CROP PROTECTION PROGRAMME

Working with farmers to control sweet potato virus disease in East Africa

R8243 (ZA0545)

FINAL TECHNICAL REPORT

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Executive Summary

A very brief summary of the purpose of the project, the research activities, the outputs of the project, and the contribution of the project towards DFID's development goals. (Up to 500 words).

The project has used participatory varietal selection trials as a tool to test a range of varieties with farmer groups in Uganda and Tanzania. Resistance to sweet potato virus disease (SPVD) previously identified in varieties bred in Uganda remained effective in all locations. Farmers were very keen to obtain the range of varieties tested and, rather than selecting a few, wished to retain all varieties to test over a longer period in their own gardens. This was consistent with varieties apparently differed in relative performance in different locations, from season to season and in satisfying different requirements. For long-term retention, drought resistance seems to be a key factor. Several of the Ugandan varieties performed very well in Kagera Region, Tanzania, and an important achievement of the project seems to be the improved links between Ugandan and Tanzanian scientists based in Namulonge and Maruku research institutes respectively. Despite the effectiveness of resistance to SPVD, several high-yielding and popular landraces and orange-fleshed, high vitamin A varieties are only moderately SPVD-resistant. For these, the project has identified roguing as an additional and effective control practice that is easy for farmers to adopt. Isolation of new crops was, by contrast, difficult for farmers to use. Posters, brochures, training notes and protocols for training have been developed by both the Ugandan and Tanzanian teams, sharing materials where possible. Material is available in local languages. These training materials have also been reproduced and disseminated. Unlike in Uganda, resistant varieties were not widely available in Tanzania and the project has collaborated with other organisations to ensure their rapid multiplication and dissemination. Collaboration with other organisations has also been key to extensive training of both farmers and extensionists there. Participatory on-farm breeding has also been done in both Uganda and Tanzania. Biotic [SPVD and Alternaria] and abiotic [drought and infertile soil] factors interacted with farmers' [mainly concerned with storage root characteristics] and breeders' [mainly concerned with storage root characteristics and disease resistance] selection criteria in determining which plants were retained. A few clones have been identified which appear to be higher yielding than the farmers available landraces yet resistant to SPVD and Alternaria: farmers are keen to continue the participatory breeding process.

Background

Sweet potato is amongst the most important food staples grown in sub-Saharan Africa. The crop is particularly important in East Africa. Uganda has the largest production in Africa and Tanzania has only a slightly smaller area under sweet potato, though with a relatively low productivity. With good husbandry, sweet potato is amongst the most productive crops but it can also yield on relatively poor soils. It requires few inputs except labour and its ability to yield rapidly and over a long cropping season if piecemeal harvested provides the flexibility both for it to fit in a range of cropping systems and to yield even with irregular rainfall patterns. Consequently, it is an important daily food for many farmers and their families in Africa, particularly resource-poor farmers growing their food on a restricted area of marginal land. It is also important in disaster relief when other crops fail, for example, when the pandemic of cassava mosaic disease destroyed crops of cassava. Sweet potato is also a cheap food for the urban poor in the growing conurbations of Africa, it is also purchased by the growing middle class in supermarkets. By 2020, it is predicted that root crops will have an even more important role in food production in Africa than now and become integrated into a more diverse range of food products (Scott et al., 2000).

Plate 1. The orange-fleshed sweet potato landrace Ejumela; high in pro-vitamin A

Poverty in communities is almost always compounded by and maintained by poor nutrition. Both the starchy storage roots and the green leafy foliage of sweet potato are consumed, contributing considerably to a balanced diet. It is also a tasty staple, particularly appreciated by children for its sweetness. The crop is grown predominantly by women farmers. The main growers of sweet potato in Uganda and Tanzania are middle-aged women with families and with little or no formal education. It is usually grown mostly for family consumption but also for cash (Bashaasha et al., 1995; Kapinga et al., 1995; Scott et al., 1999 and confirmed in survey data analysed by project R7492). The International Potato Center (CIP) is deploying high β-carotene, high dry matter content varieties from South America to Africa (see CIP Vitamin A for Africa (VITA A) website) as a means of combating widespread vitamin A deficiencies amongst poor people in Africa, particularly women, young children and HIV AIDS-affected people. CIP estimates that replacing white-fleshed with orange-fleshed varieties could alleviate vitamin A deficiencies in 50,000,0000 children in Africa under the age of six, not to mention the impact on older children and adults, particularly pregnant women and lactating mothers. Vitamin A is particularly important in child development fighting off common childhood diseases and, in the extreme, preventing blindness. It may also ameliorate malaria and delay the development of HIV AIDS. Unfortunately, there are few orange-fleshed local varieties of sweet potato and the exotic varieties that are being introduced commonly succumb to SPVD and other ailments.

Plate 2. The two plants in the foreground are cuttings affected by SPVD

Sweet potato virus disease (SPVD) is the most important disease of sweet potato in Africa (Geddes, 1990; Lenné, 1991) and perhaps worldwide (Carey et al., 1999). Affected plants have no worthwhile yield. The disease is particularly common in western and southern Uganda and the western Lake Zone of Tanzania, where the project is focused. Here, crops with 50% or more affected plants are commonly encountered and average incidences exceed 30%, leading to chronically poor yields and devastating losses to some individuals. Symptoms of SPVD include severe stunting of the plant, negligible production of storage roots and small malformed leaves, often with either a chlorotic mottle or vein clearing. SPVD results from the dual infection of sweet potato by the aphid-borne potyvirus *Sweet potato feathery mottle virus* (SPFMV) and the whitefly-borne crinivirus *Sweet potato chlorotic stunt virus* (SPCSV)(Gibson et al., 1998). SPFMV by itself is generally symptomless in sweet potato in Africa and infection with SPCSV synergises the multiplication of SPFMV: the symptoms of SPVD are more typical of a potyvirus than a crinivirus. Although SPCSV can be transmitted by whitefly species belonging to both *Bemisia* and *Trialeurodes* genera, the main species of whitefly colonising sweet potato in Africa is *B. tabaci* and this is the main vector. SPFMV is transmitted in the non-persistent manner by a wide range of aphid species. Although aphids are rarely found colonising sweet potato crops in East Africa, it is assumed that itinerant alates are responsible for spreading the disease. Both viruses become systemic in infected plants and both are thereby perpetuated through cuttings. It is, however, infection by SPCSV that limits the development of SPVD: SPFMV is either latent in many plants or spread rapidly to SPCSV-infected plants by itinerant alate aphids. Although SPCSV by itself does cause symptoms in sweet potato, such symptoms are generally transient in the field because SPVD quickly develops. The regional prevalence of SPVD is therefore closely related to the abundance of SPCSV's whitefly vector, *B. tabaci* (Aritua et al., 1998; 1999) and control of SPVD essentially involves controlling the spread of SPCSV.

SPVD has long been affecting sweet potato crops in East Africa (Hansford, 1944). SPVD is particularly damaging in southern and western Uganda including Masaka and Rakai Districts (Aritua et al, 1998) and also in Tanzania, particularly near Bukoba in the north-western Kagera Region (R6617; Gibson et al., 1999). Farmers in Uganda and Tanzania perceive that most SPVD-resistant local landraces are relatively low-yielding and late-maturing (these perceptions have been confirmed in field trials). Despite this experience, they also identified that resistance is their preferred means of combating SPVD. When given access to high-yielding SPVD-resistant sweet potato varieties (e.g., through involvement with on-farm trials or the CPP-funded BUCADEF distribution scheme), they enthusiastically adopted these varieties and increased sweet potato production. CIP (1995) confirmed that host plant resistance is the most appropriate strategy for controlling SPVD in the long term.

In Uganda, the National Agricultural Research Organisation (NARO) gives high priority to developing resistant varieties (Mwanga & Sengooba, 1996) and has recently released 12 varieties, all of which combine superior yields and resistance. Work funded by R7492 showed that some of these varieties were high-yielding and SPVD-resistant in Masaka and Rakai districts. The variety NASPOT 1 was particularly preferred and yielded twice the marketable yield of the best local cultivars in on-farm trials. Although farmers were continuing to grow most of the varieties they had been given access to, only NASPOT 1 was preferred above local cultivars in a variety ranking exercise, largely because of its massive early yield. The epidemic of cassava mosaic disease in Kagera District has resulted in the Tanzanian Department of Research and Development also giving high priority to controlling virus diseases of root crops including SPVD in sweet potato in the Lake Zone for the last several years. However, on-farm trials have shown that these varieties are not high-yielding in all agroecologies in Uganda and Tanzania (for example, Kanungu District) where sweet potato is important. Farmers there have requested better varieties but a variety ranking exercise identified several characteristics including various storage root quality characteristics and continuous storage root production for piecemeal harvesting, which would seem difficult to assess accurately on station. Control of SPVD is also a prerequisite for the success of the VITA A project as exotic sweet potato clones introduced from S. America (where the disease has been rare till recently) are almost invariably very susceptible to SPVD. There is therefore a demand a) for measures to control SPVD in superior local varieties and b) for new varieties adapted to local conditions and local needs. SPVD is not the only constraint facing sweet potato producers and several of the released varieties including NASPOT 1 were much more susceptible to Alternaria disease than the local cultivars NASPOT 1 and several other NAARI varieties also seemed particularly susceptible to weevils.

Most spread of SPVD is local, rates of spread of SPVD into unaffected newly-planted crops being determined by the amount and proximity of old crops within a radius of about 100m as well as the numbers of whiteflies (R6617; Aritua et al., 1999). SPCSV is transmitted by *B. tabaci* in the semi-persistent manner (Larsen et al., 1991) and this, together with the tendency of *B. tabaci* for short-distance flights (Byrne et al., 1996), would appear to account for this result. Whatever the explanation, the result presented the possibility that individual farmers could also beneficially use local phytosanitation to control SPVD and so be able to continue to grow their best high-yielding local landraces despite some susceptibility to SPVD. Work done under R7492 has confirmed this. On-station and on-farm trials showed that most spread in a field occurs within a few metres of an infection source and roguing out diseased cuttings within one month of planting halved ($P<0.001$) the spread of SPVD, even though unrogued control plots were next to the rogued plots. An EU-funded project (ICA4-CT-2000-30007) has also shown how neighbouring unaffected plants can compensate for either the presence of a diseased plant or the removal of a diseased plant. Small amounts of isolation also had dramatic effects; plots planted just 15m away from a diseased plot had between a third and a quarter the number of SPVD-affected plants than plots adjacent to the diseased plot ($P<0.001$). However, although some farmers realised that SPVD is caused by a “germ”, none realised that SPVD is a disease spread by whiteflies and many thought it is caused by abiotic factors such as drought (interviews done in Uganda and Kenya). Consequently, farmers interviewed had never considered isolation as a control strategy, although most did select their planting material from disease-free parents and some rogued out diseased plants (because they would never yield anything anyway). In several areas of East Africa including Masaka, Rakai and Kagera, farmers often maintain plots of planting material through the dry season under the shade of bananas.

Based on these results, the following provisional guidelines for controlling SPVD have been drawn up:

- Collect cuttings for new crops from healthy plants.
- Select cuttings from healthy plants in crops in which few other plants have the disease and avoid collecting cuttings from very old crops because sweet potato virus disease is less easy to see in these than in vigorously-growing crops.
- If possible, choose a variety or local cultivar that isn’t much affected by the disease.
- Plant new crops away from old crops.
- Avoid planting new crops where sweet potato was grown last season because storage roots and cuttings from old diseased plants surviving in the soil will produce diseased plants from which infection will easily spread to your new crop.
- Remove any diseased plants as soon as they appear, especially in young crops.
- Ensure trash from old harvested crops including unwanted storage roots dies.
- All these treatments will work better the larger the area where it is used so: work together with neighbours.

Essentially, these guidelines present a series of choices and, whilst best control will probably be achieved by combining all the practices, adequate control may be achieved, in conditions of only moderate rates of spread of SPVD by whiteflies, by using one or a few. Thus, careful selection of planting material, planting away from old crops and roguing out any new infections may allow a farmer successfully to grow quite susceptible cultivars. Alternatively, growing a very resistant cultivar may also free many farmers from all these restrictions. Currently, these recommendations are seen as options which may be ‘picked and mixed’ depending on a farmer’s circumstances both in terms of her/his opportunity to carry them out (e.g., presence of a suitable resistant cultivar) and disease incidence (carrying out just one recommended practice may be sufficient under only moderate disease pressure).

Only the first recommendation, selecting cuttings from healthy-looking plants, is normal farming practice in East Africa. Whilst most recommended cultural control practices have been proven to work technically, none had been tried in situations in which farmers otherwise manage the trials exactly as they would their own crops. Most of these practices do not obviously conflict with general good farm management and the phytosanitary control practices should benefit the control of other pests such as weevils and diseases such as *Alternaria*. However, several practices imply costs, the impacts of which are difficult to assess without actually testing them in a normal farming situation. A variety or local cultivar that isn't much affected by the disease may yield differently in several ways to a widely-grown but more susceptible cultivar; similarly with its marketability. Indeed, there may often be no suitable resistant cultivar available – hence the continuing problem of SPVD. Planting crops away from old crops and avoiding locations where sweet potato was recently grown involves access to new land which may be difficult, particularly for women farmers, and thorough killing of old crops involves extra labour, loss of any later gleanings and loss of planting material reserves.

Interviews suggested that varietal resistance is the farmers' control strategy "of choice", apparently requiring no change in her work other than a new variety. However, in practice this is over-simplistic as "the perfect variety" is elusive. Farmers are also all individuals with different preferences, with different priorities of use and different customers. Phytosanitation should allow farmers more choice in the cultivars they can grow. In particular, it may allow them to continue to grow a range of landraces. On-station breeding may, for logistic reasons, be centralised leading to the release of a series of varieties suitable in the main for the agroecology of the station – and sweet potato is grown in diverse ecological zones in most countries. Thus, neither the Ugandan nor the Tanzanian varieties appeared to perform better than the best local cultivars when tested on-farm by R7492 in agroecologies fairly different from that on-station. The on-station bred varieties also seemed to rank relatively poorly for characters other than resistance to SPVD and large early yield of large, high dry matter, sweet storage roots. Whilst the latter characteristics are amongst the most important to farmers, others such as drought tolerance and continuous yield were also ranked highly by farmers along with a string of other, less important characters.

We were thus in a position where:

- Virus diseases were a proven, farmer-identified constraint to production.
- Researchers had identified the main pest (weevils) and disease (SPVD) agents, understood their epidemiology and geographical prevalence.
- The effectiveness of SPVD-resistant varieties and phytosanitary practices had been confirmed in researcher-led trials.
- SPVD-resistant varieties had been disseminated where these are locally adapted.

Major outstanding issues in the control of SPVD are:

- The long-term adoption of station-bred SPVD-resistant high-yielding varieties needed to be confirmed, the attributes of successful varieties identified and decentralised breeding tested.
- Farmers needed to test and adapt phytosanitary practices to farming (agronomical, consumption etc) requirements and these needed to be integrated with other farming practices including control of other pests.
- Validated strategies needed to be disseminated using cost-effective approaches.

