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Development and promotion of orange-fleshed sweetpotato varieties in Western Kenya

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Abstract. Vitamin A deficiency is a major nutritional problem in Kenya, leading to night blindness and high mortality of infants. Orange-fleshed sweetpotato (OFSP) varieties are being promoted as food based intervention to combat vitamin A malnutrition. Most of the OFSP varieties being promoted in Kenya are, however, not popular with farmers because of their poor adaptability and low root dry matter content. The only two OFSP varieties SPK004 and Zapallo with moderate consumer acceptance have not reached many famers because of an inefficient planting material multiplication and distribution systems. New OFSP clones were evaluated at three sites in western Kenya between 2001 and 2002 in order to identify more clones with desirable characteristics. Clones 566632, 440248, 440208, 440031, Sponge, K118, and K135 were found to be promising in terms of root yield and taste qualities. Attempts were made to multiply and distribute planting material of the OFSP varieties using NGOs, community based organisations (CBOs), extension staff and farmer group partners working in area. A total of 49 million cuttings were distributed to 12,000 sweetpotato growers farmers within the two years.

Introduction

Sweetpotato *(Ipomoea batatas* (L.) Lam.*)* is one of the world's highest yielding crops in terms of production per unit area, exceeding that of major cereals such as rice, and with higher food value (Woolfe, 1993). In Kenya, sweetpotato is regarded as a "poor man's" crop because it is often grown and consumed by resource limited households and has the ability to give satisfactory yields under adverse climatic and soil conditions as well as under low or non-use of external inputs (Carey *et al.*, 1999; Ndolo *et al.*, 1998). It ranks third in importance after potato and cassava among root and tuber crops (Kung'u, 1999); however, it has become even more important in areas where cassava mosaic virus disease has devastated cassava (PRAPACE, 1998) and striga weed is a problem. As a food security crop, sweetpotato can be harvested piecemeal as needed, thus offering a flexible source of food and income to rural households that are mostly vulnerable to crop failure and fluctuating cash income. Additionally, it has a short maturity period of 3 to 5 months.

Sweetpotato is also important for human nutrition especially the orange-fleshed varieties which contain high levels of ß-carotene used to combat vitamin A deficiency (Low *et al*., 1996) in children under the age of five and breast-feeding mothers. Until very recently, relatively little emphasis was placed the on OFSP varieties by researchers since farmers in Kenya were not used to the orange colour in sweetpotato. The scenario, however, changed after farmers realized that the OFSP varieties have higher food value in the form of â-carotene than the white or yellow types.

Earlier experiments in Kenya led to the identification of two OFSP varieties SPK004 and Zapallo which were fairly acceptable to farmers. However, Zapallo was later rejected

by many farmers because of its low root dry matter and its inability to withstand drought and high sweetpotato virus diseases. There was therefore a need to identify more OFSP varieties with acceptable agronomic and root qualities. Lack of well-organized seed distribution system for the vegetatively propagated crops in Kenya has also contributed to the slow rate of dissemination of the new varieties. New varieties are traditionally disseminated through farmer-to-farmer variety exchange and a limited sale of cuttings in the markets at the onset of the planting season. The objectives of this study were to involve farmers in the identification of new OFSP varieties and to use the existing NGOs, CBOs and farmer groups in the promotion of the varieties.

Materials and Methods

Identification of varieties. Two variety selection trials were conducted in Kenya between 2001 and 2002. The first trial consisted of OFSP clones introduced from other parts of the world through the International Potato Centre (CIP) while the second trial was made up of local OFSP cultivars collected from farmer's field in western Kenya.

Thirteen to 18 exotic OFSP clones were evaluated at KARI-Kakamega, Agolot village and Alupe sub-centre in western Kenya. KARI-Kakamega is situated in the Upper Midland one (UM1) agro-ecological zone at an altitude of 1585 m above the sea level and with annual rainfall of 1900 mm. The soils are well-drained, deep friable clay with humic topsoil (mollic nitosols) developed on tertiary or older basic igneous rocks. Agolot is located in Busia district at an altitude of 1220 m above sea level with a mean precipitation of 1790 mm. The soils are well-drained yellowish brown friable clay over petrolinthite (orthic ferralsols). Alupe is located at an altitude of 1250 m above the sea level and consists of moderately well drained, shallow, brown to dark brown soils over petro-plinthite (murram cuirass soils).

