership (Ewell, 2002). In Uganda, and else where in the region, studies have showed that thin and thick porridge prepared from maize, millet and cassava flours are the main flour based weaning and traditional food products. As such there has been deliberate efforts to improve the nutrition status of the weaning food formulas by integrating OFSP as an ingredients. Various sweetpotato based recipes were developed and tested for acceptability among rural and urban consumers (Table 16). Sweetpotato porridge products were significantly preferred more than the existing products by children and their mothers. In Uganda, one of the recipes is being promoted by the milling company and has generated great demand among customers.

RURAL INCOME GENERATION

Rural processing and household level product development of OFSP. OFSP have already been transformed into products that have been accepted by both rural and urban consumers. Such products include among others pancakes, *mandazi, chapati*, doughnuts, fried chips and crankies. For example data from Magu district of Tanzania (Table 17) indicate a special preference to the products because of the improved taste and colour. This is confirmed by comparison ranking (Table 18). The products normally become yellow, a characteristic common with products made with eggs as an ingredient. The strategy has been to target and train women to ensure diversified the utilisation options of OFSP in households but much more important to boost their incomes after selling the products. This is one of the important entry points to commercialising production of OFSP. Targeted also are youth groups as well as women groups to engage in village based large-scale processing of flesh roots into dried chips targeting the milling companies.

The major limitations to the expanded production of OFSP varieties included:

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

TABLE 15. Hectares of convectional and rapid multiplication plots for sweetpotato establish in different regions of Mozambique

Region	Province	Estimated area (ha)	Number of partners
Northern	Carbo Delgado	0.8	1
	Nampula	13.9	9
Sub-total		14.7	
Central	Zambezia	71.4	7
	Manhica	26.2	2
	Tete	5.8	-
	Subtotal	102.4	
Southern	Gaza	27.5	8
	Maputo	5.0	3
	Inhambane	4.5	4
Total		37.0	

2. Low dry matter contents of available orange-fleshed varieties limit the increased utilisation at household level mainly by adults. Similarly, for the communities that have initiated the processing of dried chips into flours, 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 varieties.

3. 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 potentially high yielding varieties have been lost in this way.

4. The unpleasant odour associated with orange-fleshed varieties normally leads to poor reception of the varieties by adults. Other people suffer from non-familiarity with orange-flesh types seem strange. However, the bias is short lived is overcome as farmers eat more of the orange-fleshed sweetpotatoes.

5. 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.

TABLE 16. Results of preference ranking of different porridges incorporating sweetpotato flour in Bajjo - Luwero, Uganda

Porridge type	Rank totals
Maize flour	37a
Maize + sweet potato flours	46a
Maize + ground nuts +sweet potato flours	45a
Maize + *amaranthus* + sweet potato flours	39a

CONCLUSIONS

African consumers prefer dry varieties, usually over 30% dry matter. Furthermore, African consumers mainly adults, prefer high dry matter sweetpotato for consumption. New varieties are equally acceptable like local popular ones except that majority succumb to high virus disease pressure mainly in Uganda. Informal farmer-to-farmer seed multiplication and distribution systems ensures sustainability and empowers farmers in generating their own seed for own use as well as sale. New products from orange fleshed sweetpotato based flours are well accepted and easily made with local ingredients. Lastly, simple

TABLE 17. Farmers' assessment of sweetpotato secondary products made from sweet potato varieties evaluated in Magu District, Tanzania 2000/2001

Product	Taste (N = 11)	N= 11	Internal colour	External colour	Overall acceptability (N = 11)
Cake A	4.4	4.1	4.7	4.3	4.5
Cake B	3.3	3.1	2.6	3.4	3.0
Doughnut A	4.4	4.1	4.4	4.1	4.0
Doughnut B	2.9	3.3	2.8	3.7	2.5
Buns A	4.2	4.3	4.7	4.3	4.1
Buns B	3.8	3.6	3.2	3.9	3.2
Pancake A	5.0	4.7	4.6	4.7	4.3
Pancake B	4.3	4.8	3.9	4.5	3.6
Kaimat A	4.8	4.7	4.4	4.6	4.9
Kaimat B	4.4	4.0	3.9	3.9	3.9
CV (%)	14.87	5.51	17.81	15.31	23.79
LSD (0.05)	0.6**	0.6**	0.6**	0.6**	0.8**

Subjective rating scores: 1 = very bad, 2= bad, 3= moderate, 4 =good 5= very good
A= products made from orange -fleshed varieties
B= products made from white-fleshed varieties

TABLE 18. Pair wise comparison of sweetpotato based in Magu district, Tanzania

Parameters	Choice (n= 10)	Reasons for accepatablity
1A Vs 1B	1A	Taste and internal colour
2A Vs 2B	2B	Taste
3A Vs 3B	3A	Taste and internal colour
4A Vs 4B	4A	Internal colour and taste
5A Vs 5B	5A	Taste

A – Products made with orange – fleshed sweet potato
B – Products made with white-fleshed sweet potato
1= Cake, 2= Doughnut, 3= Buns, 4= Pancake, 5= Kaimat

nutritional messages have been transmitted effectively as a result of increased linkages with health care workers and nutritionists.

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