It is these remaining issues that the current project tackled. A farmer participatory research approach was taken to address all issues. Involvement of farmers in collaborative research with formally-trained scientists is now a widely accepted practice and CIP and the south-east Asian participatory research network UPWARD (User's Perspective with Agricultural Research and Development) have developed a system specifically for promoting the integrated crop management (ICM) of sweet potato (Fliert, van de & Braun, undated). An East African version of this manual is developed with the support of R7492. Participatory plant breeding has become a widely accepted practice but most PPB has been done with seed-propagated crops, particularly rice. Project R7565 which uses PPB to breed superior cassava mosaic virus resistant cassava started in 2000 in Ghana, represented the first work in sub-Saharan Africa using PPB for a vegetatively-propagated crop, providing a potential approach for sweet potato.

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Project Purpose

The broad aim of the project is to increase the productivity of sweet potato in East Africa by enabling farmers to grow the crop without the constraint of sweet potato virus disease or other pests and diseases. The project will enable farmers to grow moderately SPVD-susceptible but otherwise superior landraces and introduced orange-fleshed sweet potato varieties through developing, validating and documenting effective phytosanitary control measures for SPVD. It will also support the use and dissemination of recently-bred SPVD-resistant varieties and facilitate the development of new ones through a participatory breeding approach. Although effective control measures (resistant varieties, various forms of phytosanitation) have been identified over the last several years (R7492, B0111, R6115 and others), they have been validated on-farm only by researcher-led activities. The project aims now to test and develop these through scientists and farmers working together in participatory research groups so they fit within the total environment (agroecological, sociological, economic, other pests and diseases etc) within which sweet potato is currently grown by resource-poor rural families in SPVD-affected areas of Uganda and Tanzania. The project will do this work in collaboration with other organisations involved in providing research and extension services to farmers to develop and validate protocols and materials whereby these control measures can be disseminated widely.

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Research Activities

Introduction

In Uganda, the project is based at Namulonge Agricultural and Animal Production Research Institute (NAARI), alongside the Ugandan Potato Programme led by their sweet potato breeder, Dr Mwanga. The project employed Mr E Byamukama, Mr I Mpembe and Mr J Kayungu through IITA. Most field activities occurred off-station in association with farmer groups set up by field staff of the Buganda Cultural and Development Foundation (BUCADEF). BUCADEF's main geographical area of work includes most areas where SPVD is prevalent; it has a network of extension officers already in place working through a system of contact farmers and has successfully proved its capacity to deliver through CPP- and CPHP-funded projects.

The project worked in three main locations:

- In Luwero District, a) in Kabulanaka village with Tusitukire wamu Farmers Association and b) in Vumba village with Beera mwesigwa Farmers group, a group of farmers led by Mr Setyabule.
- In Kiboga District in a) Wattuba sub-county, Nakitembe village with Nakitembe Farmers Development Association and b) in Butemba sub-county, Rwebijumbula village with Ani yali amanyi farmers group.
- In Mpigi District, in a) Njeru village with the Tusitukirewamu-Njeru Group and b) Nabusanke sub-county, Kikomazi village, with the Twezimbe Farmers Group.
- In Masaka District, in Kyamulibwa sub-county with Kwekulakulanya women's group

The project team introduced themselves and the project to the villages and an initial 'situation analysis' was done. This confirmed the importance of sweet potato to the farmers, assessed knowledge of SPVD, identified the main problems and acted as a means of getting to know each other. It was explained how SPVD was spread by whiteflies, how diseased plants acted as virus sources and how the whiteflies could spread the disease only relatively short distances (Output 5). It was also explained how superior varieties could both increase yields and help control SPVD and how the different cultural control measures could help. This allowed us to solicit their help to develop better varieties (participatory breeding) and/or to validate cultural control practices. In all cases, our activities were welcomed by group members and farmers promised their support. BUCADEF extension officers in each district received training in general agronomy of sweet potato, breeding and control of SPVD at NAARI. Farmer group visits to NAARI and between groups were also carried out.

Table 1: The farmer groups in different districts in Uganda and the different activities they are involved in.

		Number of groups doing		
District	**Total**	**Participatory breeding**	**Varietal selection**	**Cultural control**
Masaka	1	0	1	1
Luwero	2	1	1	1
Mpigi	2	1	1	1
Kiboga	2	1	2	0
Total	7	3	5	3

Plate 3. Farmers from Kiboga District visiting NAARI to see research activities.

In Tanzania, the project was based at Agricultural Research Institute (ARI)-Maruku, part of the Lake Zone Agricultural Research and Development Institute (LZARDI), working closely with members of the Tanzanian Root Crops Programme, led there again by a plant breeder Mr E Marandu. The project employed Mr G Rwegasira again through IITA. Most field activities took place off-station, linking with Bukoba DALDO Office, village agricultural extensionists and with farmer groups set up by FAO Farmer Field School offices, Kagera Agricultural and Environmental Management Project (KAEMP) or PARTAGE (an NGO addressing the needs of HIV AIDS-affected families). Through these organisations, farmer groups (namely Jaribu Farmers, Umoja, Juhudi lulalo, Kanazi, Neema, Abatekanasya and Twende na wakati Group) keen to work with us on sweet potato were identified in 6 sites in Bukoba district: at Bugabo, Kanyigo (Nyungwe and Kikukwe), Kanazi, Kyaka and Kyema. Kanyigo, Kyaka and Kyema are high SPVD pressure zones while Kanazi and Bugabo *a*re moderate to low SPVD pressure zones. The Neema group dropped out of project activities with time. All the groups are located in reasonable proximity to ARI-Maruku: unlike much of the area around the lake shore in Uganda, the area around ARI-Maruku varies considerably in altitude so that quite diverse ecological zones can be accessed over relatively short distances. Each group agreed their own leadership (chairperson, secretary and treasure) as well as a constitution to guide their decisions. A gap analysis was conducted with each farmer group to assess what farmer knew and didn't know and their perception of the SPVD problem. Lead farmers acting as facilitators received training on breeding, agronomy, plant protection and post-harvest aspects of sweet potato at ARI-Maruku in 2003 plus refresher training in 2004. Farmers received training on SPVD on location with their respective groups both through the project team, through their facilitators and through exchange visits with other groups.

The project in Tanzania developed strong links with the donor, Norwegian People's Aid (NPA). The cooperation derived from NPA's interest in helping farmers in refugee-affected areas in southern Kagera Region (Biharimulo, Muleba and particularly Ngara Districts) recover from food shortage. The combined arrival of both refugees and the pandemic of severe cassava mosaic disease (CMD) create a crisis situation and CMD-resistant cassava varieties and improved sweet potato were a partial solution to the problem. The project therefore provided technical support on sweet potato (and cassava through R8303) to sit alongside NPA's financial support to NGOs and government institutions.

In both countries, the project worked closely with the International Potato Center (CIP) which has regional offices in Kampala and at which their sweet potato breeder (Dr R Kapinga) is based. Collaboration was particularly close for Output 4.

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Output 1. SPVD-resistant sweet potato varieties required by farmers and other stakeholders identified by farmer participatory research

Introduction

Breeding and selection activities conducted by both the Ugandan and Tanzanian national sweet potato programmes at Namulonge and Ukiriguru respectively have led to the release of a range of improved varieties derived both from landraces and seedling selections, some of which are SPVD-resistant. Kagera actually has a climate that is in many ways more similar to that at Namulonge than that at Ukiriguru. The transfer of Namulonge varieties Naspot 1 to 6 had been facilitated as a first step to assessing their acceptability there. These and other varieties have been tested in researcher-led on-farm trials (Fig. 1) by previous phases of the project in areas of Uganda where SPVD is particularly damaging and in Bukoba District in Tanzania.

Uganda

Further details of the activities associated with this output are provided in the following reports:

- E Byamukama, J Kayongo and I Mpembe (2005). Working with farmers to control SPVD: progress report: for the 2003 first rainy season, Uganda team
- E Byamukama, J Kayongo and I Mpembe (2005). End of season 2004b sweet potato virus disease project report
- Anon. (2004a). Retention of improved sweet potato varieties in Masaka and Rakai Districts
- Anon. (2004b). A follow up survey report (2004): 5pp
- Anon. (2004c). Second season trials results: 8pp

These trials were a continuation of trials done from 1999 onwards testing various improved varieties including NASPOT 1, NASPOT 2, NASPOT 3, NASPOT 4, 93493, 9329, 1093, Wagabolige, New Kawogo and Tanzania. Although those trials had been done on-farm, they had been largely researcher-led and researcher-monitored. The current trials were more farmer-led and included orange-fleshed high vitamin A varieties for the first time.

Group mobilization and sensitization. Five of the 7 collaborating groups in Uganda were involved in participatory varietal selection trials (Table 1):

- In Luwero District, in Vumba with Beera Mwesigwa Farmers group.
- In Kiboga District in a) Nakitembe village with Nakitembe Farmers Development Association and b) in Rwebijumbula village with Ani yali amanyi farmers group.
- In Mpigi District, in Kikomazi village, with the Twezimbe Farmers Group.
- In Masaka District, with Kwekulakulanya women's group

Many of the farmers had already been received or heard of the benefits of new varieties, particularly of cassava, and they were therefore keen to be involved in an activity with the potential to provide them with superior new varieties. Training associated with this output involved informing the farmers of the particular benefits of the new varieties, notably high yield and resistance to SPVD in most and orange flesh and/or associated high vitamin A content plus improved marketability in others. The farmer groups were all keen to participate in the activity. Exchange visits were also arranged.

Plate 4. Farmers making an exchange visit to see the Mpigi Group variety trial

Trials For most farmers in the groups, sweet potato was a very important crop and farmers in each group grew 7 – 12 (av. 9) cultivars, the majority of which were local landraces. Varieties provided for testing by the project included: station-bred high-yielding and SDPV-resistant varieties (Naspot 1, Naspot 2, Naspot 3, Naspot 4 and accession 9329), orange-fleshed landraces from Uganda (Ejumula and Kala) and Kenya (SPK004) and a high-yielding SPVD-susceptible landrace, Kyabafuruki, identified previously by project activity in Rukungiri. Most of the groups were unaware of any of these varieties; a few farmers in the two Luwero groups were however growing Naspot 1, Naspot 2, SPK004 and/or Ejumela. In each group, two local varieties were included making a total of 11 varieties. These 11 cultivars were each planted on 3 x 5 m plots in a randomised block design with three replicates: plots usually comprised 15 mounds each about 1 m^2. Trials were planted on two occasions by each group: in the first and second rains in 2003.

Farmers were encouraged to take careful notes of the development of each variety during the trials. For the first two trials, the yield of the crops was measured by a single harvest at the end of each trial. At the same time, diseases and weevil damage were recorded and foliage weight. A palatability test was also done: 4 tubers from each of the 9 varieties and two local checks were harvested, washed and peeled. They were then steamed in banana leaves each variety wrapped alone and coded. At a time when farmers felt that the tubers had cooked, they were removed and chopped into small pieces for the farmers to taste. Farmers scored each variety for appearance, sweetness, mealiness (starchiness), fibre content, colour of the tubers and general acceptance.

Farmers often piece-meal harvest their crop so we decided to explore with the farmer group at Masaka means by which farmers could assess different varieties for suitability for piece-meal harvesting, harvesting from when the trial was about three and a half months old and weighing each harvest.

Monitoring uptake The project also explored whether farmers were actually retaining the introduced varieties. The original researcher-led on-farm trials had been with individual farmers and, from the completion of the trials, there had been no further targeted dissemination of varieties to them. A total of twenty farmers in Masaka and Rakai districts who had received NAARI improved sweet potato varieties in 1999 were visited at their farms in 2004 and guided conversations were held with the farmers in their sweet potato gardens. The conversation included:

- Which varieties are still being grown and why
- Which varieties had been dropped and why
- Whether s/he had given or sold some vines to neighbours
- Farmers' observation and comment

Tanzania

Participatory variety selection trials were done with all seven farmer groups in 2003 and with six farmer groups (minus Neema group) in 2004. The varieties tested included the Ugandan NASPOT varieties (1, 2, 3, 4 & 6), Tanzanian released varieties (Mavuno, Simama, Polista and Juhudi) plus popular local varieties to provide comparisons both for the farmers and the scientists. Varieties were cultivated using the farmers' normal cultivation practices, generally on mounds typically 1m wide and set at a standard length of 15m by the scientists so that 46 plants were planted in each ridge (30 cm spacing). The layout of the Neema group in 2003 is presented (Fig. 1) as an example; none was identical. Both farmers and scientists kept records of SPVD and other pest problems during the growing season and yield at harvest. The plots were not rogued. One to three replications were planted during the short rains and two to three during the long rains in 2003 and durng the long rains in 2004, partly depending on the availability of land. The main aims of the trials were to validate the trial format as a learning situation in which farmers could select varieties appropriate to their environment and needs and validate the varieties themselves as potentially superior to those already available to the farmers. It was also a further opportunity for the scientists to examine the performance of varieties previously tested in researcher-led on-station and on-farm trials.

Mini trials: duplicates of variety trials were also set up as mini trials under individual farmer management for comparison with the group managed trials. In each group, two farmers each planted mini trials for the different varieties.

Figure 1. Typical field layout (not to scale) in Bukoba trials - Neema group at Kyema 2003

SPVD-resistant varieties	NASPOT 1	KOMBEGI	NASPOT 1
	NASPOT 2	JUHUDI	NASPOT 2
	NASPOT 3	POLYSTER	NASPOT 3
	NASPOT 4	SIMAMA	NASPOT 4
	NASPOT 5	MAVUNO	NASPOT 5
	NASPOT 6	NASPOT 6	NASPOT 6
	MAVUNO	NASPOT 5	MAVUNO
	SIMAMA	NASPOT 4	SIMAMA
	POLISTER	NASPOT 3	POLISTER
	JUHUDI	NASPOT 2	JUHUDI
	KOMBEGI	NASPOT 1	KOMBEGI
ROGUING (clean material)	K'NYOKO	K'NYOKO	K'NYOKO
	K'NYOKO	K'NYOKO	K'NYOKO
	K'NYOKO	K'NYOKO	K'NYOKO
NO ROGUING (4 infected plants added)	K'NYOKO	K'NYOKO	K'NYOKO
	K'NYOKO	K'NYOKO	K'NYOKO
	K'NYOKO	K'NYOKO	K'NYOKO

30m ISOLATION DISTANCE

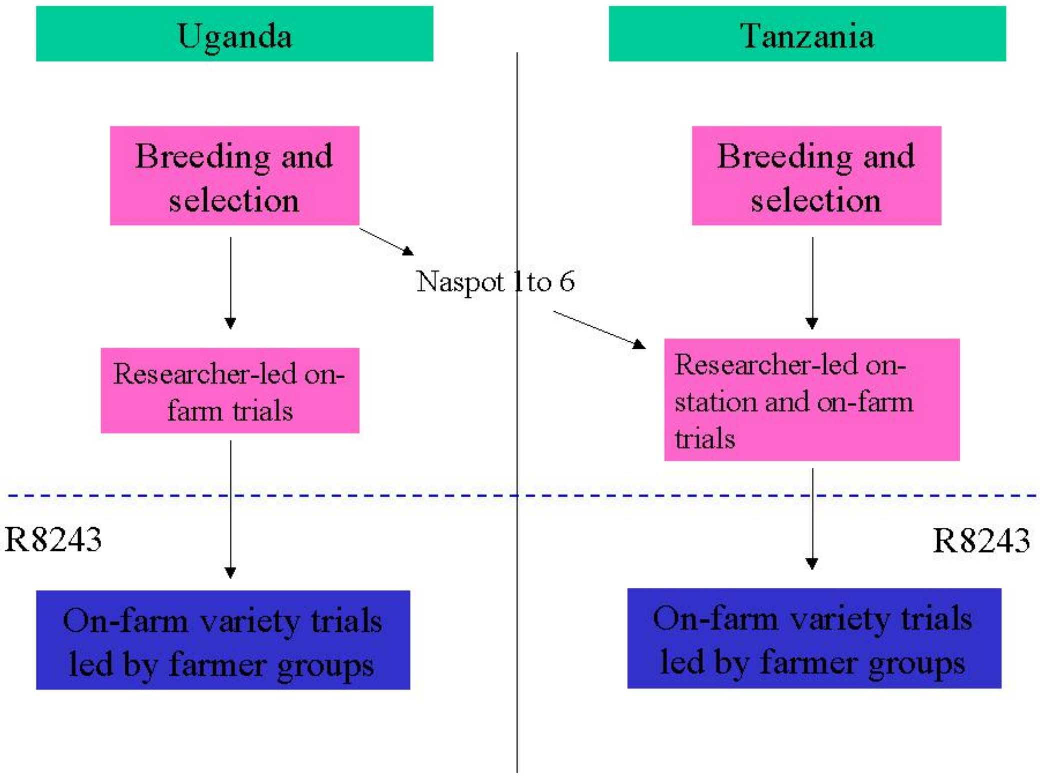
K'NYOKO	ISOLATION
K'NYOKO	
K'NYOKO	Clean Material

Performance of trials was monitored during crop development by group members and by group members and scientists at harvest. Tubers from different varieties were cooked for taste test assessment. Appearance, taste, flavour, starchiness and fibrousness were some of the criteria for the taste test. Exchange visits among the groups were also conducted to allow each group learn from the other directly.

