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Evaluation of Sweetpotato (*Ipomoea batatas* (L.) Lam.) Germplasm from North-eastern Uganda through a Farmer Participatory Approach

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Abstract

Ugandan farmers grow many landrace sweetpotato varieties, but some of these are relatively low yielding and susceptible to pests. The objective of the present research was to involve farmers in a large-scale assessment of Ugandan farmers' varieties to rapidly identify those with superior yield performance, pest resistance and consumer acceptance. One hundred sixty distinct farmers' varieties collected from Lira, Soroti, Katakwi, Kumi and Pallisa Districts of North-eastern Uganda were evaluated in on-station trials. Trials were conducted at two sites (Serere Agricultural and Animal Research Institute and Arapai Agricultural College) in Soroti District in the second rainy season of 1999. Twenty-five farmers from surrounding areas participated in trial harvest at each site. At harvest, fresh storage root yield, foliage yield, and dry matter content were determined by researchers. Farmers observed a number of characteristics and rated each entry with respect to the following variables: general impression, dry matter content, pests, and defects. A strong positive correlation was observed between farmers' general impression and yield and harvest index in the trials. Farmers selected 10 superior varieties from each trial for further multi-environment, on-station and on-farm trials. Coincidentally, nine of the selected varieties were common to both sites.

INTRODUCTION

Sweetpotato is a major crop in Uganda, where per capita production is around 100 kg per year (http://www.fao.org). It is important for food security, and increasingly, as a cash crop (Scott et al., 1999). Ugandan sweetpotato farmers grow a large number of farmers' varieties[1], mostly in low input agricultural systems. Many of these varieties have been reported to be relatively low yielding, narrowly adapted, and susceptible to diseases and pests (Bashaasha et al., 1995). However, the expression of these negative characteristics may depend on the Agroecological zone (AEZ) where the crop is grown. A sweetpotato variety can be well adapted to one of the AEZs, but not to another, since zones differ in climate, and occurrence of diseases, pests and other constraints. For example, viral incidence, which is serious in some parts of Uganda, is not a serious problem in North-eastern Uganda (Carey et al., 1996; Aritua et al., 1998; Abidin et al., forthcoming (a)).

The Ugandan national sweetpotato breeding program, based at Namulonge in Mpigi District, is working to develop improved cultivars, and has released selected

[1] In this paper we refer to the "landrace" sweetpotato cultivars grown by Ugandan farmers, as farmers' varieties.

farmers' varieties and bred cultivars, following a program of multilocational and on-farm testing. (Mwanga et al., 2001; NARO & CIP, 2000). However, some of the newly released bred cultivars including Sowola, NASPOT 2 and NASPOT 5 have yielded poorly and proven susceptible to drought, soil pests and viral diseases in recent trials in Mbarara, Mpigi and Soroti districts. In Soroti District, farmers have abandoned these cultivars (Abidin et al., in preparation). So far, it appears that institutional breeding efforts have not resulted in clearly superior varieties that are readily adopted by farmers who continue to depend on local varieties.

During the process of germplasm collection in north-eastern Uganda, it was noted that farmers had a good knowledge of the characteristics of some varieties (Abidin and Carey, 2001; Abidin et al., forthcoming (a)). This indigenous knowledge could assist to identify promising sweetpotato varieties in the farmers' fields. The farmer-assisted approach is likely to be useful for breeders to rapidly identify promising local germplasm with potential for widespread adoption within and among AEZs. Farmer participation in sweetpotato breeding efforts has led to the rapid selection and dissemination of new varieties elsewhere in eastern Africa (Anshebo et al*.*, 2000; Kapinga et al., 2000; Ndolo et al., 2001).

This paper describes farmer participation in the preliminary assessment of a large collection of sweetpotato farmers' varieties from north-eastern Uganda. Farmers evaluated and selected sweetpotato varieties from replicated trials at two sites for further testing. Farmer participation was intended to improve the understanding of farmers' preferences of varietal characteristics. This work is part of a larger effort to rapidly collect and evaluate sweetpotato germplasm from north-eastern Uganda using farmer participatory and conventional approaches. The overall objective of this larger effort is to improve the efficiency of breeding efforts to serve sweetpotato farmers in low input agricultural systems.

