African Crop Science Conference Proceedings, Vol. 7. pp. 603-609

ISSN 1023-070X/2005 $ 4.00

On-farm evaluation of orange-fleshed sweetpotato varieties in northeastern Uganda

E.G. OMIAT, R.E. KAPINGA[1], S. TUMWEGAMIRE[1],T.L. ODONG & E. ADIPALA[2]
Crop Science Department, Makerere University, P.O. Box 7062, Kampala, Uganda
[1]International Potato Center, P.O. Box 22274, Kampala, Uganda
[2]Regional Universities Forum for Capacity Building in Agriculture, P.O. Box 7062, Kampala, Uganda

Abstract Orange-fleshed sweetpotato (OFSP) varieties currently represent the least expensive, year-round source of dietary vitamin A available to poor families in Eastern Africa. An on-farm study was conducted in North-Eastern Uganda to assess field and post harvest performance and acceptability of selected OFSP varieties. Eight farmer groups participated in the evaluation. Field performance attributes assessed included foliage coverage, resistance to diseases and pests, drought tolerance, maturity, yield of roots, shape of roots, size of roots, appearance of root flesh and general crop appreciation. Taste, flavour, starchiness, cooked root appearance and general acceptability were the post harvest attributes assessed. The sweetpotato varieties evaluated were Ejumula, Kala, SPK004, Sowola 6, Sudan, 4-4 and Arivumaku. Farmer groups from different locations within the study area grew and evaluated the different sweetpotato cultivars and both adults (men and women) and children aged between 7 and 10 years assessed the post harvest attributes. Results obtained showed that there were significant variations in field performance of the sweetpotato varieties over the two seasons. Overall, field performance of the tested varieties was in the order Kala> SPK004> Ejumula> Sudan> 4-4> Sowola > Arivumaku. Consumer acceptance was in the order SPK 004> Ejumula> Sowola 6> Sudan> Kala> 4-4. Varieties Ejumula, Sudan and SPK004 had the best overall performance in post harvest attributes. At national level, results from different locations showed that varieties Ejumula and SPK004 are widely accepted by farmers, consumers and even processors.These two varieties have now been officially released.

Key words: Consumers, farmers, on-farm evaluation, orange-fleshed sweetpotato

Résumé Les variétés de patate douce chair orangée (OFSP) représentent actuellement la source la moins chère de vitamine A par la nutrition, disponible dans tout le courant de l'année dans les familles pauvres en Afrique de l'Est. Une étude faite sur ferme était conduite dans le Nord-est ougandais en vue d'évaluer la performance sur champ et après récolte et l'acceptabilité de variétés sélectionnées d'OFSP. Huit groupes de fermiers ont participé l'évaluation. Les attributs de performance sur champ qui on été évalués incluaient la couverture foliaire, la résistance aux maladies et aux parasites, la tolérance à la sécheresse, la maturité, le rendement de racine, la forme des racines, leur dimension, l'apparence de la chair des racine et l'appréciation générale de la culture. Le goût, la saveur, l'amidon, l'apparence de racine cuite et l'acceptabilité générale étaient les attributs évalués après récolte. Les variétés de patate douce évaluées étaient Ejumula, Kala, SPK004, Sowola 6, Sudan, 4-4 et Arivumaku. Les groupes de cultivateurs de différentes localisations au sein de la région de l'étude ont planté et élué les différents cultivars de patate et les femmes et les hommes adultes et les enfants âgés d'entre 7 et 10 ans ont évalué les attributs après récolte. Les résultats obtenus ont montré qu'il y avait une variation significative dans la performance sur terrain. De variété de patate douces sur les deux saisons.En tout la performance de terrain de variétés testées était dans l'ordre Kala>SPK004>Ejumula>Sudan>4-4>Sowola>Arivumaku. L'acceptation par le consommateur était dans l'ordre SPK004>Ejumula>Sowola 6>SudanKala>4-4. les variétés Ejumula et SPK004 ont montré une meilleure performance générale en attributs après récolte. Au niveau national, les résultats des localisations de variétés ont montré que les variétés Ejumula et SPK004 sont plus largement acceptées par le fermiers consommateurs et mem les traitants. Ces deux variétés ont maintenant été officiellement lancées.