Orange-fleshed varieties

No orange-fleshed varieties were included in participatory varietal selection trials with farmer groups until the final season (results not yet available) because there was insufficient knowledge of their performance. However, 39 such varieties from a wide range of backgrounds were tested on-station at ARI-Maruku. These included 3 local-origin orange-fleshed sweet potato varieties (Kabuchenche, Tomola & Kanyigo) plus one brought from Das-es-Salaam (Karoti Das-es-Salaam) Mr Rwegasira had found locally. Other varieties already tested on-station in Uganda and/or Kenya included Ejumela, SPK004, Mafutha, Japon, Zapallo, NC1560, Tainung and Kala. Further CIP varieties were obtained in tissue culture through the Kenyan quarantine facilities at Muguga,. Many of these varieties seem to originate outside Africa and are likely to be SPVD-susceptible. Varieties were initially grown in observation plots and the apparently good varieties were then propagated before further testing. A few varieties such as SPK004, Ejumela and Kala, all East African landraces and previously tested in Kenya and Uganda, have been disseminated, e.g., through NPA activities.

Figure 2. The process by which varieties had been identified for farmer group testing



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Output 2. Phytosanitary (e.g., clean planting material, isolation, roguing) methods of controlling SPVD adapted and validated through farmer participatory research groups.

Introduction

SPCSV is transmitted by whiteflies in the semi-persistent manner, whiteflies losing the ability to transmit within a few hours of departure from an infected plant. That this might restrict SPVD spread was first appreciated when rates of infection into previously uninfected trials were found to be related closely to the incidence of SPVD in nearby crops. Subsequent on-station trials showed that spread from an infector plot occurred largely to plants in adjacent rows and that roguing out infected plants from plots significantly reduced spread in plots. Other work indicated that plants infected as cuttings yielded little and also that farmers generally seemed to plant more cuttings than is necessary as even halving the number of cuttings had no appreciable effect on yield. These results (reported in previous FTR) led to the concept that SPVD might be controlled in only moderately resistant varieties by:

- Isolating new crops from old diseased ones
- Careful selection of clean planting material, and
- Roguing out (removing) the few diseased cuttings that appear in young crops

Surveys had also already identified that most farmers already avoided diseased plants as sources of cuttings and researcher-led on-farm trials had shown that roguing out diseased cuttings within 2 months of planting decreased the spread of SPVD.

Figure 3. Previous results that provided the basis for testing different cultural practices to control SPVD

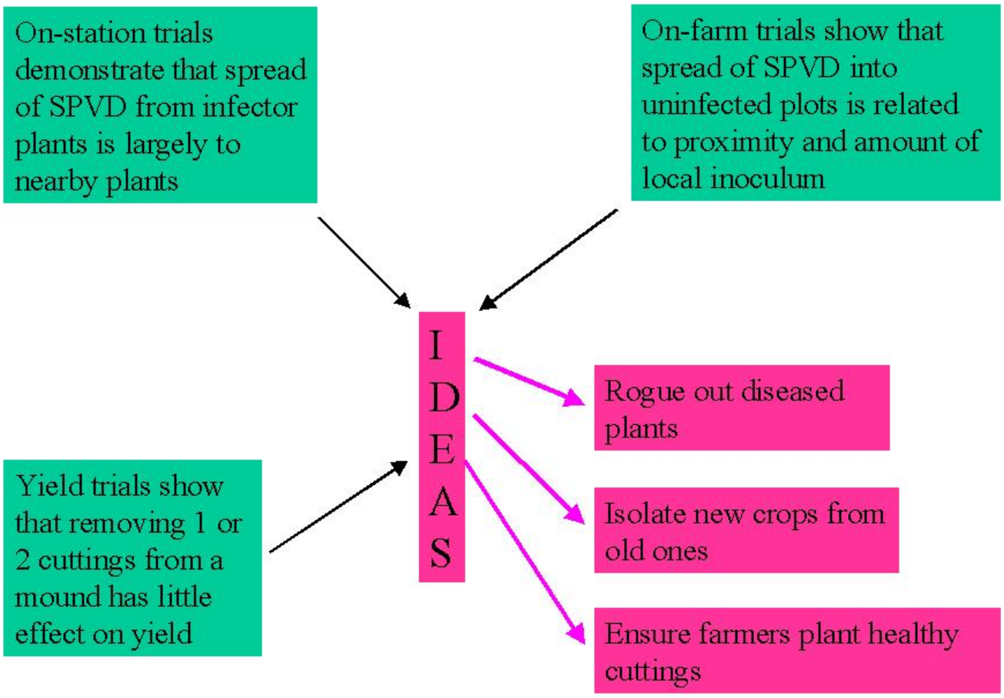
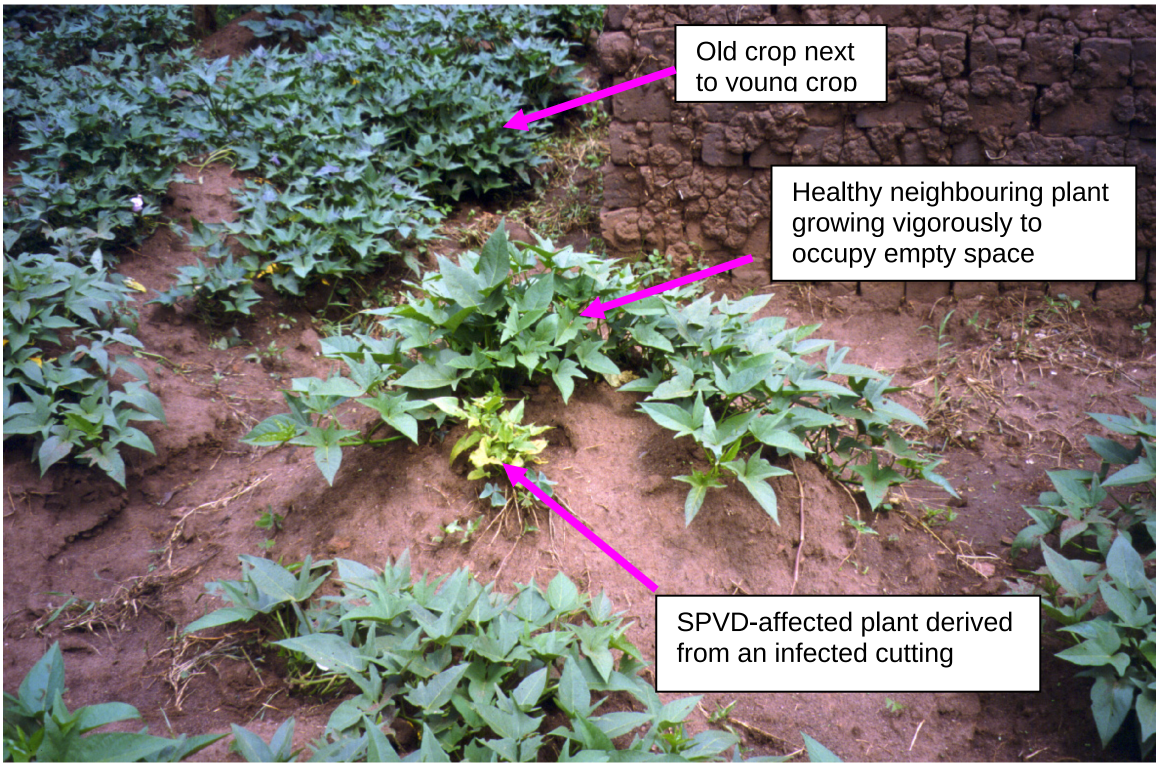


Plate 5. Photograph illustrating targets of cultural control practices for SPVD



Uganda

Further details of the activities associated with this output are provided in the following reports:

- E Byamukama, J Kayongo and I Mpembe (2005). Working with farmers to control SPVD: progress report: for the 2003 first rainy season, Uganda team
- E Byamukama, J Kayongo and I Mpembe (2005). End of season 2004b sweet potato virus disease project report
- Anon. (2004c). Second season trials results: 8pp

Three of the farmer groups in Uganda collaborated with the project in testing cultural methods of controlling SPVD, chosen very much because they were in areas where SPVD was very prevalent.

- In Luwero District, in Vumba with Beera Mwesigwa Farmers group.
- In Mpigi District, in Kikomazi village, with the Twezimbe Farmers Group.
- In Masaka District, with Kwekulakulanya women's group.

Unlike the use of SPVD-resistant varieties, the use of cultural control measures involves an understanding of the epidemiology of the spread of SPCSV by whiteflies. The necessary training for facilitators at NAARI and for farmers at a location chosen by members was an integral part of outputs 3 and 5. Farmers and facilitators agreed to participate in the training and to provide land and assistance.

Roguing trials

These trials aimed to test whether it was demonstrably practical for farmers to remove infected plants and achieve worthwhile reductions in spread of SPVD, increased yield and healthier planting material for next season. The groups in Luwero and Mpigi districts agreed to participate in this work. Each trial comprised six plots of

5 m x 5 m arranged in 3 blocks, each block with two treatments: roguing for first 2 mths and non-roguing. Both farmers and facilitators accepted the design in order to show the difference between the rogued and non-rogued plots (separation between plots, randomised). Although not locally grown, the cultivar Tanzania was used because it is a susceptible variety, and symptoms are clearly visible. The trials were planted twice, in the first and second rains of 2003.

Isolation by distance trials
This experiment aimed to demonstrate to farmers that when a new field is sited away from old fields, there is less infection in the new field. Two trials were planted: in Vumba, Luwero and Kabulanaka, Mpigi. Each trial comprised two plots near an old field and two plots at approx. 50 m away from old field. This experiment was planted in the first rains of 2003. There were logistical difficulties in both trials leading to farmers losing enthusiasm, so the trial was not repeated.

Combining roguing and isolation by crop barrier
Roguing was shown to be a cheap and effective way of controlling SPVD in initial trials with the Vumba group. Because isolation by distance had been logistically difficult, the group and project team decided to test whether a crop barrier might be a more practical means of isolation in 2004 first rains. Plots were again 5 x 5 m but the trial involved three treatments: roguing and barrier, roguing and no roguing replicated three times. The barrier used was four rows of sorghum planted around the sweet potato plot.

Tanzania

Meetings were held with farmers to explain how SPVD is spread from diseased plants to unaffected ones by the local movement of whiteflies. Farmers already practised selection of planting materials free from SPVD symptoms so training in its adoption was unnecessary (Chlorosis, vein clearing and severe stunting and sometimes reduced leaf size were the visible symptoms which farmers reported using for this selection). Farmers claimed to rogue their crops (mentioned in previous FTR) but inspection of their crops suggested this was not rigorously applied. Consequently, removing diseased plants in order to remove sources of infection and isolating new crops from old ones also cuts down disease spread were included as test treatments. Farmers in all the groups proposed using the local variety “Kigambirenyoko” in the phytosanitation trials. Research in the previous phase of the project (when it was commonly used as a local check in variety trials) had also shown it to be relatively susceptible to SPVD. Farmer groups conducted two cycles of replicated trials of roguing. Details of a typical plot layout are given in Figure 1. Diseased plants were removed 3 - 4 wks after planting when sweet potato vines had established and symptoms in diseased cuttings were obvious. Due to low SPVD incidence in some locations, three to four cuttings that were SPVD-affected were purposely included in a separate plot for demonstration purposes and not rogued out. These demonstrated how little yield such cuttings produced and therefore the small loss of removing such plants during crop growth. Three of the seven farmer groups also tested isolation during the short rains in 2004, planting separate trials away from other plots but this was difficult for other groups due to limited availability of land. None of the groups tested isolation by distance during the subsequent long rains because it was logistically difficult.

Performance of trials were monitored during crop development period by all group members. Through discussion under researcher guidance, each group decided on the work plan, learning schedule, crop management techniques to undertake, data to record in their regular assessment, parameters to consider for evaluation purpose in future etc. All members of the village were invited to the harvest. Farmers agreed on parameters to consider on evaluation of the trials. Exchange visits among the groups were also conducted to allow each group learn from the other directly.

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Output 3. Protocols, manuals and materials for training farmers in the control of SPVD and other pests developed and validated

Uganda

Content of training messages was validated in Activities 1 and 2, training materials were developed in Output 3 and were tested in Activity 5. Two sets of training materials were developed: posters and a brochure. One of the posters was drawn by a Ugandan artist; the other poster and the brochure were developed by the project team using their photographs as illustrations. Translations into Luganda were done by the project team. Both were shown to the farmer groups for comments. Electronic copies were sent to Tanzanian colleagues for adaptation for their work.

Tanzania

Three types of the training materials were developed: i) brochure, ii) notes and iii) posters. These were provided in Kiswahili language and were evaluated throughout 2003 and 2004, particularly by farmers and facilitators. Printed and bound notes were used in various training that involved different stakeholders. A training manual developed out of the workshop conducted in co-operation with the ministry of Agriculture (Crop Promotion Section) on both sweet potato and cassava is also available. The material is being checked by the ARI-Maruku evaluation committee prior to printing in large quantities.

Planting material of superior SPVD-resistant varieties was maintained and multiplied at ARI-Maruku throughout the project. A close collaboration was developed with the Norwegian People's Aid (NPA) and various NGOs, prison farms and training institutions funded by NPA. As part of this collaboration, ARI-Maruku scientists provided nuclear stocks of planting material of superior SPVD-resistant varieties to NPA which multiplied this material at its own primary nursery at Nyakahura in Ngara District. Nyakahura primary nursery multiplied this material and distributed it both directly to farmer groups and indirectly to farmers via multiplication plots based at various NGOs, prison farms and training institutions funded by NPA (see Outputs).

