Proceedings of the 13th ISTRC Symposium, 2007
pp. 82 - 94

Sweetpotato crop improvement in sub-Saharan Africa and future challenges

Kapinga R.[1], Zhang D.[2], Lemaga B.[3], Andrade M.[4], Mwanga R.[5] Laurie S.[6], Ndoho P.[7] and Kanju E[8]
[1]International Potato Centre (CIP), Box 22274, Kampala, Uganda
[2]International Potato Centre, Box 1258 Apartado, Lima, Peru
[3]PRAPACE (Regional Programme for the Improvement of Potatoes and Sweetpotato in East and Central Africa) Box 22274, Kampala, Uganda
[4]IITA/SARRNET, P.O Box 2100, Maputo, Mozambique
[5]Namulonge Agric. Research Institute, Box 7084, Kampala, Uganda
[6]Agricultural Research Council Roodeplaat Vegetable and Ornamental Plant Institute, Private Bag X293, Pretoria, 0001, South Africa
[7]Kenya Agricultural Research Institute-Kakamega, P.O. Box 169, Kakamega, Kenya
[8]IITA/ SARRNET, Box 70192, Dar es Salaam, Tanzania

Abstract. In sub-Saharan Africa region, most sweetpotato are produced from diverse landraces that have constant turnover. The preference for high dry matter is between 28 to 35%. CIP breeding strategy for the past 15 years has been to collect, characterize, and conserve farmers' varieties; evaluate and distribute the best performers regionally. It has also emphasised population development through crosses and systematic screening with partners using participatory methods. Key stages of breeding programme incorporate breeders, ICM specialists, post-harvest technologists, social scientists, consumers and farmers. To-date several varieties have been released officially by the national programmes and of recent orange-fleshed sweetpotato (OFSP) varieties have been given emphasis in almost all the countries in ASARECA and SADC regions. Varieties such as: SPK004, Mogamba, Zapallo (for children), Salyboro, Pumpkin, SPK 013, and Kemb10 (yellow-fleshed), Zapallo, Japon Tresminiso, Tainung 64, Resisto and Kandee have gained popularity. Multiplication and distribution of planting materials have continued by individual farmers and community based organizations. In Western Kenya, about 30 million cuttings of mainly OFSP varieties have been distributed to farmers from KARI stations and local CBO's/ NGO's. In the Lake Zone of Tanzania, about 6 million of three newly released varieties (SP93/ 23, SP93/2, and SP93/34) together with local varieties Sinia and Simama (SPN/O); and in Uganda farmers with BUCADEF and SOCADIDO have distributed about 10 million cuttings of the newly NARO released varieties (NASPOTs 1-5) to farmers. Improved varieties distributed in East African region, have covered over 360 hectares of fields. In Mozambique an estimated 154 ha have been planted with improved varieties. Over 347,000 households in Mozambique have received at least 200 vines of OFSP sweet potato and projections are that over one million households will have received planting material by 2004.

Introduction

Sweetpotato (*Ipomoea batatas* Lam) is among the world's most important, versatile, and under exploited food crops (Woolfe, 1992). With more than 133 million tons in annual production, sweetpotato currently ranks as the fifth most important food crop on a fresh-weight basis in developing countries after

rice, wheat, maize, and cassava. Sweetpotato is cultivated in over 100 developing countries and ranks among the five most important food crops in over 50. Only in the last decade has the crop been the focus of an intense, coordinated, global effort to realize its full potential as a source of food, feed, processed products, and income for millions of small farmers and low-income consumers in Africa, Asia, and Latin America.

Three facts have generated growing interest in sweetpotato. First, sweetpotato is typically a small farmer crop and often grown on marginal soils with limited outputs. Furthermore, although the crop is grown widely in Asia (31 countries), Africa (39), and Latin America (31), production tends to be concentrated in those countries with lower per capita incomes. Hence, increasing sweetpotato production and utilization is often considered as a means to improve incomes and food security among the poorer segments of the rural population.

Second, average yields in several countries are well below the average (15 t/ha) for developing countries as a whole, and these in turn are well below the current yield potential. Hence, rapid improvements in productivity are considered readily feasible with relatively less investment in research and extension than other crops, such as rice, where this is not the case.

Third, the last decade has witnessed a return to a positive growth rate for sweetpotato production in China—a remarkable reversal of previous trends in a country where some 85% of the world's output is harvested. Similar upward trends have emerged in a number of other developing countries. Some of these trends are evident from FAO statistics; others are not.