Mots clés: Consommateurs, fermiers/cultivateurs, évaluation sur ferme, patate douce chair orangée

Introduction

Sweetpotato (*Ipomoea batatas* (L) Lam) is the third most produced food crop in Uganda, after bananas (*Musa* spp.) and cassava (*Manihot esculenta* Crantz.) (Odongo *et al*., 2002). Two million four hundred metric tons of the crop is produced annually from 555,000 hectares of land (FAO, 2001). It is a food security crop adaptable to varied agro-ecological zones in the country (Odongo *et al*., 2002), stores well in the soil and performs well in marginal soils (Bashaasha *et al.*, 1995). The most widely grown varieties are white-fleshed, with negligible amounts of beta-carotene, the precursor of vitamin A contained in plants (Woolfe, 1992; Odongo *et al*., 2002) and this could be a contributing factor to the widespread deficiency of vitamin A in Uganda (Ssebuliba *et al*., 2001). Vitamin A is essential for the maintenance of general body immunity and good eyesight (Wanda *et al*., 2001; Ministry of Health Report, 1998). Dietary vitamin A deficiency causes debilitating health problems such as xerophthalmia, corneal lesions, keratomalacia and in many cases death (Olson, 1989). Deficiency of this vitamin is prevalent among pregnant, lactating mothers and children below the age 5 (Ministry of Health Report, 1998), causing a problem of public health significance in over 70 countries (Chakravarty, 2002). This deficiency has been associated with diets predominantly

consisting of vitamin A poor staples, such as tubers and grains, and low consumption of good sources such as meat, yellow and green vegetables and fruits (Underwood, 2000).

The common sources of vitamin A are green vegetables, fish, carrots, fruits and sweetpotato. However, green vegetables, carrots and fruits are seasonal and their consumption is low, while fish is expensive. Sweetpotato, on the other hand, is cheap, common and available most times of the year (Odongo *et al.*, 2002). The orange and yellow-fleshed sweetpotatoes contain up to 4,000 mg / 100mg (fresh weight basis) of beta-carotene while the white-fleshed sweetpotato beta-carotene content may be as low as 70 mg / 100mg (Wolfe, 1992). It is estimated that consumption of about 100gm of a deep orange-fleshed sweetpotato root can meet over 80% of a child's daily requirement for vitamin A (van Jaarsveld *et al.*, 2003).

One approach to increase food availability as well as tackling vitamin A deficiency would be to grow and utilise orange-fleshed sweetpotatoes (Low *et al.*, 1997). However, the potential of orange-fleshed sweetpotatoes (OFSP) in alleviation of vitamin A deficiency may not be realised unless the sweetpotato cultivars are good performers and are acceptable to farmers (Ssebuliba *et al.*, 2001). The main objective of this study therefore, was to evaluate the agronomic performance and acceptability of orange-fleshed sweetpotato varieties in the northeastern region of Uganda.

Materials and methods

The study was conducted between August 2002 and October 2003 in Soroti and Kumi Districts, in Northeastern Uganda. Both Kumi and Soroti are located in one of the major sweetpotato agro-ecological zones in Uganda. These two districts lie at altitudes of between 1,036 and 1,127 metres above sea level in a modified equatorial climatic zone with both heavy rainfall and high temperature. The area receives between 1,000 and 1,500 mm of rainfall per annum (Mugisha, 2002) and has two rainy seasons, the first runs from March to July while the second is from September to November (UCC, 2003). There is normally a short dry spell between the two seasons during mid June to mid July while the long dry season sets in during late November through to early March. December and January are the driest months, while the wettest months are April and May for first season, and August through October for the second season (UCC, 2003).

The study comprised of two parts: on-farm field evaluation and post harvest evaluation of OFSP varieties. Linkages were made with Soroti Catholic Diocese Development Organisation (SOCADIDO) that helped in identifying, mobilising and later, in followed up the trials with farmer research groups. In each district, four (4) farmer groups from different parishes participated in the study.