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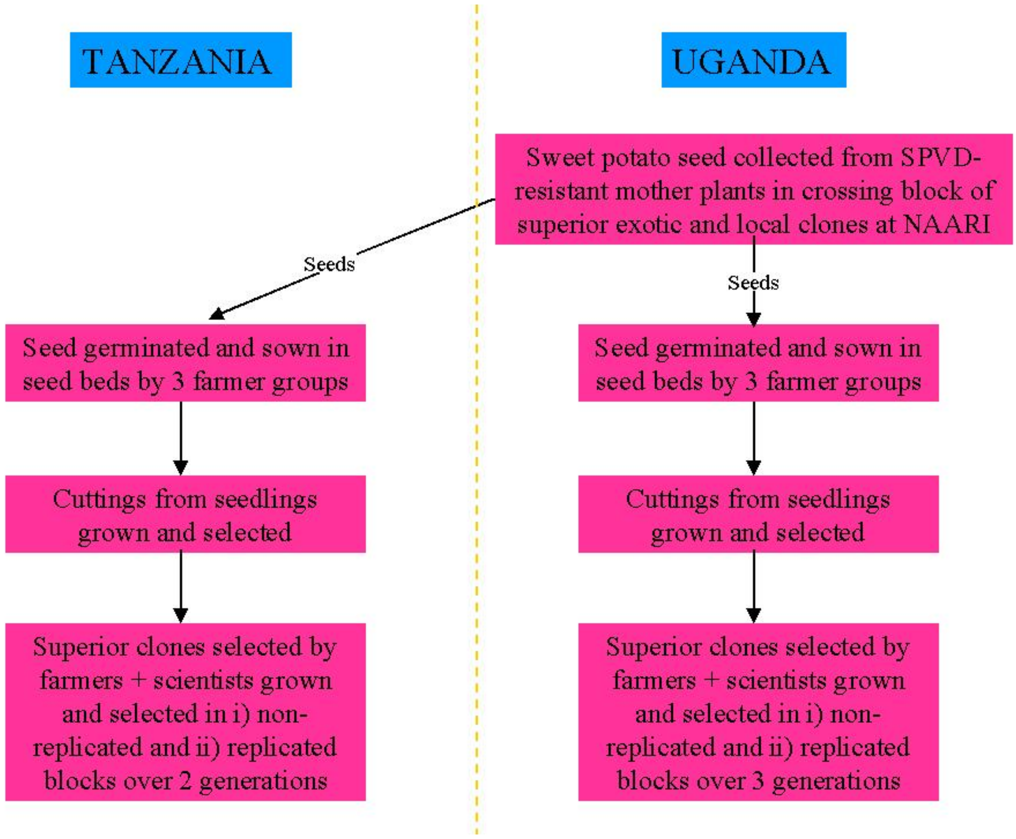
Output 4. A farmer participatory breeding programme for sweet potato initiated in the environs of Lake Victoria in Uganda

Introduction

Sweet potato is grown by most rural (and some peri-urban) households in Uganda and Tanzania and a diversity of varieties is therefore needed to cope with the diverse agroecologies involved. Furthermore, sweet potato tends to be grown predominantly by the poorest sector (women) in relatively poor communities often with access only to relatively infertile land. Centralised selection on research stations provides access only to limited and often relatively fertile agroecological conditions. The project therefore aimed to test decentralised, community-based, participatory sweet potato breeding using seedlings obtained from crosses between SPVD-resistant mother varieties (New Kawogo, Wagabolige and Bunduguza) with superior local landraces, varieties and introduced cultivars at the NAARI crossing block. The project approach builds on the inclusive philosophy developed by R8302 for cassava participatory breeding in Ghana but benefited from the much shorter generation cycle and faster vegetative multiplication of sweet potato than cassava. The project planned to test such a participatory breeding approach in three communities in Uganda. This was achieved and three locations in Tanzania were also added.

Figure 4. Flow diagram of participatory breeding process in Uganda and Tanzania



Uganda

Further details of this work are provided in the following:

- Sweet potato breeding work with farmers in Uganda: Rpt 1: 12 pp

- E Byamukama J Kayongo and I Mpembe (2005) End of season, 2004b, sweetpotato virus disease project report: 9pp.

Group mobilisation, sensitisation and seed planting Two groups were initially involved, one in Luwero District and another in Mpigi District where SPVD is prevalent. A third group, in Kiboga, where SPVD is less common, was later included as a comparison. All groups were initially developed by BUCADEF. The groups are:

- Tusitukire wamu Kabulanaka Farmers group, Zirobwe sub-county, Luwero.
- Tusitukirewamu Farmers Group -Njeru , Mpigi.
- Nakitembe Group, Nakitembe, Wattuba sub-county, Kiboga District

At a preliminary meeting, the concept of participatory breeding was explained to farmers in the groups and they were asked whether they were keen to participate in such programme. Farmers in all groups accepted enthusiastically. Several farmers in each group offered land and we asked them to identify one farmer whose land is easily accessed by all group members. Farmers were introduced to the idea of breeding, and it was explained they would work with the breeder to develop varieties in their villages.

The national breeder, Dr R Mwanga, selected superior families to test. The Kiboga and Mpigi groups were provided with seed from three half-sib families obtained from plants of the following three varieties open-pollinated in crossing blocks at NAARI: New Kawogo (very SPVD-resistant, local variety), Bunduguza (local variety) and Wagabolige (early-maturing, high-yielding station-bred variety). The group in Luwero was provided with two half-sib families derived from New Kawogo and Bunduguza. Seeds were planted in Mpigi and Luwero in May 2003; seeds were planted in Kiboga in September 2003. Seed was pre-treated with sulphuric acid (98%) to break dormancy for 45 minutes then washed in running water. At each location, about 2000 seeds from each of the above families were planted in furrows 5mm deep, made in raised seed-beds of finely tilled soil. About 2 mths later, a single cutting was taken from individual seedlings in each family and planted in handmade ridges (about 1m from ridge to ridge) at about 30 cm apart.

Trials were weeded as required by farmers. Farmers decided when the crop grown from these first generation sweet potato trials should be harvested and cuttings evaluated. In Mpigi, this was done on 16 December 2003, in Luwero on 19 and 22 December, 2003 and in Kiboga in May 2004. Determining issues in Mpigi and Luwero were:

- Maturation of crop;
- Approaching dry season presenting potential difficulties in establishing the next generation.

Harvest was attended the farmers in each group, project staff, Dr Mwanga and/or the CIP breeder Mr S Tumwegamire. Plants were harvested with foliage attached so farmers and breeders could assess both. Project staff recorded root and foliage yields of plants and disease and weevil damage. SPVD-affected plants were common in both Luwero and Mpigi. In this first trial, when there were very large numbers of plants to assess, farmers were asked to select about 10 plants they wished to keep for another generation (recording reasons) from amongst patches of about 100 plants. It was not practical to ask them to survey the whole trial at once.

Subsequent clonal trials From this first seedling trial, farmers took six cuttings from each selected plant and planted them immediately as a single plot either on 2 mounds or along a ridge, depending on the local custom. Again plots were cared for by the farmers as necessary and harvested about 8 mths later, in October 2004 in Luwero and Mpigi. Selection by farmers and plant breeders led to the retention of 14 and 21 clones at Luwero and Mpigi respectively. These were harvested in March 2005; in addition to selection based on appearance of roots and foliage, roots were also cooked as part of the selection procedure. Further replicated trials have been planted of selected materials. At all harvests, farmers commonly retained surplus planting material but this was especially encouraged at this last harvest. There was a severe drought in Kiboga; consequently, there was no root harvest and cuttings were taken from surviving plants in September 2004.

Tanzania

Details of this activity were provided in the following report:

- G.M. Rwegasira & E.F. Marandu (2004). Sweetpotato participatory plant breeding (PPB) selected clones; 10pp.

Participatory sweet potato breeding was done with three farmer groups located at Kanyigo (Nyungwe), Kyaka and Maruku (Butairuka), all in Bukoba District. SPVD is prevalent in both Kanyigo and Kyaka but is relatively rarer at Maruku. Farmer groups originated as described for Outputs 1 & 2; the breeding process had been demonstrated to group facilitators during training at ARI-Maruku and collaborating farmers had rceived this information from their facilitators and from project staff during group training. Sweet potato seeds were again provided by Dr Mwanga from three open pollinated mother varieties, Bunduguza, New Kawogo, and Wagabolige, pollinated in the crossing block at NAARI in Uganda. Two hundred seeds from each family (= 600 seeds) were provided to each group. Dormancy was again broken using sulphuric acid. The seeds were incubated on a moist tissue paper for 24 hours. After imbibition, seeds were sown in shallow furrows (10 mm deep) made at a 60 mm interval across a finely tilled. Records were kept of germination rates. When the seedlings had grown and produced a long shoot, five vine sections were cut from each seedling and planted in unreplicated blocks along mounds prepared by the farmers in their communal field, numbering each seedling clone in each family.

At harvest, scientists (Mr GM Rwegasira – crop pathologist; Mr EF Marandu – plant breeder) measured disease incidence, root yield and other parameters of the roots and foliage as part of their selection process. Farmers also selected the clones they wished to take forward to the next generation and recorded their reasons for their selections. Cuttings of clones selected either by farmers or scientists were planted in plots in the farmers' communal garden. This process was repeated for one further generation cycle.

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Output 5. Cadre of trainers in national and regional government and non-government organisations in East Africa skilled in the knowledge of SPVD control.

Introduction

Uganda and Tanzania represented quite different circumstances and therefore quite different outputs were required/realisable. Uganda had been through the travails of the cassava mosaic pandemic and there was consequently considerable knowledge even amongst farmers of virus disease being spread by whiteflies and the use of resistant varieties and cultural control methods to combat it. Agricultural extension there has, however, been through various reforms and was currently based on the customer-contract philosophy of NAADS, biasing extension towards commercial crops generating cash rather than crops such as sweet potato grown mainly for home consumption or small-scale trading. Tanzania, by contrast, retains a network of Ministry of Agriculture extension officers operating out of district Agricultural and Livestock Department offices. On the other hand, the cassava mosaic has only recently struck Tanzania. This meant there was a less knowledge even amongst agricultural officers of whitefly-borne virus diseases but there also were various initiatives to minimise the effects of the pandemic.

Uganda

Training on the causes of SPVD, its means of spread and its control was provided at NAARI to 6 extension staff of the NGO BUCADEF. An extension officer of the NGO IRDI (Integrated Rural Development Initiative) working in the Nakivale and Omurukinga refugee camps also received training on location.

Farmer members of our groups and farmers at Nakivale and Omurukinga refugee camps received training at their home bases.

Tanzania

Training was provided by the project to a range of participants from two main sources. One was the project itself: this training was provided mainly to i) farmers in the seven groups and ii) facilitators and field officers associated with these farmer groups. Training provided to leaders and facilitators of the different groups in Bukoba District in SPVD control and in sweet potato production was generally coupled with group activities at the beginning of the project followed by refresher training at ARI-Maruku and exchange visits amongst groups. The other funding source was the Norwegian People's Aid (NPA), NPA funding the costs of the participants and the travel and subsistence costs of the trainers whilst the project funded Mr Rwegasira's time inputs. Most of this training took place in Biharimulo and Ngara Districts (where NPA focuses) and training was mainly provided to iii) districts extension personnel and NPA officials iv) college students and tutors v) districts and prison agricultural officers from selected districts and stations in Tanzania (Table 16). Training of farmer groups covered a description of SPVD and alternariosis, causes, means of spread, symptoms and management techniques. Insect and vertebrate pests of sweet potato, field crop agronomy and general management. Facilitators' training included an introduction to sweet potato general management, the farmer field school (FFS) approach, participatory plant breeding (PPB), sweet potato virus disease (SPVD) and other sweet potato diseases, variety selection, evaluation of the work done during the first phase, developing training curriculum and working calendar, practicals and a station tour. The extension personnel and NPA officials were trained on broad aspects on sweet potato and cassava agronomy, sweet potato pests and diseases, breeding and conservation of planting materials as well as data collection and management. The collaboratively organised training workshop between the ministry of agriculture and project staff had a nation-wide outreach where researchers in root and tuber crops in the Lake Zone and districts and prisons agricultural officers from all over the country participated. SPVD and CMD were the principle themes of their training.

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Outputs

Introduction

In Uganda, sweet potato was an important crop for all the farmer groups; cassava, maize, beans, groundnut and bananas were also important. Farmers grew about 5 - 10 varieties of sweet potato, mainly for home consumption but also for small-scale trading, especially the Luwero groups located near Kampala. SPVD was a major problem to farmers in Mpigi, Masaka and Luwero Districts but not to the farmers in Kiboga District. Before receiving training, farmers mostly lacked an accurate knowledge of the causes of SPVD but some realised that it was perpetuated in infected cuttings.

In Tanzania, sweet potato was also an important crop for all farmer groups but here it was increasing dramatically in importance as a food crop because of the CMD pandemic destroying the cassava crop. SPVD was locally very important. Again, farmers grew about 5 - 10 varieties of sweet potato, mainly for home consumption. Most of the outputs were achieved through working with farmer groups.

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Output 1. SPVD-resistant sweet potato varieties required by farmers and other stakeholders identified by farmer participatory research

Overview

A hypothesis underlying most research under this output was that SPVD-resistant varieties are, assuming other attributes of the varieties are adequate, probably the most acceptable and easily disseminated means of preventing damage by SPVD. Furthermore, some resistance is likely to be necessary in order to support any combination of phytosanitary control practices wherever SPVD is prevalent.

Previous on-station and on-farm (but researcher-led) trials (see Fig 2) had identified a range of superior varieties were at least moderately resistant to SPVD. All had also been shown to have high yields under certain test environmental conditions – though not necessarily in farmers' fields in the agroecological conditions of our farmer groups (some Tanzanian varieties had been developed in the drier south-eastern side of Lake Victoria. Participatory variety selection trials involving a cooperation between farmer groups and scientists were the main tool used in achieving this project output. Aims of the trials included to develop and provide a format in which farmers could judge different varieties.

Uganda

Further details of the activities associated with this output are provided in the following reports:

- E Byamukama, J Kayongo and I Mpembe (2004). Working with farmers to control SPVD: progress report: for the 2003 first rainy season, Uganda team
- E Byamukama, J Kayongo and I Mpembe (2005). End of season 2004b sweet potato virus disease project report
- Anon. (2004a). Retention of improved sweet potato varieties in Masaka and Rakai Districts

- Anon. (2004b). A follow up survey report (2004): 5pp
- Anon. (2004c). Second season trials results: 8pp

The participatory variety trials were generally achieved good collaboration from farmers. Drought was a major constraint, destroying trials at Mpigi and Masaka in the first rains of 2003, at Mpigi to the extent that new planting material had to be provided for a repeat trial. Naspot 1 continued to yield well but was occasionally severely damaged by Alternaria as noted in previous FTRs. In their assessment of varieties, farmers often referred to different aspects related to the 'survivability' of the vines, in terms of disease and drought resistance and the general ability of the variety to cope with local environmental conditions. Although yield was obviously important, farmers clearly considered many other factors.

Although some of the test varieties, for example, Naspot 3 and 9329, yielded poorly throughout, for most, there was considerable variation in yield from season to season and location to location. Naspot 1 mostly yielded well - and sometimes spectacularly so - but occasionally yielded poorly. The local variety Dimbuka lived up to its high-yielding reputation and it also did very well under piece-meal harvesting, unlike several of the station-bred varieties. It was, however, quite susceptible to SPVD. Of the orange-fleshed varieties, both Kala and Ejumela were often severely attacked by SPVD, making it difficult for farmers to maintain planting material. They were also very susceptible to drought. Although both are Ugandan varieties, they may have a fairly restricted agroecological tolerance. SPK004, though it may be slightly less productive, was less susceptible to both drought and SPVD. Significantly, it appears also to do well in Tanzania (see next section), consistent with it having a wide agroecological tolerance. In terms of taste, there was also no uniform best variety. Farmers prefer sweet and starchy varieties and Dimbuka again seemed often to be preferred. Naspot 3 generally did poorly on palatability. By the end of the second season, none of the 9 varieties had been rejected completely (not even Naspot 3 which farmers said may be late maturing which can be a good attribute since it means it can stay in the soil for a long time).