In sub-Saharan Africa (SSA) sweetpotato is grown on around 2.1 million hectares, with an estimated production of 9.9 million tons. It is one of the main staples in the food systems of Uganda, Rwanda, Burundi and Eastern Congo, with per capita production of around 100 kg per year. Sweetpotato is a secondary crop in the grain-based systems elsewhere in the region, becoming important only at certain times of the year or when other crops fail (Scott *et al*., 2000; Kapinga *et al.*, 2003). Sweetpotato is an important staple crop in many regions of sub-Saharan Africa. It is grown mainly for the storage roots, which are usually eaten fresh, but the leaves may also be used for forage for livestock, or eaten as a vegetable. Apart from a few key improved varieties, most cultivars presently grown are indigenous. Many constraints to the crop are prevalent, including weevils (*Cylas* spp), viruses and lack of cultivars with characteristics such as high yield, early maturity, drought resistance, good keeping qualities and high dry matter content.

Sweetpotato plays a big role as a food security crop that is always managed for reliable supply, not necessarily for maximum yields. It is easily propagated, grows reasonably well with no inputs on degraded soils over a wide range of rainfall patterns. Of recent, sweetpotato has shown an increasing demand in urban areas as a cheaper alternative to bread. Certain production areas have specialized to supply these markets e.g. Uganda: Soroti/Kumi; Kenya: Oyugis, Bungoma and Kibirigwe; Tanzania: Coast and Gairo/ Morogoro; Malawi: Central zone around Lilongwe and Zambia in the Northwestern province.

In the southern countries of SADC, including South Africa, Namibia, Botswana, Zimbabwe, Swaziland and Lesotho, low yields are obtained from sweetpotato mainly because of planting old, local land races and virus-infection due to recurrent use of material for years (Thompson *et al* 1998). Another factor is unavailability of material, which is a large constraint in Namibia (Rusch, 1998).

Most sweetpotatoes are produced from diverse landraces. There are however constant turnovers since farmers introduce and reject varieties quickly. Majority are white, cream, or yellow fleshed-types and few are orange. The preference is for high dry matter - between 28 to 35%. Similarly in SADC region due to frequent drought, farmers prefer varieties that are able to produce vigorous

vines to survive dry season for the timely supply of planting materials at the on-set of rains.

CIP's sweetpotato crop improvement global strategy. As one of its mandate crops, CIP has an overall objective of conserving and using the genetic diversity for improving the sweetpotato production and utilization through the development of new varieties with enhanced post-harvesting characteristics and adaptability in developing countries. CIP's strategy begins by identifying, in close association with its clients, needs for research and technology. If these are addressed elsewhere, the Centre makes the appropriate information available through its cooperative linkages. If not, comparative advantage and priority of needs are analyzed to determine CIP's approach, involving one or more of the following operational models: encouraging the pursuit of the necessary research collaboration among countries; conducting appropriate research in cooperation with national agricultural research systems (NARS) colleagues; and initiating specialized research in the Centre's areas of comparative advantage. The effective transfer of research results, technology, and capabilities to partner countries is accomplished through training, information dissemination, and collaborative research designed to assist NARS in reaching and maintaining their fullest potential. In mid 1990's the main breeding goals by region were as elaborated in Table 1. Of late these have expanded to incorporate the nutritional traits with the emphasis in promoting high beta-carotene sweetpotato varieties especially in SSA.

Since 1985, CIP has carried out 90 collecting expeditions with active participation of NARS of 16 countries in Latin America and the Caribbean. Other germplasm was received from AVRDC (Asian Vegetable Research Development Centre) and IITA (International Institute for Tropical Agriculture (IITA). African Root Crops research institutes have also contributed a good number of African landraces that have been used in the breeding program as parents for producing high dry matter content genotypes. The gene bank at CIP now maintains a total of 5,526 cultivated accessions, comprising 4,168 accessions of native and advanced cultivars from 57 countries (22 countries in the Americas, 26 in Asia, and 9 in Africa), and 1,358 breeding lines.

Because of the asexual propagation of sweetpotato cultivars, numerous duplicate accessions of the same cultivars have been found in the cultivated collection maintained at CIP. There is an ongoing effort to identify these duplicate accessions. Those that are morphologically identical and produce the

Table 1: Main breeding goals by region after assessment of constraints and opportunities in sweetpotato.

Factor	CIP Region			
	Latin America	S.W. Asia	E.S.E Asia and Pacific	sub-Saharan Africa
Weevil resistance/tolerance		X	X	X
Virus resistance				X
Drought tolerance	X	X	X	X
High dry matter (starch) content	X		X	X
High foliage yield	X	X		X
Non-sweet storage roots				W.Africa
Good storability	X	X		X
High beta carotene content			X	X

Source: CIP, 1995.

same electrophoretic banding patterns or DNA fingerprints are considered duplicates (Kriegner *et al.*, 2000).

The sweetpotato collection maintained at CIP has been subject to a systematic evaluation to identify sources of desirable genes that could be used in breeding programs. So far, more than 13,000 evaluations have been made and many accessions in the collection have been identified as potential sources of genes for resistance to pests and diseases, good agronomic characters, long storability, high productivity, and high nutritive value.