MATERIALS AND METHODS

Site Characteristics

One hundred and sixty distinct Ugandan farmers' varieties were planted at Serere Agricultural and Animal Research Institute (SAARI) and Arapai Agricultural College (AAC) on 11th and 14thOctober 1999, respectively. Both sites are in Soroti District, and have sandy loam soils, but their AEZs may be somewhat different. According to Bashaasha et al. (1995) both are in the Short Grassland AEZ, while Wortmann and Eledu (1999) classify Arapai as Northern-Central Farm-Bushland, and Serere as Northern Moist Farmlands. Both sites had poor soil fertility. At Arapai, the land was intensively used for growing food crops, with cassava grown immediately prior to the trials there. At Serere, the experimental field was fallow for 5 to 6 years prior to the trial. The low soil fertility condition of the trials was similar to what farmers experience in their fields in general. Average rainfall at both sites during the growing season was very low (65.5 mm/month). With this precipitation most storage roots did not develop to their full capacity. The monthly average of maximum air temperature was 31.3 °C and minimum temperature 18.4 °C.

Crop Cultivation

Ten cuttings of each variety were planted in a row with a between-row distance of 100 cm and a between-plant distance within the row of 30 cm. A randomized complete block (RCB) design with 3 replicates was used. No fertilizers or pesticides were applied. Cuttings were planted at the end of the second rainy season (mid October 1999). Establishment and growth of plants at both sites were good; no gap filling was required. At Serere, rainfall was just enough to support the initial development of the crop. At Arapai, almost no rainfall occurred in November, December and January. Therefore, overhead sprinkler irrigation was applied daily during two parts of the cropping season; the first being from 1st to 15thDecember 1999, and the second from 6th to 9thJanuary 2000.

Harvest was done 4 months after planting (mid February 2000) during the dry season.

Measurements

At harvest, disease incidence (e.g. viruses and *Alternaria* spp.), data on fresh storage root weight, fresh foliage weight, and dry matter content of storage roots were collected by researchers. For dry matter determination, medial sections of roots from each plot were chopped and a sample of about 200 g was dried at 60 °C for 72 h or until constant weight.

Groups of twenty-five farmers from nearby communities, who planned to participate in subsequent on-farm trials, participated in the harvest and evaluation of trials at each site. Names of varieties were not given to farmers to avoid bias based on name recognition. Farmers evaluated the general performance of sweetpotato varieties, dry matter content, pest damage, and defects using 5-point rating scales as follows:

- For general impression and dry matter content, 1 was very poor general impression or very low dry matter content, 2 was poor or low, 3 was fair or medium, 4 was good or high and 5 was excellent general evaluation or very high dry matter content.
- For pests and defects, 1 was for more than 75% of storage roots damaged, 2 was between 51-75% damaged, 3 was 26-50%, 4 was between 1-25% and 5 was for 0% damaged or defects.

Farmers assessed root dry matter content by hefting storage roots, scratching the skin, biting the root and tasting the flesh, and by observing the amount of latex produced after slicing the storage roots with a knife. Farmers considered the following characteristics to be indicative of high dry matter content: 1) The storage root should be heavy; 2) The storage root is hard when it is bitten; 3) The skin is hard when it is peeled or scratched; 4) A relative sweet taste of the flesh; and 5) Little latex produced in the flesh. Root dry matter content was then rated using the scale described above. Farmers evaluated each plot in two replications of both trials and the researchers recorded the information obtained from them.

Farmers were asked to make evaluations and selections based on their knowledge of the crop, and taking into consideration the needs of Ugandan sweetpotato breeding, i.e. to produce improved varieties with high dry matter content. At each site, farmers used a 2-stage selection process to arrive at a final selection of 10 varieties for further testing.

Data Processing

Data collected by researchers, and ratings done by farmers were analysed statistically with a focus on the variables yield, harvest index (HI), dry matter content (DM), pest infestation, occurrence of defects and general impression. Harvest index was calculated by dividing the fresh storage root weight by fresh foliar weight plus fresh storage root weight. The analysis of variance of these variables including the graphics for the boxplots was computed using Genstat (1997). First, averages were calculated over replicates for Serere and Arapai for yield, HI, DM, and medians were calculated for the farmers' assessments. T-tests between selected varieties versus non-selected ones for yield, DM and HI were done. For the farmer evaluations of general impression, dry matter content, pests and defects, the Mannwhitney was used. Correlations between ratings done by farmers and data taken by researchers were determined by the Spearman rank correlations. Correlation coefficients > 0.50 were considered to be high.