Farmer groups which comprised mostly women grew and evaluated the different sweetpotato cultivars. Women were preferably chosen because in this area, women are normally responsible for farming and feeding families. The criteria for selection of the farmer groups included being well organised, easily accessible, and willingness to grow the new sweetpotato cultivars.

Seven varieties, namely Ejumula, Kakamega (SPK004), Kala, Sowola 6, Sudan, 4-4 and Arivumaku were evaluated in the first season while only six varieties were evaluated in the second season, having excluded Arivumaku due to its poor performance in the first season (2002/2003 periods). Due to limited resources, planting in the second season was done only in Soroti district but consideration was given in locating the field trials so as to cater for the different agro ecological conditions in the Northeastern region of Uganda. During the two seasons, each study location or farmer group received 100 vines of each variety that was enough to plant an area of $24m^2$. Planting in season 1 was done in August, 2002 and was harvested in January 2003, while season 2 planting was done in May 2003 and was harvested in October 2003. Each variety was planted in a plot made of 24 mounds arranged in a 4 x 6 matrix.

Various attributes were assessed using a subjective score scale of 1-5, where 1= very bad, 2= bad, 3= moderate, 4= good and 5= very good. Field performance attributes-such as foliage coverage, resistance to diseases and pests, drought tolerance, maturity, yield of roots, shape of roots, size of roots, appearance of root skin, appearance of flesh and general crop appreciation were rated by farmers. Sample roots of each of the harvested varieties were peeled, cooked and served separately to both children (between 7-10 years) and adults (men and women). Both adults and children assessed the cooked roots for appearance, taste, flavour, starchiness and general acceptability using a similar subjective score as in the field.

The scores of the different attributes (both field and post harvest) were subjected to ordinal regression analysis (Coe, 2001) using GenStat statistical package In this analysis, odds ratio indicates the number of times a given variety is likely to be rated higher or lower than the reference or baseline variety which was Ejumula in this study. The value of odds ratio greater than 1 indicates that the given variety is likely to be rated higher than Ejumula, whereas a value less than 1 indicates that a given variety is likely to be rated or scored lower than Ejumula. A value of odds ratio of 1 indicated that there is no difference in rating of the varieties being compared. Basing on the odds ratios, the different varieties were then ranked.

Results and discussion

Pest resistance. During the evaluation, farmers looked for physical pest damage on the above ground biomass of the varieties. Those with less or zero visible damage were rated as resistant while those observed with severe physical damages were rated not resistant. Varieties 4-4 and Kakamega ranked first and second respectively, suggesting that they were according to farmers more resistant to pests compared to the rest of the test varieties. On the other hand Arivumaku was ranked last followed by Sowola 6, suggesting that they were, according to the farmers, the least pest resistant varieties. Possibly, the genetic makeup of different sweetpotato varieties

influenced their resistance to sweetpotato pests. Odongo *et al*. (2002) studied the resistance to pests of the varieties Ejumula, Kala, and Bwanjule and concluded that Ejumula had moderate resistance to sweetpotato weevil and butterfly larvae infestations.

Resistance to diseases. During evaluations farmers were asked about the sweetpotato diseases common in the area. In most of the locations, farmers described the symptoms of sweetpotato virus disease (SPVD). Hence, SPVD was the main disease considered. During the first season (Table 1), Sudan was ranked first suggesting that it was the most resistant variety to diseases. This was followed by Sowola 6 and Kakamega respectively as the second and third most resistant varieties. Kala ranked last (7) followed by Arivumaku. This suggests that, according to farmers, the two varieties were the least resistant to SPVD. However during the second season, the farmers' rating of the same varieties differed. Kala was ranked first, followed by Ejumula and Kakamega. Sowola 6 was ranked last (6) followed by 4-4. The improved "resistance" by Kala and Ejumula as well as the "decline" in resistance by Sowola 6 and Sudan could probably be due to differences in the environment conditions between the two seasons. The rain period during the first season is longer than during the second season (UCC, 2003). It would therefore appear that Kala and Ejumula resist diseases under less rain conditions than high rain conditions while the opposite would appear to be true for Sowola 6 and Sudan. Ejumula is indigenous to areas in and around Soroti, and is highly adapted to the less rain conditions characteristic of this region (Mwanga *et al*., 2004). Over the two seasons, variety Kakamega consistently ranked third for resistance to diseases, suggesting that it probably has stable resistance to SPVD.