The genetic resources maintained at CIP are freely available for distribution in two forms: first, as clonal materials, either as *in-vitro* plantlets or as storage roots produced under quarantine conditions from pathogen-tested stocks; second, as true-seed lots. A pathogen-tested list of sweetpotato cultivars for international distribution is produced annually by CIP and it contains the most relevant data for use by researchers. CIP's policy emphasizes free access to both genetic resources and data related to each accession in the collections.

Sweetpotato crop improvement regional approach for SSA. Sweetpotato is one of the most important crops in densely populated eastern Africa. This crop is also becoming increasingly important in southern Africa. The crop is vital to destitute small-scale farmers with limited land, labor and capital. Sweetpotato performs well in poor soils lacking sufficient nutrients and water; traditional cereal crops often fail in these same environments. In eastern and southern Africa, women and girls, usually on small plots of land reserved for producing the family's food supply, grow sweetpotato predominantly. One of sweetpotatoes greatest assets as a food staple for Africa is its ability to be harvested in small amounts, as it is needed for home consumption or income generation.

CIP's sweetpotato improvement program aims at improving sweetpotato production and utilization through the development of new varieties with enhanced post-harvesting characteristics and adaptability to low-input, subsistence farming systems. Also the program is aimed at alleviating vitamin A deficiency by extending the use of high beta-carotene sweetpotato varieties to those currently outside reach of conventional nutrition programs, with the geographical focus in the countries of eastern and southern Africa.

In recent years, breeding efforts have been intensified in eastern, central and southern Africa. This has been largely conducted under the auspices of support to key countries from CIP and the coordinating networks such as the Programme Regional de la Pomme de terre et de la Patata douce en Afrique Centrale et de l'Est. (PRAPACE), a Regional Potato and Sweetpotato Improvement Program in Eastern and the Central Africa and Southern Africa Root Crops Research Network (SARRNET). One of the key objectives of these networks is to increase the efficiency of breeding and research into the target crops by dividing responsibilities among the participating countries.

The diverse sweetpotato germplasm held at CIP are being recombined to generate superior parental clones and seeds families using conventional and biotech tools. A well established, decentralized breeding framework is using this enhanced germplasm to produce new varieties with good adaptability to cope with abiotic and biotic stresses in targeted environments. High yielding varieties with improved post-harvesting qualities, such as starch and beta-carotene content, will significantly contribute to better nutrition status and higher profits for the rural poor in the sweetpotato based agricultural system.

The sweetpotato varieties grown in Eastern and Southern Africa are mostly white fleshed, which contains only a negligible amount of beta-carotene. OFSP varieties represent the least expensive, year-round source of dietary vitamin A available to poor families in this region. As small an amount as 40 grams of OFSP sweetpotato can meet the daily requirements of preschool age children.

Replacing white-fleshed varieties now grown widely by farmers with OFSP materials can substantially increase the pro-vitamin A intake of all individuals; the vast majority of whom do not consume enough of this micronutrient to satisfy 50% of their daily requirements (Low *et al.*, 2003). The burden of Vitamin A deficiency falls largely on pre-school age children and pregnant and lactating women. These groups at risk comprise about one-third of the population. The pilot prevention study jointly conducted by CIP and its collaborating institutions in Kenya confirmed that African mothers are motivated to accept the new varieties, thus dispelling the notion that African tastes preclude the use of OFSP varieties.

Recent estimates based on geo-referenced data show the magnitude of the potential impact of replacing the currently used white-fleshed varieties of sweetpotatoes with OFSP sweetpotato varieties in six countries of eastern Africa to relieve Vitamin A Deficiency (VAD). Preliminary results indicate that each increase of one kg in per capita production of OFSP results in a one-percent rise in the attainment of requirements up to about 25 kgs per capita (Low *et al.*, 2003). Under this scenario, assuming the harvesting season can be extended throughout the year, full adoptions of OFSP in Rwanda, Burundi, and Uganda could lead to an average increase of 50% in the attainment of Vitamin A requirements. Even in countries such as Ethiopia, about 30% of the population enjoy partial benefits in enhanced pro-vitamin A intake from switching white flesh to orange-fleshed varieties of sweetpotato.

In the last five years, our African collaborating institutions from materials selected from CIP mediated germplasm or CIP developed breeding lines have released 45 sweetpotato varieties. International distribution of seed populations for selection by breeding programmes has been carried out by CIP for 2000-2003 cropping seasons (Table 2). Principal sources have included the CIP breeding programmes in Peru and Indonesia, the Chinese programmes, Mississippi State University (USA), and the USDA Vegetable

Table 2: Sweetpotato germplasm distributed by CIP to East, Central and Southern Africa countries from 1993 to 2003.