RESULTS AND DISCUSSION

Comparison between Non-Selected and Selected Varieties

At Serere 43 varieties were initially selected, and at Arapai, 45 varieties were originally selected. Following further discussion farmers selected 10 varieties per site for further multi-locational on-station and on-farm trials. Nine varieties were common to both trial sites, resulting in a total of 11 varieties. Comparisons of mean yields, harvest index and dry matter content of selected and non-selected varieties at Serere and Arapai are shown in Table 1. The selected varieties were significantly different from the non-selected ones with respect to yield and harvest index at both sites. Dry matter content of selected varieties was significantly higher at Arapai, but not at Serere.

Median values for variables rated by farmers in the trials at Serere and Arapai are given in Table 2. There were highly significant differences between selected and non-selected varieties for general impression, while there were significant differences for dry matter assessment at both sites. No differences were detected for evaluations of pests and defects.

Comparison between Researchers' and Farmers' Assessments

There was a high correlation between general impression as observed by farmers and yield as determined by researchers (r = 0.84). This indicates that yield was one of the most important variables considered by farmers in the process of evaluation and selection. Figure 1 presents boxplots of farmers' general impression of varieties at Serere versus yield. A similar spread of yield values can be seen for each of the levels of general impression (except the lowest level, where the spread is smaller), and a straight line can be drawn through a set of observations: the smallest observation, the first quartile, the median, the third quartile and the largest observation. A high correlation also appeared between general impression and harvest index (r = 0.62), indicating the importance of foliage characteristics in farmer assessment.

There was only a small correlation between dry matter content determined by researchers and rating of dry matter content done by farmers (r = 0.21). While dry matter content was among the important factors for farmers and the breeding program in Uganda, the varieties tested mostly had high dry matter content, and there was relatively low variation for this variable among the varieties evaluated. In north-eastern Uganda, there may have been particularly strong selection for high dry matter by farmers, due to their traditional way of utilizing the sweetpotato for amukeke (dried root slices).

From the comparison of the means and the observations on the correlations, it can be concluded that farmers are able to evaluate and to select the best varieties. Farmers' rating of general impression of the varieties, in particular, was significantly and highly correlated with the determination by the researchers of the yield and harvest index.

Farmer Participation and Selection Criteria

Results obtained from the case study during sweetpotato germplasm collection in north-eastern Uganda showed that the farmers have adequate knowledge of the varieties (Abidin et al., forthcoming). So, in this case, it was quite easy to involve farmers in a large-scale assessment to identify superior varieties. It would be advisable to do some preliminary surveys to assess on the indigenous knowledge and level of interest before involving farmers in the evaluation of crop varieties.

During farmer assessment and selection of varieties, researchers noted criteria used by farmers. Farmers took several factors into consideration when assessing the varieties. These criteria may be separated into three categories. The first category included the numbers and size of the storage roots, the taste, the number of secondary stems and the shape of leaves. Farmers paid particular attention to these characteristics. The second category included the skin and flesh colour and the third category included weevil damage, and defects. Farmers have a preference for varieties with numerous and large roots, which tend to have large yields. Also they prefer varieties with few secondary stems, knowing that these have larger harvest indices. Those varieties identified by farmers to have good culinary quality were found to have high dry matter content.

The market situation demanding white skin and yellow flesh of storage roots influenced the choice of farmers. Dry matter content, pests and defects were important because of the tradition of farmers in the region to make amukeke.

Twenty-five farmers proved to be too many to discuss efficiently cultivar performance and we therefore recommend that the number of farmers be no more than twenty during assessments. Also in order to speed assessment, a limited number of parameters should be used. In our experience, general impression provided for a combined assessment of a number of attributes.

Implication for Breeding

Yields of storage roots, and foliage (related to harvest index) were low in our trials, due to harsh environmental conditions, particularly rainfall and soil fertility. These poor conditions inhibited the development of the crop and above all, increased weevil (C*ylas* spp.) infestation at the time of harvest. In the interviews done during the process of germplasm collection farmers noted that Soroti District had a very high weevil infestation (Abidin et al., forthcoming (a)). Nevertheless, none of the 160 sweetpotato varieties showed any disease symptoms, not even rots caused by secondary pathogens. This observation confirms the information given by farmers during the germplasm collection in north-eastern Uganda in 1999 (Abidin et al., forthcoming (a)), and previous observations reported by Carey et al. (1996), Smit (1997), and Aritua et al. (1998)

Both Arapai and Serere are situated in marginal environments: low soil fertility and precipitation of rainfall with relatively high air temperatures. In spite of that, some germplasm in the assessment showed excellent performance. While mean yields were lower at Arapai than at Serere, 84 varieties yielded at least 10.5 t/ha or more at the Serere site. Also the striking coincidence between varieties selected at Serere and Arapai, may give cause for optimistic expectations of future performance of these varieties under a range of low-input agricultural environments in Uganda.