Drought tolerance. The North-eastern districts of Soroti and Kumi experience prolonged drought between November and March, and short dry spell between July and September. Farmers' rating of drought tolerance varied significantly ($P<0.001$) with variety. Varieties Kakamega and Ejumula were ranked first and second, respectively, suggesting that farmers rated them as the most drought tolerant sweetpotato varieties. Ejumula is a local variety, and is indigenous to Katakwi district (Mwanga *et al*., 2004), which neighbours Soroti and Kumi districts. It is probably adapted to the dry conditions characteristic of the region. Kakamega on the other hand is an introduction from Kenya but is now widely adapted and accepted by farmers (Wanjekeche *et al*., 2000). Arivumaku ranked last (7) followed by Sowola 6, suggesting that farmers rated the two varieties as the least drought tolerant.

Foliage coverage. In this study farmers' rating of the foliage coverage varied significantly ($P<0.001$) with the test variety, season, and interaction effects of variety and season. Different varieties differ in leaf structure and numbers (Mwanga *et al*., 2004), both of which have a compounding effect on the overall canopy of the crop. The interaction between varieties and season means the farmers' rating of the foliage coverage for test varieties was not consistent over the two seasons. Generated rankings for the varieties over the two seasons are presented in Table 1. During the first season Kakamega ranked first, followed by Kala, and Sudan in that order as the second and third best varieties in terms of foliage coverage. The poorest ranked varieties were 4-4, Ejumula, Arivumaku and Sowola 6. However, during the second season (Table 1) the same varieties ranked differently; Ejumula was ranked first followed by Sudan and 4-4 as the second and third best varieties with good foliage

Table 1. Overall ranking of field attributes by farmers (2002/2003).

Variety	Overall ranks by farmers (N= 96)				
	Pest resistance	Disease resistance	Drought tolerance	Foliage coverage	Overall performance
			Season 1		
Arivumaku	7	6	7	5	7
4-4	1	4	6	7	5
Sudan	5	1	3	3	2
Kakamega (SPK004)	2	3	1	1	1
Ejumula	4	6	2	6	5
Kala	3	7	4	2	3
Sowola 6	6	2	5	4	4
			Season 2		
4-4	-	5	-	3	
Sudan	-	4	-	2	
Kakamega (SPK004)	-	3	-	5	
Ejumula	-	2	-	1	
Kala	-	1	-	4	
Sowola 6	-	6	-	6	

1 = Best, 6 and 7 = poorest.

coverage. During the second season Sowola 6 ranked last, followed by Kakamega, Kala, and 4-4 in that order. Sudan and Kala exhibited nearly the same foliage performance over the two seasons. The change in ranks of Kakamega, Kala and Sowola 6 could be attributed to weather changes over the two seasons. It is probable that the short duration of rains characteristic of second season (UCC, 2003) could be responsible for a shift to poor foliage performance of the varieties. Indeed, Kakamega has been observed to exhibit poor foliage coverage when planted at times when there is low soil moisture (Mwanga *et al*., 2004). The reason for better foliage performance by Ejumula during the second season is not clear. However, Ejumula is indigenous to Soroti and is therefore probably adapted to low moisture conditions characteristic of that season (UCC, 2003).