Lessons learnt

- Farmers were pleased to receive large numbers of varieties from which they can choose over time
- Different varieties have different advantages and disadvantages; there may be no single 'best' variety
- The format of a communal variety trial seemed appropriate for farmers to be made aware of new varieties
- Most of the orange-fleshed varieties were confirmed to be susceptible to SPVD

Table 2. Summary of comments about different varieties at end of trials by farmers from different groups [A = Twezimbe Farmers Group; B = Beera Mwesigwa Farmers Group; C = Nakitembe Farmers Development Association; D = Ani Yali Amanyi Farmers Group; E = Masaka Kwekulakulanya Womens Group]

<u>Naspot 1:</u>

A. Early maturity, vines are good but get diseased (Alternaria).
B. Less attacked by SPVD, attacked by disease that defoliates it (Alternaria) but very high yielding.
C. Vines look nice, early maturity, but vines get diseased (Alternaria).
D. Looks nice, grows fast but gets diseased (Alternaria).
E. Early maturing, high yielding but vines don't last long. Vines dry quickly.

Table 2 continued

<u>Naspot 2 :</u>
A. Tolerant to drought, less SPVD observed.
B. Relative resistant to SPVD but attacked by other diseases. Tubers have red skin that is liked by market.
C. Tolerant to area conditions, grows quickly.
D. Spreads very quickly.
E. This variety is tolerant to area conditions, it looks nice. It does not get diseased.

<u>Naspot 3:</u>
A. Tolerant to drought. No SPVD observed but it is late maturing.
B. Healthy looking without any SPVD infection but late maturing.
C. It is tolerant to area conditions, vines look nice.
D. Tolerant to drought, is not attacked by pests.
E. Resistant to SPVD, tolerant to drought but does not yield well

<u>Naspot 4:</u>
A. Less SPVD observed, few tubers seen in the first three months.
B. Tolerant to SPVD, also tolerant to drought but not early maturing.
C. Vines are good and is tolerant to area conditions.
D. Does not cover land fast, but vines look good.
E. Early maturing, nice vines but it gets weeviled a lot

<u>Accession 93/29:</u>
A. Tolerant to area conditions, but late maturing.
B. Not attacked by SPVD but its leaves get defoliated. It’s also late maturing.
C. Tolerant to area conditions.
D. Nice looking, grows quickly.
E. Grows fast but is late maturing, it is also drought tolerant.

<u>Kyabafuruki:</u>
A. Is nice looking, spreads fast and is high yielding but is heavily attacked by SPVD.
B. Seriously attacked by SPVD infection, but it high yielding.
C. Spreads quickly, nice vines, but is attacked by pests.
D. Spreads very quickly but it is attacked by pests.
E. Grows quickly, looks nice and is high yielding.

<u>SPK004:</u>
A. Tolerant to SPVD, does not grow fast, but it stays in soil for long.
B. Less SPVD observed. “ Because of its small and narrow leaves, it’s easy to cut and transport”. It is also high yielding and straight tubers.
C. Is a slow grower, but tolerant to drought.
D. Does not spread fast, is not high yielding.
E. It is tolerant to drought, it looks nice but is not early maturing.

<u>Ejumula:</u>
A. Seriously attacked by SPVD. Very difficult to keep planting material.
B. A lot of SPVD infection, difficult to get planting material for next trial, but fair yield.
C. Is not tolerant to drought, easily attached by diseases.
D. Gets diseased, but grows fast.
E. Got infected early with SPVD, the vines do not look nice.

<u>Kala:</u>
A. Also attacked by heavily SPVD but is relatively early maturing.
B. Quite a lot of SPVD infection, but relatively high yielding.
C. Does not cover the ground fast, is attacked by diseases.
D. Doesn’t spread, and gets diseased.
E. It is not drought tolerant.

Table 3: Yield of test cultivars in different locations and planted in the first (2003a) and second (2003b) rains of 2003 (The highest yielding cultivar is highlighted)

	Yield/plot (kgs)							
Cultivars	**Vumba 2003a**	**Nakitemba 2003a**	**Butemba 2003a**	**Vumba 2003b**	**Nabusanke 2003b**	**Nakitemba 2003b**	**Butemba 2003b**	**Kyamulibwa 2003b**
Naspot2	7.1	7.3	16.3	19.7	11.4	11.8	12.5	16.3
Naspot1	6.6	10.6	14.7	31.3	4.7	25.8	11.4	16.3
Ejumula	5.6	8.6	18.9	18.4	2.2	7.9	7.6	11.0
SPK004	5.3	4.4	15.9	20.9	7.9	3.6	2.7	11.3
Naspot4	5.3	3.8	13.0	18.3	3.4	4.6	8.8	14.3
Kala	4.9	4.5	14.4	17.9	9.6	9.9	9.1	15.5
Kyabafuruki	4.2	9.5	11.8	13.8	14.5	8.1	10.5	16.6
Naspot3	3.9	3.6	7.8	14.4	2.5	9.6	6.8	10.1
9329	3.3	2.6	6.2	10.5	1.8	7.6	4.1	5.5
Dimbuka	*8.0*	*13.5*	--	*28.4*	*9.5*	*14.8*	--	--
Bunduguza	--	--	*13.0*	--	--	--	*13.0*	
Siliki	--	*5.1*	*5.5*	--	--	*5.1*	*15.0*	
Njule	*4.96*	--	--	*21.8*	--	--	--	--
Local1	--	--	--	--	--	--	--	*5.5*
Kavunza	--	--	--	--	--	--	--	*7.5*
Kalebe	--	--	--	--	*2.3*	--	--	--
LSD	*2.54*	*4.36*	*9.36*	*11.1*	*4.6*	*4.36*	*NS*	*NS*

Local check varieties are italicised

Long-term retention of varieties. In Masaka, 7 of ten targeted farmers were available for interview. One had completely lost all the improved varieties due to the long intensive drought which is normally experienced between May and August. Because of lack of food, farmers had harvested all the sweet potato in their gardens leaving no planting material for the next season. NASPOT 1, the most commonly grown of the improved variety, was retained by 5 of the interviewees. High yield, sweetness, and an attractive yellowish flesh colour were some of the reasons given. However, farmers complained about its susceptibility to Alternaria and drought.

Other varieties that were still kept by at least farmers visited included NASPOT 2, NASPOT 4, Wagabolige and 9329. New Kawogo, NASPOT 3, 1096 and Tanzania were each being grown by one farmer. Susceptibility to drought was the major problem determining retention of NAARI improved varieties. Although NASPOT 3 is one of the drought resistant varieties among the improved ones, it was not well adopted because of its low yield and late maturity. Even though few farmers were still growing Wagabolige, it was one of the highest yielding varieties in the area according to one farmer interviewed. She was very proud of its yield and resistance to the drought and had given out planting materials to six other farmers neighbouring her. Even though these farmers were impressed by the high yield and drought resistance of Wagabolige, they expressed dissatisfaction about the round shape of the tubers and tuber cracking especially during drought. These qualities make Wagabolige difficult to market and to peel and explained its neglect by other farmers. All farmers interviewed were impressed by the taste of Tanzania, but not many adopted it, mainly because of its susceptibility to SPVD and drought. New Kawogo was seldom adopted because it only does well on newly opened land and yet opening up of new land each time a farmer wants to plant is not feasible. One commercial farmer who was interviewed said that, during the previous season, he planted ten acres of NAARI improved varieties to feed the boarding schools in Masaka but was disappointed by their cooking quality. He said that NAARI varieties can only cook well if they are steamed. In schools, the practice is to boil the roots in water because of the large volumes of food which have to be handled. The roots of NAARI varieties became mushy and the students reject them. At the time of this survey this farmer had planted more than ten acres of sweet potato but very few improved varieties were included. Somba busere a local variety which has the required cooking qualities, dominated the farm. All farmers interviewed had either given out or sold planting materials to other farmers. More then 140 farmers received NAARI improved sweet potato planting materials from the pilot farmers.

In Rakai, all 8 of the 10 farmers which had received NAARI varieties were available. Three households had lost all the improved materials and their local cultivars due to the long drought that hit the area. They had harvested all their sweet potato due to lack of food, leaving no planting material. Another three had lost just the NAARI varieties due to drought. Only two farmers had maintained the NAARI varieties. The varieties maintained include NASPOT1, NASPOT 2, NASPOT 4, 9329, 93493, and New Kawogo. However, these farmers have access to swampy areas where they planted during the dry spell. One of them also planted it under a coffee garden during this time. They said that the major reasons for maintaining these varieties were-

- They are high yielding especially NASPOT 1 and NASPOT 2
- They produce big tubers especially NASPOT 1 and New Kawogo
- Some, like 93493 and New Kawogo, are drought resistant,

but unfortunately these two varieties are susceptible to Alternaria and New Kawogo does not do well on exhausted soils.

Lessons learnt

- Retention of varieties may be determined by survival during short catastrophic periods [often drought] as well as by good performance during normal cropping
- It may be more effective to distribute new varieties especially to farmers who have access to locations remaining wet during drought
- Different farmers and markets can differ considerably in their requirements

Tanzania
Details of the achievements of this work in Tanzania are provided in two annual reports:
- GM Rwegasira & Mr EF Marandu (2004). Working with farmers to control sweetpotato virus disease in the Lake Zone of Tanzania - 2003. 53pp.
- GM Rwegasira & Mr EF Marandu (2004). Working with farmers to control sweetpotato virus disease in the Lake Zone of Tanzania - -2004. 15pp.

Six farmer groups collaborated with project participatory varietal selection trials for the duration of the project; a seventh, the Neema group, dropped out of project activities with time. The village extensionists in the area where the project worked were the facilitators for the groups at Bugabo, Kanazi, Kyaka and Kyema. The Bukoba DALDO office were very supportive here, making available another facilitators for the Twende na Wakati group after the first facilitator was transferred. The NGO PARTAGE (focus on HIV AIDS-affected families) arranged the formation of two groups at Kanyigo, providing transport and other assistance to the facilitator for the two groups.

Table 4. Initial training provided to facilitators and farmers

Date	Theme	Trained cadres	No. of participants
22-31st May 2003	SPVD control and sweet potato agronomy	Farmers (group and non-group members	97 people
2nd June 2003	Sweet potato health, agronomy and effective facilitation	Facilitators and Field officers at ARI-Maruku	12 people
22-31st December 2003*	SPVD, alternariosis management, PPB, sweet potato agronomy and postharvest techniques	Farmers (group and non-group members	125
27-29th January 2004*	Diseases and pests, PPB, FFS approaches, sweet potato agronomy and postharvest techniques	Facilitators and Field officers at ARI-Maruku	14

* Refresher courses

Group facilitators were provided with training at ARI-Maruku - at the initiation of project activities (2003) and midway (2003/4) as a refresher. Discussions with farmers identified that sweet potato was a major food crop for them all and that they grew about 5 – 10 varieties. The locally available varieties mentioned included none of the improved ones that were formally released by Ukiriguru research station and had been disseminated by Kagera Agricultural and Environmental Project (KAEMP). SPVD was known to all the groups but was apparently particularly severe in Kyaka and Kanyigo. Most groups organised visits to other groups to exchange ideas etc in

September 2003. These were lively affairs in which farmer groups compared how each had progressed (see Annexes of GM Rwegasira & Mr EF Marandu (2004)).

SPVD occurred at a relatively low incidence in the NASPOT varieties in both the 2003 and 2004 trials (see reports). These results confirm that disease resistance identified on-station is maintained under farmers' conditions and is effective over a wide geographical area. They also suggest that the NASPOT varieties should be promoted particularly in areas where SPVD is prevalent. NASPOT 1 was occasionally severely affected by Alternaria, again consistent with previous results of on-station and in on-farm researcher-led trials. There were no major differences amongst the varieties and local checks in incidence of damage by weevils, the main pest of sweet potato.

Farmers' criteria for assessment were very diverse. For the foliage, they included foliar colour, vigour, resistance to SPVD and Alternaria, resistance to foliar pests (leaf damage), tolerance to drought and capacity for production of vines (planting materials). For the storage roots, they included early maturity, yield, root size, root shape, raw root skin and flesh colour, weevil damage, cracking and rotting. When farmers were asked to rank uncooked roots of the different varieties, they consistently selected their local varieties, perhaps biased because they could identify them from their skin colour and shape. When the roots were cooked, however, they could not know which were their local varieties and their ranking became much more variable, Naspot 4 often being preferred.

An interesting outcome of the current set of trials in Tanzania is that, as in Uganda, there were no consistent differences in yield either amongst the varieties or with the local check. NASPOT 1, for example, yielded very well in the 2004 long rains planting season but was only average during the 2003 short rains planting season. This inconsistency was also evident in other varieties and supports the project's policy of providing farmers with a relatively wide choice of varieties rather than a 'one variety fits all' policy. It also suggests that farmers may require experience of several seasons in order to adopt or reject a particular variety.

Another viewpoint of the success of the trials was obtained from Mr Philippe Krynen, Director of the Victoria Programme of Partage Tanzania (PTZ) Mission, whose organisation facilitates our work with 3 women farmer groups in two locations at Kanyigo. PTZ used to have a lunch programme for 7,000 orphans but has stopped this in preference for *shamba* (garden/small farm) rehabilitation. He was extremely enthusiastic about the potential of sweet potato for his work – it is easy and quick for them to grow, very productive, traditionally a woman's crop and has provided a way of promoting collaboration between group members. He reported that sweet potato cuttings of our introduced varieties were selling for 10/- each in the local market and 40/- each in his subsidised market (2,000/- = £1). The most popular variety is NASPOT 1, introduced by our project from Uganda and people are 'fighting for it'. His organisation has a total of 110 women's groups, comprising about 4,000 orphans in 2,600 families. NASPOT sweet potato varieties have spread to about 20 of his groups and to about 100 individual farms this season. (RW Gibson BTOR entitled: Notes from my visit to Uganda and Tanzania 9 – 23rd February, 2004)

It is clear from the trials that the Ugandan varieties performed well in Bukoba (and indications from multiplication plots elsewhere in Kagera Region suggests this is widely true) in terms of yield, SPVD resistance and, with a few exceptions, were broadly acceptable to the diverse criteria of the farmers. This result emphasises the potential benefits of maintaining and ideally further improving links between ARI-Maruku and NAARI for sweet potato. Cassava varieties selected in Uganda are also being trialled in Kagera Region. This is occurring largely because the local varieties in Kagera are mostly very susceptible to pandemic of cassava mosaic spreading from Uganda, but the results with sweet potato trials suggest that such exchanges should be maintained when ‘normal’ circumstances return and also extended to include other crops. Whilst it is perhaps wrong to use these results to identify specific varieties for distribution to farmers, it is clear that the collection presents a basket of useful options for them, the NASPOT varieties in particular providing valuable resistance to SPVD combined with generally good yields. It also seems clear from project staff observations supported by Mr Krynen’s comments that the format of the participatory varietal selection trials was an effective means of introducing the varieties to rural communities.