Country of destination	Source of germplasm			No. of seed families received
	South America (CIP, Lima)	North America	Other countries	
Angola	16	4	21	-
Burundi	2	-	4	-
Botswana	17	4	13	-
DR. Congo	20	17	36	22
Eritrea	-	-	18	-
Ethiopia	21	-	26	-
Madagascar	7	-	4	-
Malawi	8	-	20	45
Mozambique	32	-	28	11
Kenya	73	41	171	265
Rwanda	45	21	41	92
Sudan	22	4	29	-
Tanzania	28	7	60	149
Uganda	83	34	116	117
Zambia	23	3	48	234

Source: CIP Annual Reports (1999- 2003).

Research Laboratory (S. Caroline, USA). In the past the ISAR Programme in Rwanda served as a source of seed for distribution both within and outside of Africa. More recently, Namulonge, Uganda and Roodeplat, South Africa have become principal sources of seed in the east and southern African countries. The seeds are generated from the crossing blocks as well as open pollinated fields. The parents used are both from the region as well as introductions from other countries through CIP. Kenya having an advantage of hosting CIP serves as the principal regional location for the regional redistribution of clonal germplasm by CIP from the Kenya Plant Quarantine Station at Muguga.

The introductions by country have been supported by evaluations and rigorous multiplication schemes. This has enabled new germplasm to be evaluated in the national breeding trials. Results from different countries have shown that many of the clones initially selected from IITA have poor performance with respect to dry matter content, indicating a need for using regionally adapted parental clones with acceptable qualities e.g. SPN/O, Mugande, etc. In fact Mwanga *et al.*, 2001, have shown that most varieties selected which have reached the advanced breeding stage, have the regionally important sweetpotato variety, SPN/O as their female progenitor.

Breeding priorities in SSA. To increase production and efficiency, CIP has been working with key breeding institutions in SSA. African breeders have taken the population improvement approach. The population mean has steadily increased due to the efficient recombination of new genes and traits from the local germplasm and the introduced ones. The new generation of parental clones will be developed in foreseeable future.

The breeding programs in SSA have always taken a holistic approach with different components. These include: collection, characterization, and conservation of farmers' varieties, regional distribution of best performers and the introduction of best cultivars from other parts of the world. Seeds are mainly generated by the national crossing programs in Uganda (for East and Central African countries), Zambia and South Africa for the Southern African countries. In all countries systematic screening with partners using participatory methods, based on study of genotype by environmental effects continues.

The primary breeding objectives aim at selecting varieties that are acceptable with respect to utilization characteristics. These include: acceptable taste, high dry matter content, suitability for improved farm-level processing, extended shelf life of roots and tolerance to market conditions, attractive appearance and properties of products particularly flour and ability to produce vines for animal feed. Of recent, breeding for high beta-carotene content a precursor of Vitamin A has received high priority. Secondary traits include: earliness vs. in-ground storability, drought tolerance, high root yield, good establishment, and good resistance to SPVD and sweet potato weevils. All these in addition to socio-economic factors pose as constraints limiting the increased production of sweetpotato in the region (Table 3).

Achievements

Over nineteen million vine cuttings of popular varieties were distributed to farmers during the year 2003. This is estimated to have covered about 600 hectares of farmers' fields. OFSP varieties are currently estimated to occupy 1-2% in the Lake zone of Tanzania, 15-20% in Central Uganda, 10-15% in Mozambique, and 10-15% in W. Kenya. (CIP, 2002).

Improved varieties have continued to be introduced from CIP, Lima Peru and shared with other countries in the region as indicated earlier on. There have been also deliberate efforts to introduce high dry matter varieties with high beta-carotene content for inclusion in the breeding programs. Of the 40 varieties

Table 3: Major constraints to the sweetpotato crop identified in sub-Saharan Africa.

Type	Constraint
Biotic	Viruses Weevils (mainly *Cylas* species)
Abiotic	Declining soil fertility and natural resource base
Available varieties and planting material	Lack of varieties that are high yielding, early maturing, drought resistant, have high dry matter and have high beta carotene contents Lack of good quality planting material of improved varieties
Post-harvest	Lack of storage and processing technology Lack of varieties that are less perishable Opportunity for utilization and marketing not well developed
Socio-economic and policy	Lack of policy for the production and supply of seed or planting material Lack of market studies and weak distribution systems Poor linkage between research, extension and private sector Lack of credit systems and inability of farmers to purchase inputs

Source: Kapinga and Carey, 2003a.

already developed at CIP, Lima, twenty clones were introduced to Muguga, Kenya in early 2003 (Table 4). These have been multiplied and now they are ready for dissemination to other countries. All varieties developed or introduced are normally tested in different agro-ecologies for adaptability and acceptability in individual countries. In most cases, yield performances of most of varieties are higher or equal to that obtained in landraces (Table 5). Most preferred varieties have been identified and released/ pre-released in different countries. Among them are: Zapallo, Tainung 64, W – 151, Jewel, Mafutha, Jonathan, Ejumula (Table 6). In South Africa, varieties W-19 and Excel have been selected for high dry matter, high beta-carotene content while variety 1656-97 has been selected for processing into products (Laurie *et al.*, 2003). Most of the varieties have high dry matter content, a characteristic that contributes to their acceptability.