Yields and yield components of OFSP varieties. The assessment was also conducted in a participatory way where farmers sorted roots into marketable and non-marketable heaps, counted and weighed them. The ANOVA results indicate that varietal effect had a significant influence on the marketable weight (P=0.001), non-marketable weight (P=0.016), number of marketable roots (P=0.003), number of non-marketable roots (P=0.002) and total weight (P=0.001). Ejumula had the highest total yield (8.75 t/ha), followed by Kakamega and Kala with 8.61 t/ha and 8.21 t/ha, respectively (Table 2). The lowest total yields were from Arivumaku, followed by 4-4, implying that Arivumaku was probably the poorest yielding of the varieties tested in this agro ecological zone. Farmers recommended for its exclusion during the second season. On the other hand, Ejumula had the highest weight of marketable roots, followed by Kala and Kakamega, respectively. For marketing purposes, this suggests that Ejumula was the best variety followed by Kala and Kakamega, respectively. Like for total yield, the lowest weight of marketable roots was observed with Arivumaku, followed by 4-4 and Sowola 6. Thus, for marketing purposes, Arivumaku was considered the poorest variety followed by 4-4 and Sowola 6.

Maturity earliness. Farmers' rating of varieties for maturity earliness significantly (P<0.001) varied with varieties and seasons, and the interaction effect of season with varieties was significant. During the first season, Ejumula was ranked as the earliest maturing variety. It was followed by Kala and Kakamega as the second and third earliest maturing, respectively. Arivumaku ranked last (7) suggesting that according to the farmers, it was the latest to mature. However, during the second season, 4-4 was ranked first, Kakamega second, and Sudan third. On the other hand Sowola 6 ranked last (6). The results suggest that Kakamega maintained consistent ranking in the two seasons. The inconsistent ranking of the varieties in terms of maturity period over the two seasons is probably due to differences in weather conditions.

Root shape. Farmers understood root shape as how straight or bent or oval is the root and how appealing (attractive) it was to the assessor. The farmers' ratings for the root shapes of the test varieties significantly (P<0.001) varied with variety, season and interaction between variety and season. According to the farmers, Ejumula ranked first suggesting that it had the best shape during the first season (Table 3). This was followed by Kakamega and Kala as the second and third best, respectively. On the other hand, Arivumaku ranked least (7) suggesting that it had the poorest root shape. In season 2 Sowola 6 was considered to have the poorest root shape whereas the best was that of 4 -4. This contradicts the findings of Ocitti p'Obwoya and Namakula (1997) where root shape of Sowola 6 was considered very good. Apart from the genetic make up, soil physical characteristics could have played a role in determining the root shape of sweetpotatoes. For example, sandy soil is easy to penetrate by the roots thus sweetpotatoes from it may not have a lot of depressions. Sweetpotato roots that are round and irregular in shape with a number of depressions are cumbersome to peel (Ocitti p'Obwoya and Namakula, 1997). It is also probable that the variation in rainfall pattern over the two seasons affected the soil compaction, which in turn may have affected the sweetpotato root shape.

Table 2. Mean yield and yield components of the OFSP varieties evaluated.

Variety	Average # of non-marketable roots /24m^2	Average # of marketable roots /24m^2	Non-marketable root yield	Marketable root yield	Total yields (t/ha)
Arivumaku	9.1	3.3	0.35	0.51	0.76
Ejumula	40.9	26.7	2.25	6.51	8.75
4-4	34.7	19.0	2.31	3.82	6.13
Kakamega (SPK004)	29.3	25.8	2.11	6.5	8.61
Kala	37.2	24.6	1.99	6.22	8.21
Sowola 6	32.2	18.5	3.00	4.61	7.61
Sudan	30.6	22.0	1.78	5.02	6.8
LSD(0.05)	13.9	11.4	1.33	2.89	3.65

Root size. Farmers indicated that a good variety has medium (250-500g) to big (500-800g) sized roots, while a poor variety has a lot of small (<250g) sized roots. At the same time farmers noted that very big tubers are generally not tasty. The farmers' rating of sweetpotato root sizes varied significantly ($P<0.001$) with variety, season and interaction of variety and season was significant. In season 1, Ejumula ranked best followed by Kakamega, while Arivumaku and 4-4 ranked last and second last, respectively (Table 3). This indicates that Ejumula had the best root size followed by Kakamega while Arivumaku had the smallest root size followed by 4-4. However, in season 2, variety Kala was ranked first followed by 4-4 whereas Sowola 6 and Ejumula were ranked last and second last, respectively. Arivumaku was dropped by farmers during the second season due to its poor yield performance.