Lessons learnt
– Varieties again differ in their success in different seasons and locations, consistent with farmers keenness to try several varieties for several seasons – Sweet potato is a valuable crop for families in particular need – Varieties identified in Uganda may be valuable in Kagera Region of Tanzania

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2. Cultural (e.g., clean planting material, isolation, roguing) methods of controlling SPVD adapted and validated through farmer participatory research groups

Overview

The generally good yield and early maturity, good taste etc of many somewhat SPVD-susceptible landraces identified in a previous phase of the project means that many farmers currently plant susceptible but otherwise much preferred landraces, risking crop loss due to SPVD. The local variety, “Kigambirenyoko”, popular in much of Kagera region, is a typical example. Cultural control measures, often involving phytosanitation, have the potential to limit the risk of damage by SPVD in such varieties. It is also clear that many of the orange-fleshed, high vitamin A sweet potato cultivars are also susceptible to SPVD and again phytosanitation has potential to restrict damage and allow such varieties to be grown sustainably.

Validation of cultural control measures involved working with farmer groups and required farmers to understand what causes SPVD and how it is spread by whiteflies. In Uganda, some farmers involved in group activities were aware of this from previous involvement with project activities and extensive dissemination on how cassava mosaic is spread backed this up. Elsewhere, farmers had much less knowledge and providing them with knowledge of the epidemiology of sweet potato viruses was a necessary first step to enable them to participate fully in experiments developing practical ways of controlling SPVD.

In both Uganda and Tanzania, discussions with farmers established that they already select disease-free planting material as part of avoiding weak, abnormal planting material. This was probably backed up by poor success when diseased material was used either by accident or lack of choice. Training therefore included an explanation of why it is important to select healthy planting material and demonstrated its value only secondarily e.g., the Tanzanian groups purposely included separate plots in which a few diseased cuttings were purposely planted in their roguing work. The two cultural methods of control that were tested were roguing (removing diseased plants) and isolation of new crops from old diseased ones. Removing any diseased cuttings from plots as soon as possible after planting has been shown in on-farm or on-station researcher-managed trials to control SPVD. Isolating new crops from old diseased ones was the other potential means of cultural control. Planting plots a small distance away from established SPVD-affected plots had been successfully tested on-station. This method has to be combined with roguing: there is little point in isolating a crop that contains infected plants. Because both methods had been proved technically, the main aims were therefore to test if they were appropriate for farmers' circumstances and to test methods to demonstrate them to farmers.

Uganda

Roguing trials

In Mpigi, drought led to the roguing trial there not establishing well in the first rains. Otherwise, roguing had a dramatic effect on incidence of SPVD both statistically and in the opinion of the farmers. In the second rains trial at Mpigi, one non-rogued plot had about 90% infected plants at harvest. Part of the reason why there was so much infection in the second rains was because cuttings from rogued and non-rogued plots in the 2003 first rains trial were used to plant rogued and non-rogued trials in the second rains trials. There was a high carryover of infection in planting material from non-rogued plots even though only symptomless plants had been used to provide the cuttings. There was also a clearly greater yield in rogued plots in the opinion of the farmers even though it was only significantly so for Luwero in the first rains.

Table 5. Effect of roguing on SPVD incidence at harvest and yield in 2003 first and second rains trials

	% SPVD Incidence at harvest		**Total yield /plot**	
	Luwero	**Mpigi**	**Luwero**	**Mpigi**
First rains				
Rogued	Data not collected by farmers		77.2	26
Not Rogued			41.9	23
Second rains				
Rogued	53.7	77.5	20.3	12
Not Rogued	22.3	32.9	13.6	7.6

Farmers were initially hesitant at removing infected cutting but, when asked at the conclusion of the trials, declared that the real waste was NOT roguing. Farmers wondered whether uprooted vines could be fed to animals: this was confirmed. Farmers also reported that it was easier and quicker to select healthy material for planting the next crop in rogued plots than in non-rogued ones and selectively took planting materials to plant in their own gardens from rogued plots.

Isolation trials

Two trials were planted in 2003 first rains, one in Luwero and one in Mpigi. The one in Luwero was destroyed by livestock and the one in Mpigi did not do well because it was planted on infertile soil. Farmers in both locations pointed out that isolation by distance was often impractical because of land shortages. Good land was scarce and planting isolated plots made them very vulnerable to attack by domestic and wild animals. They were therefore not willing to continue the trials.

Combining roguing and isolation by crop barrier

Roguing once again appeared to reduce SPVD spread but, for the combination of the sorghum barrier + rouging, one farmer said "the vines are so healthy even a child can cut vines for planting". But, although there was low incidence in the shielded plots, farmers considered yield was low. Apparently, sorghum normally reduces the yield of neighbouring crops which is why they don't normally intercrop it. Farmers also argued that the barrier could have provided cover for thieves: there was a lack of food in the area and the trial was attacked by thieves.

Table 6. Effect of roguing and barrier on SPVD incidence and yield

Treatment	% SPVD Incidence	Weight (kg) of tubers/ plot
No Roguing	62.00	25
Roguing	44.33	20
Roguing + Barrier	21.33	13

Lessons learnt

- Roguing fits easily within the Ugandan system of growing sweet potato
- The benefits of roguing are easy to demonstrate and include:
  - Greater yield
  - Healthier vines for next growing season
- Isolation either by distance or barrier is difficult for farmers to achieve

Tanzania

As for the participatory variety selection trials, details of the achievements of this work in Tanzania on cultural control are provided in two annual reports:

- GM Rwegasira & Mr EF Marandu (2004). Working with farmers to control sweetpotato virus disease in the Lake Zone of Tanzania - 2003. 53pp.
- GM Rwegasira & Mr EF Marandu (2004). Working with farmers to control sweetpotato virus disease in the Lake Zone of Tanzania - -2004. 15pp.

Farmers and facilitators received training in the epidemiology of SPVD as a part of the training described under Output 1. Training for farmer groups included such aspects on SPVD as a description of the disease, its cause, means of spread and management plus agronomy-based crop management practices. Facilitators' training at ARI-Maruku was broader, introducing sweet potato general management, the Farmers Field School (FFS) approach, epidemiology and control of SPVD, use of crop calendars and a station tour to give firsthand experience of the work of the Root Crops Programme at ARI-Maruku. As in Uganda, farmers routinely selected planting materials free from SPVD symptoms using chlorosis, vein clearing and severe stunting and sometimes reduced leaf size as the visible symptoms against which to select. The cultural control trials were generally established adjacent to the variety trials and comprised three sets of paired blocks each of three ridges of 46 plants of the susceptible local variety Kigambirenyoko (Figure 1). One of the sets was rogued 3 – 4 wks after planting, one was not rogued and the third was isolated at least 30m from any other sweet potato crop and rogued. However, this isolated third set was only achieved in 2003 and in just three sites: Kyaka, Kyema and Nyungwe. Although it achieved the lowest level of spread, farmers found it too difficult to provide sufficient land/did not consider the benefits worth the effort and disruption. Roguing of diseased plants was done three to four weeks after planting when sweet potato vines had established.

Table 7. Newly infected plants in cultural control trials

a) 2003 Short rains planting season

Sites	Roguing				No roguing				Isolation + roguing			
MAP*	1	3	5	Total	1	3	5	Total	1	3	5	Total
Bugabo	0	0	0	0	0	1	0	1	-	-	-	-
Kanazi	1	0	1	2	2	0	0	2	-	-	-	-
Kikukwe	1	0	4	5	0	1	32	33	-	-	-	-
Kyaka	0	2	2	4	0	0	3	3	1	0	0	1
Kyema	2	1	0	3	3	2	2	7	0	0	0	0
Nyungwe	16	0	3	19	12	9	15	36	0	0	0	0
Total				33				82				1

b) 2004 Long rains planting season

Sites	Roguing				No roguing			
MAP*	1	3	5	Total	1	3	5	Total
Bugabo	0	0	0	0	0	0	0	0
Kanazi	0	3	0	3	1	0	0	1
Kikukwe	0	0	0	0	0	1	0	1
Kyaka	3	3	8	14	2	11	13	26
Nyungwe	3	2	6	11	3	5	21	29
Total				28				57

* Months after planting

Consistent with previous on-station and/or on-farm researcher-led trials, both roguing diseased plants and isolation demonstrably lowered SPVD spread, especially when used together and especially in areas where SPVD was spreading most (Table 11). It also seems noteworthy, however, that some sites, for example Bugabo, had little spread in either year. If this is maintained, it may be possible for farmers there to grow relatively SPVD-susceptible varieties and such locations may be worth testing production of exotic orange-fleshed varieties or serve as a multiplication point for the disease-free planting materials for farmers elsewhere.

One aspect of the non-rogued plots is that recording spread of infection requires marking plants as symptoms appear using different markers to distinguish cutting infection and subsequent whitefly-borne spread. Harvesting especially the cutting-infected plants demonstrated how negligible is the yield of such plants, and thereby how little is lost by removing them. Farmers also perceived that 'clean' planting material selected from rogued plots had less cutting infection that that from non-rogued plots

Lessons learnt

- As experienced in Uganda, roguing seems to fit easily in the farming system and farmers could see the benefits
- Demonstrating how little cuttings infected with SPVD actually yielded was a useful way of showing farmers they risk little by roguing
- Isolation again wasn't easy for farmers to adopt

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3. Protocols, manuals and materials for training farmers in the control of SPVD and other pests developed and validated

Overview

Training material has been generated in several ways:

- Dr T. Stathers has generated a technical manual on sweet potato for farmer field schools as part of R8167. The project has facilitated its development, in particular contributing sections on pest and disease management, including an illustrated description of SPVD and lesson-learning exercises on SPVD for farmers.
- The project has developed training 'handouts' specifically on control of SPVD. These include posters and brochures for both Tanzanian and Ugandan farmers, adapted to local conditions and languages.
- In Kagera Region, Tanzania, where there had been no previous dissemination of the high-yielding, SPVD-resistant NASPOT varieties, the project developed links with other organisations to achieve this.

Achievements in the latter two aspects are described below. More details of the technical manual are provided in the FTR for R8167.

Uganda

Two posters, the art drawing and photographic poster were developed. Both posters were designed to make people more aware of SPVD and how it can be controlled. The brochure gave same message though with more detail. Testing the artist's poster elicited the following recommendations from farmers:

- The man should wear gumboots, not shoes.
- The man should not be carrying a baby but should hold him by hand
- The people in the drawing do not look like African farmers
- There was no home in the poster
- There was no garden of sweet potato on the poster.

The following comments were observed on the brochure:

- The yield, given in tonnes per hectare, should be changed to bags per acre
- Districts around L. Victoria basin should be listed

Posters and training brochures have been utilised in training programmes for group members and refugees and disseminated through BUCADEF and at national farming days.

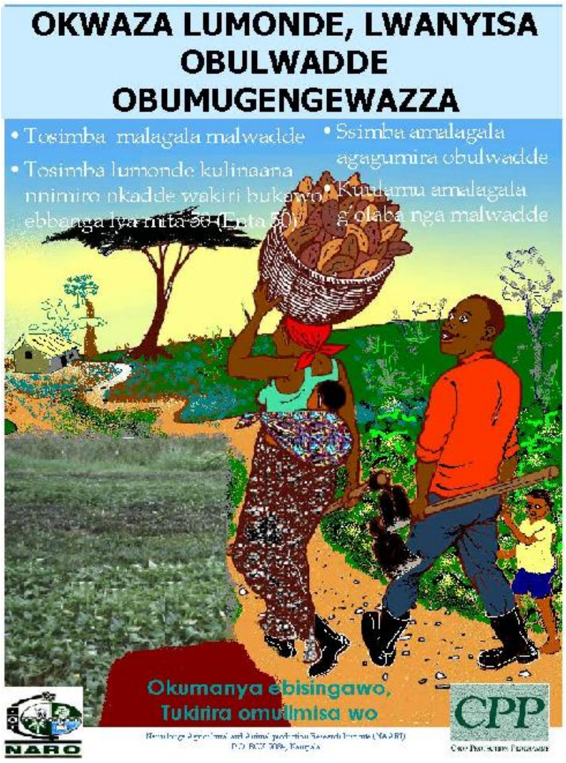

Plate 6. Two posters illustrating the benefits of controlling SPVD developed by the project

Dissemination of SPVD-resistant varieties
The new SPVD-resistant NAARI varieties have been widely disseminated in districts bordering Lake Victoria by BUCADEF (with CPP funding) and the Ugandan National Programme. Therefore, it seemed inappropriate for the Project to engage in wholesale distribution of planting material to farmers. Farmers in groups collaborating with the project in participatory varietal selection were able to obtain planting material from the trials after harvest. Only one major dissemination of planting material was made: to refugees in camps at Nakivale. High-yielding, SPVD-resistant sweet potato planting material were provided at the request of IRDI; they were multiplied at 11 different sites throughout the camp.

Tanzania

Written and illustrated materials: The development of training material occurred hand-in-hand with the validation of the control methods themselves (Outputs 1 & 2). The 'successes' in SPVD control have been resistant varieties, selecting clean planting material and roguing. Three types of training packages were developed: a leaflet, notes and posters. A leaflet in Swahili illustrating SPVD, outlining its causes and how to control it has been completed. A more extensive guide to both SPVD and cassava mosaic disease including training appropriate for farmer groups and farmer participatory breeding has been completed in a first draft. This developed out of a workshop conducted in co-operation with the Ministry of Agriculture (Crop Promotion Section): Finalisation is scheduled for the proposed next phase of the project.

The suitability of these training packages was evaluated initially by researchers at ARI-Maruku, then during the initial training sessions of facilitators and farmers and ‘refresher’ training (see Activities: Introduction). Finally, the leaflet has to be approved by an official committee at ARI-Maruku. The training handouts are available and already being used in the Lake Zone. Printed and bound notes are the ones mostly in use. Posters and leaflets both in English and Kiswahili are available although they are yet to be printed in large quantities to guarantee their use. The SPVD + CMD training manual is also available to stakeholders on both sweet potato and cassava.

Plate 7. The initial multiplication of NASPOT varieties at the NPA nursery in Ngara District, Tanzania

Supply of planting material of SPVD-resistant varieties: An important aspect of training packages is ensuring the availability of requisite materials so that trained farmers are not disappointed. A key component of SPVD control is resistant varieties. In Uganda, there has already been extensive dissemination of new varieties developed at NAARI under CPP-funds provided to the Ugandan NGO BUCADEF (Buganda Cultural and Development Foundation). There had been some distribution of sweet potato planting material in Kagera District in Tanzania by KAEMP (Kagera Agricultural and Environment Management Project) but that was of relatively SPVD-susceptible, high-yielding varieties and the project had largely finished by the time the SPVD-resistant varieties identified by the project had become available. Spread of these new varieties occurred informally from project group farmers but this was negligible in comparison to the demand. Links were therefore established with the international donor, NPA that was assisting refugee-affected districts in Kagera Region. NPA agreed to assist in both training and in the distribution of superior disease-resistant cassava and sweet potato varieties. ARI-Maruku provided the initial planting material of all sweet potato varieties and NPA established its own nursery at Nyakahura. A total of 528 vines of different clones were introduced (Table 1) and planted in 0.2 acre plot. Harvesting of vines for further multiplication is continuing at the nursery and the plot has now expanded to 0.5 acre. Since then, NPA has also been provided with sweet potato planting materials from ARI-Maruku’s sister institute, ARI-Ukiriguru including orange fleshed clones. These are also undergoing multiplication at the nucleus nursery.