The clones were planted in a randomized complete block design with three replications. Each plot consisted of four ridges 4.5 m long and 100 cm apart. Each ridge was planted with 15 cuttings, 25-30 cm in length at a spacing of 30 cm between plants. The trial at Agolot was managed by the farmers in collaboration with Ministry of Agriculture extension staff and Rural Energy Food Supply Organization (REFSO), an NGO operating in the area. The trials at Alupe and KARI-Kakamega were managed by researchers but farmers from the surrounding were invited to evaluate the clones at harvest. Data were collected on virus infection using a scale of 1 to 5, where, 1=no virus attack and 5=severe virus infection. Reaction to drought was also assessed using a 1 to 5 scale, where 1=very susceptible to drought and 5=very resistant/ tolerant to drought. At harvest, vines were cut at 10 cm above the ground and weighed. Storage roots were lifted and separated into marketable and non-marketable sizes. Marketable roots were those with cross sectional diameter at the largest portion of the root above 3 cm. The sum of marketable and non-marketable roots formed the total storage root yield. Dry matter content of roots was determined by oven drying a 200g-root sample for 48 hours. Five roots of each clone were cooked and evaluated by farmers using a score of 1 to 5, where 1=very poor taste and 5=excellent taste.

The second experiment consisting of seven local OFSP varieties was conducted for two seasons at Alupe sub-centre and KARI-Kakamega. Varieties were grown in 4.5-m plots of four rows, 100 cm apart. Cuttings were planted 30 cm from each other. The varieties were randomized within the blocks and replicated three times. Data were taken on virus infection, fresh weight of vines, storage root yield and dry matter contents of roots as described in the first trial.

Results and Discussion

Analysis of variance showed that there was significant site x variety interaction in all

parameters measured. Mean root yield was highest at KARI-Kakamega followed by Alupe. The high root yield at Kakamega was attributed to the high rainfall received during the trial period. Agolot had the poorest root yield as a result of the black cotton soil which compacted during the dry season and restricted the expansion of roots. Total root yields at Kakamega (Table 1) ranged between 15 and 49 tons/ha. Varieties 566632, 440248, 440208, 440031, 420014 and 440060 had higher root yield and dry matter content than the check variety Zapallo. All the best clones had acceptable root taste except for 440208. Although clones 566632, 440208 and 440060 had promising root yields, they were found to be susceptible to drought. Performance of the sweetpotato clones at Agolot is given in Table 2. The best clones at the site were 420094, 400014, 420054 and 400013. The results at Alupe (Table 3) showed that although clones 440208, 420009, 566632, 420094, 420001, 420286, 440248 and 420014 performed well, they were not significantly superior to Zapallo in terms of root yield. The dry matter contents of roots were higher than at Kakamega.

Mean performance of the local orange-fleshed varieties at Kakamega and Alupe was low compared to the exotic varieties (Tables 4 and 5) suggesting that the local accessions were either harvested before attaining their maximum maturity or they just have lower yield potential than the introductions. Varieties K44, K135 and K52 gave 17.1, 14.1 and 13.5 tons/ha of roots at Kakamega compared to 11.6 tons/ha obtained from SPK004 while none of the local varieties performed better than SPK004 at Alupe.

Promotion and dissemination of orange-fleshed varieties. While the selection of new orange-fleshed varieties was going on, researchers, extension staff, NGOs, CBOs and farmers' groups were involved in the

Table 1: Mean performance of exotic orange-fleshed varieties planted at KARI-Kakamega for two seasons.

Entry		Total root yield t/ha	Foliage wt T/ha	Virus score (1-5%)	Taste score (1-5)	Reaction to drought (1-5)	% DM
566632	-	49.2	25.4	2.3	3.3	2.4	23
440248	-	44.7	19	3	2.6	2.7	19
440208	Serenta	40.8	22	3.2	4	3.2	29
440031	-	36.9	14	3	3.6	3.4	27.3
420014	Jonathan	21	23.9	2.7	4.5	3.2	28.2
440060	TIB 4	21.9	10.2	2	2	2.6	27.2
440255	SP 094	21.4	13.4	4.3	3.5	3.3	19
440286	Bei jieng 553	22.5	15.4	3.6	3	3.7	25
420027*	Zapallo	20.2	23	4.3	2.9	2.5	14.5
LO-86-33	-	17.5	36	3	3	3.4	17.9
400014	Comote amarilo	16	33.6	3.2	4	3.6	22
420054	-	16.9	34.5	3.6	2	2.2	25.6
420009	Japanese	18.3	23.6	2.9	2.5	2.4	20.5
420094	Huanchano	15	14	3	2.9	2.6	29
187017	Salyboro	14.6	18.9	1.2	2	4	33.2
Mean		25.1	21.8	3	3.1	3	
LSD (0.05)							
C V %		9.4	10.8	0.8	0.6	0.7	
		33.6	41	14.3	20.4	19.7	

*Check

Table 2: Mean performance of orange-fleshed varieties planted at Agolot (Busia).