Colour of root flesh. Root flesh appearance of the sweetpotatoes varied inconsistently over the two seasons (Table 3). Farmers ranked Ejumula and Kakamega first and second respectively during the first season, suggesting that these varieties have appealing and acceptable flesh colour. Ejumula is deep orange flesh coloured while Kakamega is orange flesh coloured (Mwanga *et al*., 2004). Arivumaku was ranked last (7) followed by 4-4, suggesting that these varieties' flesh colour were least appealing. However, during the second season, 4-4 and Sowola 6 ranked first and second, respectively while Kala and Kakamega were ranked last (6) and second last (5), respectively. This suggests that 4-4 had the most preferred root flesh appearance during the second season followed by Sowola 6 while Kala had the least followed by Kakamega. It is not clear as to what is responsible for changes in flesh colour appearance over the two seasons. However, differences in weather conditions and soil physical properties could have contributed to this. Also the variation of views of different farmers who participated in the assessments in the first and second seasons respectively.

Culinary characteristics. There was inconsistency in the rating of post harvest attributes of the sweetpotato varieties by children. Cooked root appearance of variety Kakamega was ranked first by children followed by Sowola 6, while Sudan ranked last. The differences in preference for different appearances for cooked sweetpotato has been observed elsewhere in Uganda (Odongo *et al.*, 2002; Mwanga *et al*., 2004). Children ranked varieties Sowola 6 and Kala as first and second respectively in taste and flavour while Sudan and Ejumula were ranked last. Ejumula ranked last for children suggesting that it tasted poorly for them. This finding is in disagreement with what has been observed in other studies (Odongo *et al*., 2002; Mwanga *et al.*, 2004) where children reportedly showed strong preference for the taste of variety Ejumula. Ssebuliba *et al*. (2001) reported that the smell of sweetpotato variety Tanzania was considered desirable by some farmers and undesirable by others. According to children, Kala and Sowola 6 ranked first and second in starch content, respectively, while variety 4-4 ranked last. In the study locations, farmers understood starchiness to refer to how 'floury' the cooked root appears. The flourier, the more acceptable is the variety. Ejumula is reported to have higher dry matter content (>35%) compared to Kala (32%) and the rest of the test varieties (Mwanga *et al*., 2004). In some studies attractive colour is key in selecting the variety by children (Odongo*et al*., 2002).

Generally, there was consistency in the rating of consumer acceptance of cooked roots by adults. Variety Ejumula was ranked first by adults in terms of cooked root appearance, flavour, starchiness and taste followed by

Table 3. Assessment of yield components by farmers in Eastern Uganda.

Variety	Overall ranks by farmers (N= 96)				
	Maturity earliness	Root shape	Root size	Colour of root flesh	Overall performance
			Season 2 (2002-2003)		
Arivumaku	7	7	7	7	7
4-4	6	6	6	6	6
Sudan	5	5	5	5	5
Kakamega	3	2	2	2	2
Ejumula	1	1	1	1	1
Kala	2	3	3	3	3
Sowola 6	4	4	4	4	4
			Season 2 (2003-2004)		
4-4	1	1	2	1	1
Sudan	3	2	3	4	2
Kakamega	2	4	4	5	4
Ejumula	5	5	5	3	5
Kala	4	3	1	6	3
Sowola 6	6	6	6	2	6

*1 = Best, 6 and 7 = worst/poorest.

Table 4. Consumer acceptance of cooked roots by children and adults in Eastern Uganda.

Variety	Cooked root appearance	Flavour	Starchiness	Taste	Overall acceptability
			Children		
4-4	4	4	6	3	4
Sudan	6	6	5	5	6
Kakamega	1	3	4	4	3
Ejumula	5	5	3	6	5
Kala	3	2	1	2	2
Sowola 6	2	1	2	1	1
			Adults		
4-4	6	6	6	6	6
Sudan	2	2	2	2	2
Kakamega	4	3	3	3	3
Ejumula	1	1	1	1	1
Kala	5	4	4	5	5
Sowola 6	3	5	5	4	4

1 = most preferred; 6 = least preferred.