Table 8: Sweet potato planting material provided to NPA by ARI-Maruku.

Clone	NASPOT-1	NASPOT-2	NASPOT-3	NASPOT-6	Polista	SP93/2	Total
Quantity	178	26	40	22	82	180	528

The multiplication of improved sweet potato varieties including orange-fleshed varieties supplied under the CPP project has been in progress since 2003 season. Only disease-free material is provided to farmer groups for further multiplication and local diffusion. Since 2003, the supply of a large number of sweet potato vines to farmer groups has been documented (Table 2): onward dissemination of planting material to individual farmers can be assumed to be much greater.

Table 9. Number of sweet potato vines distributed by NPA to various groups

Group / **Variety**	Mabare chini	Nyamizi	Gwesero	Kumubuga & Ntanga	Murusaga mba	Magamba	Rulenge Caritas
Naspot 1	700	3,400	2,000	200	-	-	-
Naspot 2	3,400	3,400	2,000	1,400	1,500	1,000	-
Naspot 3	2,800	3,400	2,000	1,400	2,500	2,022	-
New Kawogo	1,200	3,400	2,400	2,000	1,700	1,800	-
Polista	5,500	3,600	11,600	1,600	1,800	1,700	500
Juhudi	6,700	6,600	3,300	4,300	2,500	2,000	1,000
Sinia	800	3,100	2,000	-	700	800	-
Simama	1,000	3,400	3,100	2,000	1,800	1,700	500
Kala*	-	-	11,200	-	3,300	3,200	-
SPK004*	-	-	11,200	-	1000	1000	-
Ejumula*	-	-	3,350	-	-	-	-
TOTAL	22,100	30,300	54,150	12,900	16,000	16,000	2,000

* Orange-fleshed varieties.
NB: The Gwesero group was the first to receive 8,000 vines for Naspot 1,2,3 and Sinia during 2003. It now continues with local diffusion for these varieties.

Improved sweet potato varieties [NC 1560, Kakamega, Kala, Ejumula, Naspot 6 and Japon] and CARITAS [Naspots 1,3,4,6, New Kawogo, Juhudi, Sinia, Simama, Ejumula, Kakamega and Japon] have also been supplied to REDESO and CARITAS. REDESO is a Ngara-based NGO established with a main aim of promoting proper land use and soils and water conservation for sustainable agriculture in the refugee affected areas. CARITAS is a Catholic Church based NGO that work closely with farmers to improve the livelihood of the community. The NGOs work in collaboration with NPA on both cassava and sweet potato. In appreciating this achievement of the project, it should be borne in mind that Ngara District is roughly a quarter of the way around Lake Victoria from the initial importation of NASPOT sweet potato vines across the Ugandan/Tanzanian border and that this occurred only some 3 – 4 yrs ago.

Monitoring collaboration with NPA A mid-term monitoring survey in Muleba, Biharamulo and Ngara districts was carried out in April 2004 by scientists from ARI-Maruku to assess initial achievements and to improve future collaboration with NPA. A further visit by ARI-Maruku and NRI scientists was carried out in November 2004. SPVD was confirmed as a major problem especially in Muleba and some parts of

Ngara district. Severe disease was noted in varieties Sinia, Simama (SPN/0) and Kigambirenyoko (but not in the NASPOT varieties) in an old nursery crop at Nyakahura Primary Nursery. REDESO's sweet potato nursery looked good. The nursery is organically maintained and all varieties were SPVD free. The varieties being rapidly multiplied in the nursery included NC 1560, Kakamega, Kala, Ejumula, Naspot 6 and Japon. CARITAS's sweet potato nursery was good apart from nutrient deficiencies: addition of organic manure was advised. Varieties available at the nursery included Naspots 1, 3, 4 & 6, New Kawogo, Juhudi, Sinia, Simama, Ejumula, Kakamega and Japon.

Lessons learnt

- The key lesson learnt in this output is the need to develop linkages with other organisations sharing common aims and, through collaboration, leverage increased impact for all concerned
- This collaboration ensured that both training and essential materials to put the training into practice could be provided to trainees

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4. A farmer participatory breeding programme for sweet potato initiated in the environs of Lake Victoria in Uganda.

Overview

Originally, this activity was planned to occur only in Uganda, partly because it was previously untried and partly because conventional sweet potato breeding had not yet been initiated at ARI-Maruku although a plant breeder (Mr Marandu) had recently been appointed to head the Root Crops Programme there. The extension of this activity was at the insistence of the Tanzanian scientists.

Evidence of the importance national and international programmes are attaching to this breeding approach was evidenced by their strong support by:
a) providing seed for the work; and
b) involvement of national and CIP breeders at all major activities.

Uganda

Group mobilisation, sensitisation and seed planting Three groups of farmers, all initially developed by BUCADEF, accepted our invitation to collaborate in sweet potato breeding work. The groups are:
- Tusitukire wamu Kabulanaka Farmers group, Zirobwe sub-county, Luwero.
- Tusitukirewamu Farmers Group - Njeru , Mpigi.
- Nakitembe Group, Nakitembe, Wattuba sub-county, Kiboga District

Farmers in all groups provided land and labour: the former was always free, the latter was generally free except in instances when it was necessary to clear land in swampy areas because of the approaching dry season. Farmers also received training in how new sweet potato varieties originate in addition to standard training on

SPVD control. The national breeder, Dr R. O. M. Mwanga, provided seed of superior sweet potato families to test. The Kiboga and Mpigi groups received seed from three half-sib families: New Kawogo (very SPVD-resistant, local variety), Bunduguza (local variety) and Wagabolige (early-maturing, high-yielding station-bred variety). The group in Luwero received seed of two half-sib families derived from New Kawogo and Bunduguza.

Farmers had about 50% germination, allowing a few thousand cuttings to be taken from individual plants and transplanted into the seedling cutting trials. The numbers of accessions retained declined by about 5 – 10-fold each generation (Table 12). The reasons given by farmers for their selection of seedlings are given in Tables 10 & 11. Reasons for retention or rejection were broadly similar for succeeding generations but less data was obtained because of the fewer accessions retained. The national sweet potato breeder and CIP breeder selected almost none additional to those of the farmers and would have rejected several of those that the farmers selected.

The clonal 1 generations at Mpigi and Luwero became severely affected by SPVD that had by now become established within the population. This resulted in affected plants having very poor yields and led to many rejections of clones at these sites. Alternaria was much less common though, perhaps due to different climatic conditions or selection of resistant clones within the seedling cutting generation. At Kiboga, clonal generation 1 produced no yield, instead drought killing about half the plants. The 67 surviving clones were therefore just replanted.

Table 10: Reasons given by farmers for selection of seedling accessions

Luwero		Mpigi		Kiboga	
No.	Reason	No.	Reason	No.	Reason
81	High yielding	65	High yielding	117	High yielding
62	Big tubers	54	Big tubers	33	Big tubers
19	Long straight tubers	30	Long straight tubers	15	Long straight tubers
5	Resistant to SPVD	2	Resistant to SPVD	94	Resistant to SPVD
29	Orange fleshed	1	Orange fleshed	2	Orange fleshed
3	Drought tolerant	2	Drought tolerant	37	Drought tolerant
2	Healthy looking	2	Healthy looking	23	Nice looking
2	Yellow fleshed	1	Yellow fleshed	22	Yellow fleshed
6	Cream colour	1	Cream colour	2	Cream colour
6	Lots of vines	13	Early maturing		
2	Medium yielding	6	Vines not inhabit rats		
2	Seem to be sweet	2	Medium yielding		
1	Attractive	1	Continuous yielding		
1	Canopy not spreading much	1	Delayed maturity		

Plate 8. A, Farmers being shown the crossing block at NAARI, the source of the sweet potato seeds; B, a farmer monitoring the growth of the seedlings; C, Farmers collecting cuttings from the seedbed; D, Farmers harvesting sweet potato accessions at Mpigi; E, Farmers in Luwero discussing whether or not to retain a particular accession; F, Farmers assessing the palatability of roots of different accessions.

Table 11: Reasons given by farmers for rejection of particular seedling accessions

Luwero		Mpigi		Kiboga	
No.	Reason	No.	Reason	No.	Reason
15	Low yielding	14	low yield	18	low yield
15	Infected with SPVD	5	infected with SPVD	16	infected with SPVD
11	Weeviled	1	Weeviled	9	Weeviled
2	Very fibrous	5	Fibrous	1	Fibrous
6	Small tubers	2	Small tubers	2	Small tubers
3	Dry vines	1	Cracking	8	Not drought tolerant
2	Skin colour not attractive	1	Vegetative growth		
1	Unattractive skin				

Table 12. Summary of progress of participatory breeding trials in Uganda at Mpigi, Luwero and Kiboga

	Numbers of genotypes present (month planted)		
Generation	Mpigi	Luwero	Kiboga
Seeds	6,000+ (May 2003)	6,000+ (May 2003)	4,000+ (Sept 2003)
Seedling cuttings	553 (July 2003)	1506 (July 2003)	1055 (Nov 2003)
Clonal generation 1	121(Dec 2003)	163(Dec 2003)	126 (May 2003)
Clonal generation 2	21 (Oct 2004)	14 (Oct 2004)	67* (Sept 2004)
Clonal generation 3	11 (March 2005)	13 (March 2005)	40 (March 2005)

* Selected on the basis of those clones that survived the drought.

Clonal generation 2 also experienced a prolonged period of hot dry weather but no clones appeared to have been killed by it. This was perhaps because these survivors were relatively resistant and also because they had become established before the drought set in. Alternaria was again rare (but it had been very dry). In clonal generation 2, several clones selected had included some which had SPVD-affected plants. However, farmers carefully selected unaffected cuttings for replanting as they would in their own crops and by clonal generation 3, relatively few SPVD-affected plants were evident even at Mpigi and Luwero where SPVD was prevalent in surrounding crops. At Mpigi, most of the clones yielded relatively poorly, probably a combination of infertile soil, drought and SPVD affecting some of the clones. A few clones did, however, yield much better than the local checks, Dimbuka and New Kawogo and both the latter were rejected by farmers in this group. Interestingly, at Luwero, one of the accessions previously rejected by farmers had been retained by an individual farmer at his own farm where it had yielded very well. It was also orange-fleshed and was brought back into the cohort of selected clones for clonal generation 3. This clone had also been exhibited at a CIP meeting at NAARI, creating considerable interest.

Clonal generation 2 was the first stage at which there were few enough clones remaining for it to be practical to include cooked roots as part of the selection procedure. Roots were peeled, cut into pieces and steamed by the farmers in separate marked polyethylene bages. Most of the roots were satisfactorily palatable; even those that weren't were not rejected at this stage as they had already been planted in the next trial.

Lessons learnt

- Farmer participatory breeding appears to be able to achieve rapid progress with sweet potato
- Although farmers' and breeders' criteria may differ, there is considerable overlap in the phenotypes selected by both
- Farmers can easily handle large numbers [>1,000] seedlings
- Resistance to abiotic as well as biotic stress factors are important in selection

Tanzania

Seedlings germinated well at all three sites, averaging >60% so that 1124 seedling clones were planted across the three sites.

Following establishment, various biotic and abiotic stresses caused serious damage at the different sites. At Nyungwe (Kanyigo), the whole experiment was destroyed by monkeys when was only three months old. Since the pest uproots the whole plant, nothing survived at all despite farmers' attempt to drive them away. This was a major loss to the project with no apparent gain since farmers already understood what a serious pest monkeys are. At Maruku (Butairuka), the materials planted at clonal evaluation stage were badly affected by alternariosis. Out of nearly 400 seedling clones, only 36 clones were selected for advancement to the next stage. However, this biotic stress had the major advantage that it allowed resistant material to be selected. At Kyaka the clones were highly affected by drought necessitating irrigation. This forced the use of a cheap *AproTech* foot pump to support the material through excessive drought. Only a few planting materials survived and most of these few survivors were severely affected by SPVD. Again, only 33 clones out of nearly 400 seedling clones were selected for advancement. Although resistance to Alternaria, and SPVD and drought were the main selection criteria of both farmers and scientists at Maruku and Kyaka respectively, other criteria considered by farmers in the evaluation of clones were foliage cover, resistance to pests such as weevils, early maturity, yield, root size and shape, skin and flesh colour. When cooked their key attributes were; appearance, taste, flavour, starchiness, fibrousness and cookability.

The second clonal trial planted at Maruku established well, although it was severely affected by weeds and, this time, some clones were severely damaged by eriophyid mites which cause hairiness (erinose) on leaves and stems. The second trial at Kyaka was again severely affected by drought at planting time despite being planted next to the river. Survivors that were transferred to a 'rescue' plot were then destroyed by hippos!

Elimination of clones has been remarkably 'dramatic' in the participatory breeding trials in Bukoba. Biotic (monkeys, SPVD, Alternaria, erinose and weeds) and abiotic (drought) factors allowed elimination of >90% of genotypes within one selection cycle. The environment seems to have been much harsher in Bukoba than at the sites chosen for breeding in Uganda. Part of the reason for this is that Bukoba District is slightly further from the Equator, resulting in rainfall tending towards a unimodal distribution. This gives both a longer and harsher dry season and a longer wet season. The soils may also be less fertile and water-retentive.

Overall conclusions from the participatory breeding trials

Perhaps the over-riding lesson is how 'tough' it can be for crops in the on-farm situation. Drought was often a major constraint at most sites, even causing plant death and causing farmers to plant in swampy areas in what was probably infertile, waterlogged soil. SPVD and Alternaria also affected many plants and rersistance to them appears to have been selected for quite strongly, although formal on-station trials are needed to confirm the resistance of selected clones. The occasional devastation caused by wild animals was also shocking.

Despite the toughness of the conditions (or perhaps, because of), there has rapid progress, particularly in Uganda. Over a 3 generations, we have managed to select a small cohort of accessions that appear to yield well under farmers' conditions. Individual farmers are becoming more closely involved in selection in their individual gardens, perhaps enabling selection for quality characteristics to be emphasised. Superior accessions have also been exchanged with the permission of the groups.

One initial concern that has been addressed is the ability of farmers to select from amongst thousands of seedling. By subdividing the crop and asking farmers to select a fairly constant proportion from within these subdivisions, farmers were able to select. It was possible to select amongst the whole group in later generations when the number of accessions was reduced.

Although farmers' selections generally included more than the breeder would have selected, few good ones were apparently overlooked in this process

Breeding for staple food crops in developing countries now mostly involves participation of farmers at some stage; participatory breeding now therefore has to be defined by the *early* and *major* involvement of farmers in selection. Participatory breeding also occurs under different formats; unlike ours, sometimes the trials are maintained on-station and farmers are brought on-station to assess plants. The project's on-farm approach to participatory breeding meant that labour and land costs were small. On-farm selection involved additional time and transport costs for scientists but seemed cheaper, involved less farmer time and provided more realistic conditions than organising farmers to come to judge clones grown on-station. It is currently too early to assess the added value achieved by such participation for sweet potato in terms of the frequency with which participatory breeding versus conventional breeding generates adopted varieties. It seems relevant that the main reason why farmers failed to retain released varities was because they lost all planting material during drought (see Output 1) and on-farm conditions seemed to select strongly for drought resistance.

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5. Cadre of trainers in national and regional government and non-government organisations in East Africa skilled in the knowledge of SPVD control.

Overview

Training provided in Uganda was mainly to farmers associated with project activity. The commercial focus of National Agricultural Advisory Development Service in Uganda meant there was little interest in government extension officers. Previous training had also been provided to BUCADEF extension staff in Uganda. In Tanzania, there was demand for training within the national extension service and NPA was keen to fund training costs for both government and non-government extension staff.