Some fourteen different viruses or virus-like agents have been identified as affecting sweetpotato. Virus diseases can cause substantial damage in both temperate and tropical regions. It is particularly serious in East Africa (INCO-DEV., 2002). The development of virus-resistant or tolerant cultivars has been the most effective means of reducing sweetpotato losses from virus infection. A few African cultivars have been identified as having high-level field resistance to sweetpotato virus complex. These cultivars are now used intensively as resistance sources in breeding programs in CIP-Lima, Africa, and China.

Sweetpotato variety adoption study completed in Western Kenya and results show that at least 70% of sweetpotato growers have adopted one or two new varieties. Preferred varieties are: Mugande, SPK 004 and Kemb 10. Key impacts noted are: improved self-sufficiency in food supply at least 20% and improved incomes mainly by women in Kakamega district up to 30%. Also farmers in Mwanza district, Lake Zone of Tanzania and Uganda indicated significant increase of food supply and rural incomes for household cores. In Kenya varieties with high dry matter and other desirable characters were evaluated and advanced to different breeding advanced stages per attached details. Varieties: Kanziga1, and 2; Cemsa, Mugamba, Bikira

Table 4: High dry matter content and high beta-carotene clones distributed to selected countries in SSA, 2003.

CIP number	Pedigree	Origin	DM (%)	Skin colour	Flesh colour	Reaction to root knot nematode
199004.2	CC89.147. 4 x OP	CIP breeding lines	34	Red	Light orange	R
199004.3	CC89.147. 4 x OP	CIP breeding lines	33	Red	Intermediate orange	MR
199005.11	CHGU 1.002 x OP	CIP breeding lines	26	Pink	Intermediate orange	R
199015.13	LM92.032 x OP	CIP breeding lines	31	Cream	Pale Yellow	R
199015.14	LM92.032 x OP	CIP breeding lines	25	Yellow	Interm. Orange	R
199024.1	SR91.109 x OP	CIP breeding lines	26	Cream	Light orange	MR
199024.2	SR91.109 x OP	CIP breeding lines	26	Red	Light orange	R
199025.2	SR92.095. 3 x OP	CIP breeding lines	25	Orange	Light orange	R
199026.1	SR92.095. 8 x OP	CIP breeding lines	26	Red	Light orange	R
199027.1	SR92.095. 10 x OP	CIP breeding lines	31	Red	Pale Yellow	MR
199027.3	SR92.095. 10 x OP	CIP breeding lines	26	Red	Light orange	R
199034.1	SR95.628 x OP	CIP breeding lines	34	Red	Dark Yellow	R
199034.1	SR95.628 x OP	CIP breeding lines	34	Red	Dark Yellow	R
199035.1	SR95.636 x OP	CIP breeding lines	25	Orange	Light orange	MR
199035.5	SR95.636 x OP	CIP breeding lines	25	Purple	Orange-purple	R
199035.7	SR95.636 x OP	CIP breeding lines	30	Cream	Light orange	R
199035.8	SR95.636 x OP	CIP breeding lines	37	Red	Pale Yellow	MR
195037.2	SR90.411 x OP	CIP breeding lines	28	Red	Light orange	MR
199057.4	LM94.422 x OP	CIP breeding lines	34	Purple	Light orange	R
199062.1	SPV 78.001. 3 x OP	CIP breeding lines	30	Orange	Interm. Orange	R
199073.1	SR95.478 x OP	CIP breeding lines	31	Brown	Pale Yellow	R
440203	Hong Mi	Korean cultivar	28		Light orange	unknown
440262	Chin Mi	Korean cultivar	28		Light orange	unknown
440443	Nashu 88	Chinese cultivar	28	Yellow	Light orange	unknown
440445	Chuan 29-4	Chinese cultivar	27	Yellow	Light orange	unknown

MR- Moderate resistant; R- Resistant.

Table 5: Yield performance of OFSP clones across 4 environments in Uganda, 2002/2003.