Entry		Total yield t/ha	No. of roots/plant	Foliage wt t/ha	Virus score (1-5)
440284	BIS 192	8.1	3	7.9	2.3
420001	Anaranjo itende	8.1	4	7.2	1.7
420094	Huanchano	12.1	4.7	15.7	1.7
440286	Bei jieng 553	8.1	1.3	6.7	1.3
400014	Comote amarilo	14.8	4	7	2.3
420054	-	9.6	3.2	9.2	1.3
440208	Serenta	7.5	4.9	3.8	3
420006	-	6	3.9	8.9	1.2
420019	Pedro	5.7	3.6	13.8	1.3
420005	Nemanete	6.4	3.8	7.3	2
400013	100092	9.3	4.7	8.1	2
420014	Jonathan	4	3.8	4.3	1.3
440151	LA10 44	6.4	3.9	9.4	1
Mean		8.2	3.8	8.4	1.8
LSD(0.05)		3.6	2.3	3.2	1.7
C V %		26.6	36.6	23	56.5

Table 3: Mean performance of exotic orange-fleshed varieties at Alupe sub-centre in western Kenya.

Entry	Total yield t/ha	Foliage wt T/ha	Virus score	Taste score (1-5)	Reaction to drought (1-5)	% DM (1-5)
440208 Serenta	22.1	19.5	1.3	3.6	3	29
420009 Japanese	21.9	29.6	2	3.2	3.3	26.2
566632 -	20.3	17.4	1.7	3.5	2.8	24.6
420094 Huanchano	19.9	44.4	1.6	2.9	2.7	29.8
420001 Anaranjo itende	19.4	20.2	2	3	2.9	27.6
440286 -	19.3	11.9	2	3.3	3.1	30
440248 Jonathan	19	24.5	1.9	4	3.9	25.8
420014 Zapallo	18.4	41.2	1.3	2.6	3.2	25.4
420027 SP 094	17.9	15	4	2.4	1.6	17.6
440255 -	16.3	35	3.7	2.6	3.5	33.6
440031 -	15.2	29.3	3.9	3	3.5	26.8
440091 Kafr El-layat No 1	13.3	26	4	3	2	25
440047 Bugs buny	11.3	23.1	2	3.4	2.2	22.7
420054 -	7	14.1	2.3	3.2	2.6	28.9
187017 Salyboro	8.7	56	1.2	3.5	2.7	30
440015 W-220	5.8	29.6	2.1	2.9	2.1	28
420005 Nemanete	8.2	36.6	2.3	2.8	3.9	29.7
420019 Pedro	3.6	22.2	3	4	3.7	22
Mean	11.4	14.9	27.6	3.2	2.9	26.8
SED+	4.2	5.2	7.1	0.6	0.4	5.6
C V %	35.2	32.7	31.7	15.8	15.6	22

Table 4: Mean performance of local orange-fleshed varieties planted at Alupe sub-centre in western Kenya.

Entry	Total yield t/ha	Foliage wt t/ha	Virus score (1-5)	Taste score (1-5)	DM%
K118	15.7	36.9	1.7	4.5	26.8
K135	14.4	36.7	2	4	30
K207	1.5	52.9	1	3.6	29.3
K37	12.4	41.9	2.3	4	34.2
K44	4.4	41.2	1	4.2	29.8
K52	12.5	35.5	2.3	4.3	31.9
SPK004*	23	50	1	3.8	29.9
Sponge	13	47.4	2	4.5	32
Mean	12.1	42.8	1.7	4.1	
SED+	2.8	6.8	0.5	0.7	
CV%	28	19.5	12	15.6	

Table 5: Mean performance of local orange-fleshed varieties planted at KARI- Kakamega during 2001 and 2002 seasons.