Sudan while variety 4-4 and Kala were ranked last and second last, respectively. However, adults and children were in agreement that 4-4 is the least starchy variety. Thus, on post harvest attributes, children and adults differed in their rating of the sweetpotato varieties. Other authors (Mwanga and Mateeka, 1994; Ocitti p'Obwoya and Namakula, 1997) have reported differences in taste and preferences between adults and children.

Conclusion

Farmer-participatory evaluation of orange-fleshed sweetpotato varieties identified Ejumula as the best variety in the study areas, in terms of both field and at post harvest attributes. SPK004 (Kakamega) was equally rated highly by farmers in the study areas. Data analysis revealed inconsistencies in the field performance attributes over the two seasons. In the case of post harvest attributes, children and adults preferences differed. Children rated Sowola 6, Kala and Kakamega highly while adults instead rated Sudan, Ejumula, and Kakamega highly. Overall, post harvest preference was in the order Kakamega> Ejumula> Sowola 6> Sudan> Kala> 4-4. The results indicate that OFSP varieties are acceptable to communities and would probably offer great potential as an inexpensive way for improvement of vitamin A nutrition in North-eastern Uganda and other neighbouring areas where sweetpotato is an important crop and share agro-ecological conditions.

Acknowledgement

The authors extend their gratitude to the International Potato Center (CIP) for the financial support towards this research, National Agricultural Research Organisation (NARO) and Soroti Catholic Diocese Development Organisation (SOCADIDO) for their collaboration, and to the farmers for participating in the trials.

References

Aritua, V., Adipala, E., Carey, E.E. & Gibson, R.W. 1998. The incidence of sweetpotato virus disease and viruses of sweetpotato grown in Uganda. Ann. Appl. Biol. **132,** 399-411.

Bashaasha, B., Mwanga, R.O.M., Ocitti p'Obwoya, C. & Ewell, P.T. 1995. Sweetpotato in the farming and food systems of Uganda: A Farm Survey Report. International Potato Center (CIP), and National Agricultural Research Organisation (NARO), Kampala, Uganda. pp. 29-40.

Chakravarty, I. 2000. Food-based strategies to control vitamin A deficiency. Food and Nutrition Bulletin **21,**135-143.

CIP (International Potato Centre). 2001. The VITAA Project. http://www.cipotato.org/Market/VITAA/vitaproj.htm.

Coe, R. 2001. www.personal.rdg.ac.uk/~snsstern/ICRAF/Data AnalysisFAO (Food and Agricultural Organisation), 2001. Bulletin and Statistics 2, 49.

Food and Nutrition Board. 1980. Recommended daily allowances. National Academy of Sciences, National Research Council, Washington, D.C

Kapinga, R., Lemaga B., Ewell, P., Zhang, D., Tumwegamire, S., Agili, S. & Nsumba, J. 2003. Increased promotion and utilization of orange-fleshed sweetpotato as part of the food based approaches to combat vitamin A deficiency in sub-Saharan Africa. FoodAfrica, 5-9 May, 2003, Cameroon.

Legg, J., Sseruwagi, P.& Aritua, V. 1998. Sustainable integrated management of Whiteflies as pests and vectors of plant viruses in the tropics. Phase 1 Sub-Project 4-Whiteflies as vectors of viruses in cassava and sweetpotatoes in Africa.Progress Report. DANIDA. 60pp

Low, J., Kinyae, P., Gichuki, S., Oyunga, M.A., Hagenimana, V. & Kabira, J.N.1997. Combating vitamin A deficiency

through the use of sweetpotato. International Potato Centre (CIP), Lima, Peru. 110pp.

Low, J., Walker, T. & Hijmans, R. 2001. The potential impact of orange-fleshed sweetpotatoes on vitamin A intake in sub-Saharan Africa. In: Proceedings of The VITAA Project, vitamin A and orange-fleshed sweetpotatoes in sub-Saharan Africa. 9-11 May, 2001, Nairobi, Kenya.Ministry of Health Report, 1998.