CIP code	Clone	Storage root yield (t/ha)				Means
		NAARI	Kacwekano	Ngetta	SAARI	
440189	Tainung No. 64	45.7	42.5	33.3	32	38.4
420009	Japon Tres.	19.5	21.4	11.4	14.1	16.6
440016	Excel	36.3	21.5	22.0	10.4	22.5
440060	TIB 4	39.5	9.0	8.4	13.4	17.6
420027	Zapallo	29.9	47.5	20.9	22.4	30.2
187017.1	Salyboro	41.7	41.9	15.9	32.4	33.0
440140	Kandee	25.0	18.9	11.5	24.4	20.0
440005	W-151	21.0	16.8	18.5	18.5	18.7
440215	Tainung No. 65	19.0	33.5	10.1	47.0	27.4
420005	Nemanete	26.4	27.8	15.0	18.2	21.8
440112	Centenial	26.2	14.5	16.6	9.7	16.8
556638	Jewel	5.7	32.5	10.6	3.5	13.1
440288	VSP 4	15.0	23.7	11.1	28.5	19.6
420014	Jonathan	19.0	17.6	14.0	19.7	17.6
440031	Jewel	23.6	23.5	28.2	12.6	22.0
440141	Julian	5.8	9.6	12.9	6.7	8.7
440293	BP-SP-2	46.6	44.5	52.3	32.3	43.9
440018	W-223	40.5	29.0	29.9	30.0	32.4
440090	CN 317	46.6	29.0	16.7	14.4	26.7
Land race	Sudan	20.3	21.5	30.4	15.5	21.9
Land race	Ejumula	42.8	29.4	49.6	24.0	36.4
Land race	Kala	47.0	22.5	43.8	25.4	34.7
-	SPK 004	35.5	24.9	47.0	16.7	31.0
Land race	Mahuri	40.5	32.0	40.2	24.3	34.2
-	TZ (check 1)	23.5	26.7	44.0	9.5	25.9
Land race	Sowola-6	13.4	22.3	22.6	3.3	15.4
	Local check 2	45.8	NA	24.7	NA	NA
Mean		29.7	26.3	24.5	19.6	24.9
$LSD_{0.05}$		5.3	5.5	4.4	6	2.7
CV (%)		12.8	14.9	12.7	21.9	15.3

Source: McKnight Uganda report, 2003.

Maria, 320/06 316/02 and Polista have selected by farmers for on-farm testing. Polista was recommended specifically for targeting the drier environments of Western Kenya. Five varieties have been selected by farmers for foliage production in zero grazing farming at Kabete, Kenya. These include TZ-L- 13, Bita-L-30, 316-H-20, WK-L-8 and Toro-L-5.

Multidisciplinary team approach in the national breeding programs is being employed in the evaluation of sweetpotato varieties. Key stages of breeding program incorporate breeders, ICM specialists, post-harvest technologists, social scientists, consumers and farmers. Farmers in Kenya, Tanzania and Uganda have evaluated OFSP varieties. Preferred varieties include: SPK004, Mogamba, Zapallo (for children), Sayboro, Pumpkin, SPK 013, and Kemb10 (yellow-fleshed). Increased markets of orange- fleshed varieties (both roots and vines). In the Lake Zone of Tanzania, 49 clones (hybrids from crosses of South African orange- fleshed germplasm) have preliminarily been identified

Table 6: Popular sweetpotato varieties (released and near release) currently disseminated in selected SSA countries.

Country	Disseminated varieties		Collaborating partners **
	Non OFSP	OFSP	
Uganda	NewKawogo, Naspot 1, TZ, Kyabandula, Magabale	SPK 004, Ejumula, Kala	AFRICARE, BUCADEF, JAF, SOCADIDO, Parliamentarians, NAADS, Farmer groups
Kenya	Marooko, Kalumb, Nyerere, Jayalo, Nyathiodiewo, Ex-Diani, Muibai	Kemb 10, SPK004, SPK013, KSP20, Mwavuli, 566682/03, Salyboro, Kazinga 2-1, Mogamba	Resource Project Kenya (RPK), Christian Partners Development Agency (CPDA), Africa Now, Rural Energy Food Security Organization (REFSO), Appropriate Rural Development Agricultural Programme (ARDAP), Catholic Relief Services (CRS), Akukuranut Development Trust (ADT)
Mozambique	Chingowva, Nemanete,	Japon Tres., Zapallo, Mafuta, Zondeni, Resisto	CARE, Action Aid, CRS., SARRNET, Save Children, World Vision, INIA, World Relief, Farmer groups
Tanzania	Simama, Juhudi, Sinia, Mavuno, Vumilia	Zapallo, Japon Tres.	CCT, TAHEA, Plan International, WI, KAEMP, CARE-Magu, AIC, EGAJ, World Vision -Magubike,MAFS- Crop promotion, Farmer groups
S. Africa	Mafutha, Bosbok, Ndou, Monate, Mokone, Letlhabula, Amasi, Phala, Mamphenyane	Resisto, Mafuta, Japon Tres., Excel, Jewel, W-119	-
Ghana	Sauti, Okumkom, Santum Pona, Faara,	-	UNICEF, Farmer groups
Rwanda	Mugande, Wadada, K51/3261, TIS2498	Kwezikumwe, 97-046, 97-004, 4-143	UNICEF, Farmer groups, CRS
Ethiopia	Koka 6, Koka12, 192009 – IX, 192026 – II, Belella, Awassa 83, Dubo, Falaha, Damota	-	-
Malawi	Mugamba, Cemsa 74-288, Salera, yoyera, Babache, Kakoma, Kenya	Kamchiputu, Tainoni, Zodeni	SARRNET, Extension Agents