It appears that local germplasm from north-eastern Uganda has the potential for contributing considerably to sweetpotato breeding by providing new varieties for selection. It will be important to assess how broadly adapted these varieties will be. The answer to this question may be influenced by viral disease incidence in the target areas, and the reaction of varieties from north-eastern Uganda to sweetpotato virus disease (SPVD). So far, persistent viral disease problems have not been reported in north-eastern Uganda (Carey et al., 1996; Smit, 1997, Abidin et al., forthcoming (a)), and it is probably safe to say that most of the varieties arising in north-eastern Uganda are not particularly resistant to SPVD. SPDV pressure is high in the higher rainfall Tall Grassland AEZ areas of Lake Victoria Zone of Uganda. However, there may be similar AEZs to north-eastern Uganda, such as the Lake Victoria Zone of Tanzania, where selected varieties from north-eastern Uganda may have a chance of performing well.

CONCLUSIONS

Farmers' participation assisted in the rapid identification of varieties for further testing over a range of sites, both on-station and on-farm. The involvement of farmers in the evaluation is quite new to the Ugandan crop improvement scene, except for the evaluation of Osukut or Tanzania, which has already attained importance in the short grassland Agroecological Zone (AEZ). The farmer participatory method in sweetpotato varietal selection should be promoted.

Eleven varieties were promoted for further in-depth study of yield stability, diseases and pests resistance and consumer acceptance. These varieties are adapted to the low input agricultural systems.

Farmer participation appears to be contributing to improving the efficiency and effectiveness of sweetpotato variety selection effort in Uganda.

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Tables

Table 1. Mean fresh storage root yields, harvest indices (HI), and dry matter contents (DM) of selected and non-selected sweetpotato farmers' varieties at Serere and Arapai, Uganda.

	Serere			Arapai		
	Yield(t/ha)	HI (%)	DM (%)	Yield(t/ha)	HI (%)	DM (%)
Non Selected (n = 149)	9.7	51	37.7	3.0	40	37.9
Selected (n = 11)	14.1	65	37.8	4.3	57	39.5
Probability	< 0.001	< 0.001	0.467	0.004	< 0.001	< 0.01

Table 2. Median scores of farmer assessments of varieties in trials at Serere and Arapai, Uganda. Farmers rated varieties for the following variables: General impression (GenImp), dry matter content (DM), pests and defects.

	Serere				Arapai			
	GenImp	DM	Pests	Defects	GenImp	DM	Pests	Defects
				(1-5)				
Non-Selected (n=149)	3.0	3.00	3.5	4.00	2.5	3.0	4.0	4.0
Selected (n=11)	4.5	4.00	3.5	3.5	4.5	4.0	4.0	4.0
P	< 0.001	0.011	ns	ns	<0.001	0.059	ns	ns

Figures

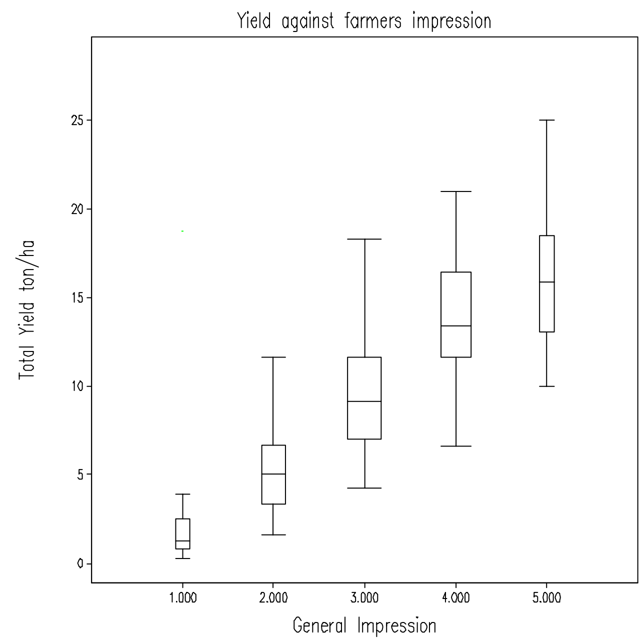

Fig. 1. Boxplots of farmers' general impression versus yields for sweetpotato farmers' varieties assessed at Serere, Uganda**.**