Mugisha, O.R. 2002. Uganda Districts Information Handbook. Fifth Edition.Fountain Publishers Ltd. Kampala, Uganda.

Mwanga, R.O.M. & Mateeka, B. 1994. Sweetpotato germplasm evaluation and utilization in Uganda. In: Proceedings of the 5th ISTRC-AB Symposium. pp.122-124.

Mwanga, R.O.M., Niringiye, C., Odongo, B., Opio, A.F., Lemaga, B., Kyadondo, B., Serunjogi, L., Owori, C.& Kapinga, R. 2003. Partnership: An approach to promote orange-fleshed sweetpotato, experiences from Uganda. In: Tropical Root and Tuber Crops: Opportunities for Poverty Alleviation and Sustainable Livelihoods in the Developing World. Proceedings of the Thirteenth Symposium of the International Society for Tropical Root Crops (ISTRC), 10-14 November, 2003. AICC Arusha, Tanzania.

Mwanga, R.O.M., Turyamureeba, G., Alajo, A., Kigozi, B., Carey, E.E., Niringiye, C., Kapinga, R., Makumbi, R., Zhang, D., Tumwegamire, S., Lugwana, E., Namakula, J.,Abidin, P.E., Lemaga, B., Nsumba, J. & Odongo, B. 2004. Submission to the variety release committee for the release of sweetpotato varieties. National Agricultural Research Organisation (NARO).

Ocitti p'Obwoya, C.N. & Namakula, J. 1997. Sweetpotato on-farm evaluation and selection with farmer participation: The case of Luwero District in Uganda. In: Proceedings of the 4th Triennial Congress of the African Potato Association, Pretoria, South Africa. pp. 102-106.

Odongo, B., Mwanga, R.O.M., Opio, F., Niringiye, C., Owori, C., Kapinga, R., Sserunjogi, L., Gita, F., Kyadondo, B., Lugwana, E., Kigozi, C., Namakula, J. & Nanteza, J. 2002. Evaluating selected orange-fleshed sweetpotato varieties for environment adaptation, biotic stress and farmer acceptability in Luwero, Uganda. In: Integrated Pest Management Conference Proceedings, 8-12 September, 2002, Kampala, Uganda. pp. 200-207.

Olson, J.A. 1989. Biological action of carotenoid introduction. Journal of Nutrition **119,** 94-95.

Purseglove, J.W. 1968. Convolvulaceae. In: Tropical Crops, Dicotyledons. Harlow: Longman. pp. 78-88.

Ssebuliba, J.M., Nsubuga, E.N.B. & Muyonga, J.H. 2001.Potential of orange and yellow-fleshed sweetpotato cultivars for improving vitamin A nutrition in central Uganda. African Crop Science Journal **9(1),** 309-316.

Underwood, B.A. 2000. Dietary approaches to the control of vitamin A deficiency: An introduction and overview. Food and Nutrition Bulletin **21,** 117-123.

UCC (Uganda Communications Commission). 2003. Soroti District: Background Information. http://www.soroti.go.ug/index.htm

Wanda, C., Ed Sulzberger., Carman, D., Lilia, S. & Stares, J. 2001. Using sweetpotato to address vitamin A deficiency. In: The VITAA Partnership Newsletter, Number 1, November, 2001. pp.1-4.

Wanjekeche, E., Lusweti, C., Hagenimana, V., Wakasa, V., Misto, E. & Lopel, I. 2000. Performance and acceptability of orange sweetpotato varieties in the marginal areas of West Pokot District, Kenya. In: Adipala, E., Nampala, P. & Osiru, M. (eds.). African Potato Association Conference Proceedings **5,** 143-147.

van Jaarsveld, P.J., Faber, W.M., Tamumihardjo, S.A., Lombard, C.J., Spinnel Benade, A.J. 2003. The efficacy of orange-fleshed sweet potato to improve vitamin A status of children 5-10 years of age. Final report to the micronutirent initiative. Grant agreement No. 10-0020-1-1, CIP/NIRU. 34pp.