**- List not exclusive.

with dry matter contents ranging between 29% and 42%. Majorities have good resistance to sweetpotato weevils and viruses. Rural incomes from sales of OFSP planting materials and storage roots by farmers in Uganda have increased significant. Some farmers have recorded success stories in their improved life standards through the sale of both roots and vines (*www.cipotato.org/vitaa*).

Multiplication and distribution of planting materials have continued by individual farmers and community based organizations. In Western Kenya, about 18million cuttings of mainly OFSP varieties have been distributed to farmers from KARI stations and local CBO's/ NGO's. In the Lake Zone of Tanzania, about 2.5 million of newly three released varieties (SP93/23, SP93/2, and SP93/34) together with local varieties Sinia and Simama (SPN/O) were distributed by farmers' groups and local NGO's. In Uganda farmers with BUCADEF and SOCADIDO have distributed about five million cuttings of the newly NARO released varieties (NASPOT's 1-5) to farmers through sale/ free. 15-20 promising OFSP clones have been identified and selected by farmers through participatory evaluation in SSA. Improved sweetpotato varieties currently grown by farmers in major growing areas of Kenya, Tanzania and Uganda form at least 30% of the total planted area. Efficient and sustainable planting material dissemination mechanism is in place. There is an increased use of participatory research approaches by NARS in varietal evaluations and selection for promotion in sweetpotato growing areas. Varieties suitable for livestock feed have been identified. These are to be promoted in the livestock production sector. Experiences between NARS Root Crops Programs are exchanged through Networks (SARRNET and PRAPACE). These have facilitated resource mobilization and sharing of responsibilities based on the existing capacities. The number of OFSP varieties currently evaluated in the region has increased tremendously. There is increased acceptance and consumption of OFSP varieties by consumers mainly children and caregivers.

Summary

To-date several varieties have been released officially by the national programs and of recent orange-fleshed sweetpotato (OFSP) varieties have been given emphasis in almost all the countries in ASARECA and SADC regions. Varieties such as: SPK004, Mogamba, Zapallo (for children), Salyboro, Pumpkin, SPK 013, and Kemb10 (yellow-fleshed), Zapallo, Japon Tresmesino, Salyboro, Tainung 64, Resisto and Kandee have gained popularity. Multiplication and distribution of planting materials have continued by individual farmers and community based organizations. In Western Kenya, about 30 million cuttings of mainly OFSP varieties have been distributed to farmers from KARI stations and local CBO's/ NGO's. In the Lake Zone of Tanzania, about 6 million of newly three released varieties (SP93/23, SP93/2, and SP93/34) together with local varieties Sinia and Simama (SPN/O); and in Uganda farmers with BUCADEF and SOCADIDO have distributed about 10 million cuttings of the newly NARO released varieties (NASPOT's 1-5) to farmers through sale/ free. Improved varieties distributed in East African region, have covered over 360 hectares of fields. In Mozambique an estimated 154 ha have been planted with improved varieties. Over 347,000 households in Mozambique have received at least 200 vines of OFSP sweet potato and projections are that over one million households will have received material by 2004. Crop diversification policies due to drought in Malawi and Zambia and social disruptions in Zimbabwe.

Future challenges. Developing and selecting sweetpotato varieties for animal feeds. Recent research has documented the widespread use of sweetpotato by small farmers in their efforts to sustain local livestock production systems. In fact, virtually wherever sweetpotato is

cultivated, some part of the plant, in some form, is used in some type of animal production. These trends need to be facilitated by the introduction and take-up of higher-yielding sweetpotato varieties with appropriate post-harvest traits integrated with improvements in small-to-medium scale food processing and pig production. In SSA, improvements in sweetpotato germplasm for feed, for example, can reduce dependence on imported cereals as more roots and vines can be substituted for maize in the pork industry. This should also make farmers and village enterprises less reliant on imported concentrates for raising pigs.