Entry	Total yield t/ha	Foliage wt t/ha	Virus score (1-5)	Taste score (1-5)	DM%
K118	11.7	41	2.3	4.1	29
K135	14.1	36.1	3	3.9	31.3
K207	0.9	43.1	4	3.7	29.8
K37	1.3	39.4	4	4.2	30.2
K44	17.1	47.5	1.6	4	28.7
K46	8.8	40.3	2	4.2	30.3
K52	13.5	50	2.2	3.9	30.5
SPK004*	11.6	38.9	1.7	3.8	33.4
Sponge	6.1	48.1	3		
Mean	9.5	42.7	1.6	4	
SED+	3.5	9.1	0.6	0.5	
CV%	34.4	26	23.2	17.3	

promotion and dissemination of the existing orange-fleshed varieties to farmers. The NGO and CBO partners were selected from those already involved in agricultural activities. The main NGOs involved in seed multiplication and promotion of the orange-fleshed varieties are given in Table 6. The dissemination process of the OFSP varieties in western Kenya started with the on-farm selection of the varieties by the farmers. The selected varieties were bulked in primary multiplication sites at KARI-Kakamega, Alupe sub-centre, Yala swamp and Siaya FTC in western Kenya. Sweetpotato cuttings from these sites were used by the partners to establish decentralized secondary seed multiplication units close to farmers. Planting materials from the decentralized seed bulking units were distributed to the group members or their neighbours either freely or at a cost. Some planting material from these plots were also purchased by other organizations and used to establish more secondary multiplication plots in other parts of Kenya. The amount of OFSP cuttings distributed to farmers by the different stakeholders is given in Tables 6 and 7. A total of 49 million cuttings covering 2700 hectares of land were distributed to farmers

Table 6: List of NGOs and CBOs partners involved in the promotion of orange-fleshed sweetpotato varieties in western Kenya.

Name of NGO	Operation areas (Districts)
Resource Project Kenya (RPK)	Vihiga
Christian Partners Development Agency (CPDA)	Vihiga
Africa Now	Vihiga, Kisumu
Ugunja Community Resource Centre (UCRC)	Siaya
Rural Energy Food Security Organization (REFSO)	Busia, Teso
Appropriate Rural Development Agricultural Programme (ARDAP)	Busia
Catholic Relief Services (CRS)	Migori, Rachuonyo
Rural Farm Alternatives Organization (RUFAO)	Bungoma
Community Research in Environment and Development Initiatives (CREADIS)	Bungoma
Akukuranut Development Trust (ADT)	Teso
International Chritelijk Steunfond Africa (ICS)	Busia, Teso

Table 7: Number of the cuttings distributed and area planted in each district in western Kenya.

District	Amount of cuttings distributed x 10^6	Area planted(ha)
Busia	13.0	680
Kakamega	6.8	340
Bungoma	3.1	150
Lugari	2.0	110
Teso	8.0	400
Vihiga	8.2	410
Butere/Mumias	2.7	200
Siaya	5.2	350
Kisumu	1.0	70
Total	49.1	2710

during the reporting period. The highest amount of planting material was given to Busia district as it had more NGOs involved in agricultural activities compared to other districts. A total of 102,000 households consisting of 511,000 people benefitted from the orange-fleshed varieties (Table 8).

In order to sustain seed multiplication efforts, partners were trained on the rapid multiplication techniques of planting materials (using 2-node cuttings; beds) and for maintaining them (plantings in well watered areas or in shaded areas near households). Efforts were also made to identify farmers with access to swamps or other permanently well-watered locations to serve as suppliers (in drier areas, presumably sellers) of planting material. Quality of planting material was maintained through rejuvenation of multiplication plots with virus free planting material obtained from CIP, Muguga and rapidly multiplying these using tissue culture technique at KARI-Kakamega.

Promotion of OFSP varieties and their nutritional benefits was also done through agricultural shows, farmers' field days, from which participants departed with samples of cuttings to plant. Efforts were also made to use field schools or formal training institutions to popularize orange-fleshed varieties to the farmers and consumers. Attempts were also made to include ministry of health staff and village birth attendants in the promotion of the OFSP varieties.

Table 8: Number of households and beneficiaries of the orange-fleshed varieties in western Kenya.

District	Number of households	Number of beneficiaries
Busia	16400	82000
Kakamega	19000	95000
Kisumu	8740	43700
Siaya	6300	31500
Bungoma	7700	38500
Lugari	10600	53000
Teso	8800	44000
Vihiga	18000	90000
Butere/Mumias	6700	33500
Total	102,400	511,200

The approach also placed strong emphasis in training partners and farmers on sweetpotato utilization and nutrition including production of various sweetpotato-based products such as chapatis, chin chin, donuts, mandazis, juices, crackies, and weaning diets. Some members of the groups are already involved in commercial production of OFSP products. Training efforts in post-harvest utilization and nutrition have stimulated high interest among farmer groups on the orange-fleshed varieties. Participating NGO and CBO partners were used as trainers and models for the expansion of activities to other locations through training exercises and exchange visits.

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