1. Improvement of sweetpotato varieties for starch industry and potentially for bio-based fuel source. In China, the processed products made from sweetpotato including starch, ethanol, starch based chemical products, noodles, candy, desserts, and flour have long been made by farm households to extend the availability, diversify the use, and increase the value-added for the crop (Li *et al.*, 2001). Sweetpotato is an abundant and renewable resource, and the search for energy alternatives makes it a natural choice as a fuel source. To reach this goal, CIP and the breeding programs in SSA need to use both conventional and biotech approaches to enhance the starch yield of sweetpotato.
2. Enrich genetic diversity in SSA breeding programmes and enhance sweetpotato dry matter yield. So far, most of the African cultivars have very low yields and moderate DM content of <30%. In recent years, post-harvest processing of sweetpotato has become an important way for farmers to increase their incomes. Existing cultivars do not meet these demands. Disease-resistant cultivars with high starch content and high DM yield are urgently needed. Given the lack of progress, there appears to be a need for an infusion of new sources of genetic diversity. Biotech approaches to improve productivity, weevil resistance and dry matter content in sweetpotato should also be given emphasis in the long run.

Acknowledgements

CIP, SARRNET and PRAPACE are highly acknowledged for the financial support and technical backstopping.

References

CIP (International Potato Centre). 2002. Fueling growth, health, and prosperity. CIP Annual Report for 2002. Apartado, Lima Peru.

CIP (International Potato Centre). 1995. Vines to roots: Sweetpotato breeding for impact. Recommendations and abstracts from an International workshop held in Lima, Peru. June 1-3, 1994. International Potato Centre, Apartado, Lima, Peru. 1SBN 92-9060-172-8.

INCO-DEV (International Co-operation with Developing Countries 1998-2002). 2002. Identification and characterization of sweetpotato viruses in East and South Africa, and assessment of host plant resistance for sustainable production. Second Annual Report (1st October, 2001-30th September, 2002). Natural Resources Institute, United Kingdom.

Kapinga, R., P. Ewell, S. Jeremiah, and R. Kileo. 1995. Sweetpotato in Tanzanian Farming and food systems: Implications for Research.Working paper for International Potato Centre (CIP), Nairobi, Kenya and Ministry of Agriculture Dar es Salaam, Tanzania. 47p.

Kapinga, R.and Carey, E. E.2003. Present status of sweetpotato breeding for Eastern and Southern Africa. In: Rees, D. , Q. van Oirschot and R. Kapinga. (eds.). Sweetpotato post-harvest Assessment. :Experiences from East Africa. Chatham, United Kingdom. NRI/ CPHP/ DFID/ CIP/ Ministry of Agriculture. Natural Resources

Institute: The University of Greenwich. ISBN 0 859554 548 2. pgs. 3-8.

Kriegner A, J.C. Cervantes, K Burg , R.O. Mwanga, and D.P. Zhang. 2000. A genetic linkage map of sweetpotato [Ipomoea batatas (L.) Lam.] based on AFLP markers. In: International Potato Centre Technical Progress Report (1999-2000), International Potato Centre. Lima, Peru.

Laurie, S., A. van den Berg, M. Magoro and M. C. Kgonyane. 2003. Breeding of sweetpotato and evaluation of advanced breeding lines and cultivars in off-station trials in South Africa. In : Second SARRNET scientific workshop; Programme, abstracts of papers and list of participants. May 2003, TAJ Pamodzi Hotel , Lusaka, Zambia.

Li X.Q., M. Haroon, J. Benavides, B. Stevens, M. Bonierbale, M. Ghislain and D. P. Zhang. 2001. EST development in sweetpotato from cdna libraries of pencil and storage roots (abstract) Plant and Animal Genome Conference. San Diego, CA, USA

Low, J., Walker, T., Kapinga, R., Hijmans, R.,Reynoso, D., Ewell, P. and Zhang, D. 2003. The Potential Impact of beta-carotene-rich sweetpotatoes on Vitamin A Intake in Sub-Saharan Africa. pp. 35 & 82. In: Report of the XXI International Vitamin A Consultative Group (IVACG) Group. Marrakech, Morocco. Feb. 2003. Harvey, W.J. and Taylor, T. M. (eds.). IVACG Secretariat, United States of America. ISBN 1-57881-166-X.

Mwanga, R.O.M., B. Odongo, C. O. p'Obwoya, R.W. Gibson, N.E.J.M. Smit and E.E. Carey 2001a. Release of five sweetpotato cultivars in Uganda. HortScience 36(2): 385-386.

Rusch, B.R. 1998. The Maintenance of Sweetpotato Planting Materials in Namibia: Options for the Development of a Vine Production and Distribution System. M Inst Agrar thesis, University of Pretoria, South Africa.

Thompson, G.J., Van der Mescht, A., Naudè, S.P., Thompson, A.H., Nuiten, E. and Lubout, P. 1998. Sweetpotato and Cassava in the KwaZulu-Natal Province of South Africa: a baseline study. Proc. Workshop of SARRNET. Lusaka, Zambia 17 - 19 May. p.40-50.

Woolfe, J. 1992. Sweetpotato: an untapped food resource. Press Syndicate of the University Cambridge. CB21RP. New York, USA. ISBN 0 521 40295 6. 642pp.,