Uganda

Training on the causes of SPVD, its means of spread and its control was provided at NAARI to 6 extension staff of the NGO BUCADEF and also to Mr Marandu from ARI-Maruku and Mr Ndamugoba from FAO in Bukoba. An extension officer of the NGO IRDI (Integrated Rural Development Initiative) working in the Nakivale and Omurukinga refugee camps also received training on location. Farmer members of collaborating farmer groups and farmers at Nakivale and Omurukinga refugee camps received similar training at their home bases.

Table 13. Farmers provided with knowledge of SPVD, means of spread and control in Uganda

Date	Farmer group	No. farmers
21/02/04	Twezimbe Farmers Group, Mpigi	27
23/02/04	Tusitukire wamu Farmers Association, Luwero	41
24/02/04	Ani yali amanyi farmers group, Kiboga	27
05/03/04	Kwekulakulanya women's group, Masaka	31
09/03/03	Beera mwesigwa Farmers group, Luwero	10
04/06/03	Tusitukire wamu Farmers Association, Luwero	23
09/04/03	Nakitembe Farmers Development Association, Kiboga	21
10/04/03	Bukwiri Farmers Group, Kiboga	23
16/04/03	Tusitukirewamu-Njeru Group, Mpigi	25
17/04/03	Twezimbe Farmers Group, Mpigi	21
25/08/04	Refugees in Omurukinga camp	40
26/08/04	Refugees in Nakivale camp	>100

Impact of training on farmer group members

A survey was initiated to find out the impact of the training farmers on SPVD incidence, spread and control. Six months after the training, impact of the project was evaluated in areas of its operation for both group members and non-group members. For each location, 10 members of the group who had received training and 10 nonmembers but belonging to the same community were interviewed. All seven groups in the four districts (Luwero, Mpigi, Kiboga and Masaka) were surveyed involving a total of 138 interviewees.

Table 7: Current varieties grown by farmers

Variety	Group Member	Non group members	Reason 1	Reason 2
Project varieties				
Naspot 1	22	16	Sweetness	High yielding
Project Varieties	16	0	High yielding	Nutritional value
SPK004	9	0	Sweetness	Vines are marketable
Tanzania	6	5	Sweetness	High yield
Ejumula	2	0	Nutritional value	
Kyabafuruki	1	0	Sweetness	

Local varieties				
Dimbuka	33	33	Sweetness	High yield
New Kawogo	18	15	High yielding	Available variety
Bunduguza	7	7	High yielding	Available variety
Kavunza	6	1	High yielding	
No Name	4	7	High yielding	
Siriki	4	3	Sweetness	Late maturing
Jaguza	3	5	High yielding	Available variety
Namwezigum u	2	2	Early maturity	Tolerant to area conditions
Kimotoka	1	5	High yielding	Available variety
9 Others	10	6	Mainly because of high yield	

Before training and project activities in 2003, farmers were growing their local varieties. At the time of the survey, however, the new varieties were being adopted by group members and a few non group members said they were planning to grow them.

Table 8. Varieties that farmers are planning to plant

Variety	Group members	Non group Members	Reason 1	Reason 2
Project varieties				
Naspot1	24	15	High yielding	Sweetness
Project varieties	37	16	Sweetness	High yielding,
SPK004	14	2	Sale of vines	Highly marketable
Ejumula	11	0	Sale of vines	High yielding
Kyabafuruki	7	0	Sweetness	
Tanzania	6	1	High yield	
Local varieties				
Dimbuka	14	15		
New Kawogo	7	10	High yielding	Available variety
Bunduguza	6	7	Sweetness	High yielding
Kimotoka	2	5	High yielding	Available variety
Any available	1	9		
Kavunza	2	2	Early maturity	High yielding
11 others	5	16	Mainly high yield & sweetness	

More group members than nonmembers recognised the SPVD and could give a name describing it. Also more group members mentioned whiteflies and planting infected plants to be the cause of symptoms. Roguing and selection were the most mentioned actions to reduce SPVD incidence and were also being practiced by both group members and non-members; few group members said they were doing nothing to control SPVD. The knowledge of the control methods was reported to be derived mainly from project training for group members while experience and neighbours were sources of information for most nonmembers.

Lessons learnt
– Training to farmers was effective both in increasing their knowledge and achieving adoption of new practices – In the normal cause of events, farmers in Uganda gain little knowledge on sweet potato cultivation from extension

Tanzania

Training on control of SPVD and CMD has been provided for 5 categories of people:

- Farmers in FFSs (now Ministry policy).
- Facilitators (Government and NGO extensionists) of farmer groups.
- Homecraft training for the youth at training institutions.
- NPA-funded staff, e.g., extension staff (Government and NGO extensionists) and leaders at various levels such as division, ward and villages.
- National government staff including DALDOs.

Four different types of training were undertaken including i) farmer group-based training, ii) Facilitators training, iii) district extension officers, iv) a workshop involving researchers, policy makers, law enforcers and NGOs (Table 1). Training of farmer groups covered aspects on SPVD such as description of the disease, cause, mechanism of spread, symptoms and management techniques. Other agronomy-based crop management practices were also trained. Facilitators' training was broad covering introduction to sweet potato general management, Farmers Field School (FFS) approach, aspects on SPVD such as description of the disease, cause, mechanism of spread, symptoms and management techniques, variety selection, cropping calendar, practical and field tour. The extension personnel and politicians were trained on broad aspects of sweet potato and cassava production. These included agronomy, breeding, plant protection and data management techniques. This was a collaborative training between the project staff and Norwegian People's Aid (NPA). A training workshop in Mwanza organised between Ministry of Agriculture and project staff involved district (10 regions mainly in Lake Zone **but even including Tanga on the Coast**) and prison agricultural officers from 10 prisons from throughout Tanzania. SPVD and CMD-UgV were the principle themes of the training, contributed primarily by the project staff.

Much of this training involved a collaborative between the project staff and Norwegian People's Aid (NPA), whereby project staff provided time and materials and NPA funded logistical costs. There is also a trial site under the collaboration with NPA in Muleba district at Igabiro Agricultural College. Igabiro Agricultural College includes foreign students e.g., from DR Congo, thereby achieving long-distance dissemination of project-derived knowledge.

Table 1. Training achieved on various different themes in Tanzania

Date	Themes	Trained cadres	No. trained
22-31st May 2003	SPVD control and Sweet potato agronomy	Farmers in FFS & Non FFS members	97
2nd June 2003	Sweet potato health, agronomy and effective facilitation	Facilitators and Field officers at ARI-Maruku	12

5-6th June 2003	Sweet potato and cassava as additional food and cash crops in Kagera region	DC's, DALDOs, Researchers, Councillors, extensionist	120
23-27th Sept. 2003	Breeding, agronomy, plant protection and data management in root crops	Extensionist, ward leaders to district level, NPA personnel	50
13-18th October, 2003	SPVD management, Orange fleshed sweet potato, Agronomy, FFS, data management; post harvest techniques	Extensionist, Field officers from NPA, DALDO's Pilot farmers	38
22-31st December 2003	SPVD, alternariosis management, PPB, Sweet potato agronomy and Post harvest techniques	Farmers in FFS & Non FFS members	125
27-29th January 2004	Diseases and pests, PPB, FFS approaches, Sweet potato agronomy and Post harvest techniques	Facilitators and Field officers at ARI-Maruku	14
11th June 2004	Breeding, OFSP, SPVD and Post harvest techniques	Students and teachers from Ntoma home craft college	52
18-22nd October, 2004	Diseases and pests, breeding, agronomy, rapid multiplication. Post harvest processing.	District agricultural officer and prison agricultural officers	20
March 2005	Diseases and pests, breeding, agronomy, rapid multiplication.	Concern extensionists & farmers	24

Lessons learnt

– The main lesson learned was again the benefits for extension of collaboration with other organisations sharing the project's aims

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Additional Output: Survey of incidence of SPVD in Rwanda

Mr E Byamukama (project team) accompanied by Dr. M Mugunga and Ms M Mutumwinka (Plant Protection Programme, ISAR) conducted a survey of SPVD in Rwanda during the period 9 – 18th August 2004. The survey was done in 6 major sweet potato producing provinces namely Butare, Gikongoro, Gitarama, Kigali Ngari, Ruhengeri and Umutara. Generally there was only a moderate incidence of SPVD though, in Gikongoro, incidence averaged nearly 30% and one field was100% affected. Interestingly, drought was again a factor in constraining production but here a major factor seemed to be official control of wetlands preventing sweet potato farmers gaining access to swampy areas to retain planting material during the dry season. For additional details, see: *Report on national sweet potato survey, Rwanda; 09-18th August, 2004*.

Lessons learnt

– SPVD is also prevalent in certain areas of Rwanda
– Drought again restricts retention of planting material

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Contribution of Outputs to developmental impact

Broad contributions

Sweet potato is a crop grown in Africa mainly by relatively poor, mostly women farmers. The project has developed and disseminated control measures for its main disease, SPVD, thereby increasing its productivity in a sustainable manner to the benefit of these farmers.

The project has facilitated links between scientists in Uganda and Tanzania based respectively at Namulonge and Maruku research institutes, facilitating technologies relevant to their common agroecology to be shared across national borders to the benefit of both.

The project has initiated and, to an extent already validated, a participatory breeding approach for sweet potato, for the first time in Africa.

Drought resistance was identified as a key factor in all project activities involving on-farm work and by farmers as a major constraint in survival of planting material essential for the successful production of sweet potato. It appears that drought resistance and maintaining planting material through dry seasons has been under-researched in sweet potato.

Specific contributions

Working with farmer groups, the project has practised both participatory varietal selection and participatory breeding. The former has identified a basket of appropriate varieties for farmers in Uganda and Tanzania and the main reasons for their preferences. There is probably no single ‘best’ variety and farmers were keen to retain a wide range of varieties rather than make a quick selection of a few.

Although orange-fleshed sweet potato varieties have the advantage of providing large amounts of vitamin A cheaply to rural families, one major problem associated with most of the varieties was susceptibility to SPVD. SPK004 was the only orange-fleshed variety demonstrated to resist this disease adequately and resistance needs to be incorporated if the international VITA A project is going to achieve its necessary full impact.

The project has identified further orange-fleshed landraces in Tanzania. These are currently being multiplied before being tested for yield and resistance to SPVD and other constraints – it seems likely they will be more resistant than exotic varieties. It also seems likely that further orange-fleshed landraces could be identified quickly by a purposeful survey in Tanzania and it is suggested that this may be a quick way of sustaining the VITA A programme of activities.

Susceptibility to SPVD, Alternaria and drought caused the elimination of many seedling accessions. The participatory breeding will continue under an agreed project extension; the team and the collaborating farmers are optimistic that high-yielding accessions with resistance to SPVD, Alternaria and drought will be identified. Few of the accessions are orange-fleshed; it is suggested that this approach should be repeated with seed families derived predominantly from orange-fleshed parents.

Roguing was a demonstrably effective and easy means of controlling SPVD. It also increased yields and improved the health of planting material derived from the crop. Isolation of new crops from old crops either by distance or by the use of a crop barrier combined with roguing were a very effective package for controlling the disease but both means of isolation were difficult for farmers to practice. Roguing may enable the full potential of high-yielding but only moderately resistant landraces such as Kigambilinyoko and Dimbuka to be realised. It may also enable moderately resistant orange-fleshed landraces such as Ejumela and Kala to be grown widely, assisting in the realisation of the full potential of the VITA A project.

The introduction of superior SPVD-resistant varieties bred at NAARI to Tanzania had been facilitated by the previous phase of the project. In addition to small-scale dissemination of the varieties through work with farmer groups, the project arranged for them to be multiplied and disseminated widely in southern Kagera region through the activities of NPA. This is an especially poor area of Tanzania, with impoverished soils and affected by the influx of millions of refugees from Rwanda and Burundi.

Training in an understanding of SPVD, its causes, means of spread and means of control has bee provided to extensionists and farmers in both Uganda and Tanzania. Numbers of government and NGO extensionists trained in Tanzania were particularly large due to support by external funds, particularly from NPA. The project has developed brochures and posters in various languages for facilitating training in SPVD control for such farmers. These have already been disseminated; the material is available to national programmes for future dissemination but it will also be used within the DFID-funded Tropical Whitefly Project (2005 – 2008).

Disseminations

Training materials
Posters, brochures and training notes as described in Output 3

Scientific Papers

J.P. Legg, R.W. Gibson and J.d'A. Hughes. 2003. Virus diseases of root crops in Africa: an overview. *Proceedings of Symposium of International Society of Tropical Root Crops*

G. M. Rwegasira, E. F. Marandu, R. W. Gibson and R. E. Kapinga. 2003. Control of sweetpotato virus disease through farmer field schools approach in Kagera region, Tanzania. *Proceedings of Symposium of International Society of Tropical Root Crops*

RW Gibson, E Byamukama, ROM Mwanga, I Mpembe & J Kayongo. 2003. Evaluation of orange-fleshed sweet potato entries for resistance to SPVD and high yield. *Proceedings of Symposium of International Society of Tropical Root Crops*

E. Byamukama, RW Gibson, ROM Mwanga, I Mpembe, and J Kayongo. 2003. Effect of shading and intercropping in management of sweetpotato virus disease in Uganda. *Proceedings of Symposium of International Society of Tropical Root Crops*

Internal Reports:

- J Legg. Visit to Kagera Region, Tanzania, 5 – 9 July, 2004
- GM Rwegesira & EF Marandu. Monitoring visit to NPA initiated activities in collaboration with MARDI
- E Byamukama. Retention of improved sweet potato varieties in Masaka and Rakai districts: a follow up survey report
- M. Mugunga, M. Mutumwinka & E Byamukama. Report on national sweetpotato survey, Rwanda 10 – 17 August, 2004
- B Adolph. Trip report of a visit to the CPP funded research project on "Working with farmers to control sweet potato disease in East Africa", June 2003.
- E Byamukama. Retention of improved sweet potato varieties in Masaka and Rakai Districts
- A follow up survey report. Aug 2004

- M. Rwegasira and E. F. Marandu. Working with farmers to control sweetpotato virus disease in the Lake Zone of Tanzania. March 2004.
- Quarterly and annual reports as requested by CPP

Other dissemination of results:

- Byamukama, E., Mpembe, I, Kayongo, J, Adolph, B. & Gibson, R. Establishing impact of participatory research in the adoption of new technologies in sweetpotato research in Uganda. Presentation made to the International Society for Tropical Root Crops - Africa Branch 9th Triennial Symposium, 31st Oct. – 5 Nov., 2004 in Mombasa, Kenya
- CBS Radio: 2, 1hr broadcasts in Luganda on 8 and 22 June on CBS-FM radio
- R Kalyango. NAARI fights potato virus. New Vision, September 29th, 2004
- **J.P. Legg, R.W. Gibson and J.d'A. Hughes. 2003.** Virus diseases of root crops in Africa: an overview. *Presentation at Symposium of International Society of Tropical Root Crops*
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Biometric issues

Send reply to:	"Emma Byamukama" <ebyamukama@naro-ug.org>
From:	"Emma Byamukama" <ebyamukama@naro-ug.org>
To:	"GIBSON RICHARD W" <R.W.Gibson@greenwich.ac.uk>
Subject:	**Statistical training**
Date sent:	Wed, 23 Mar 2005 08:42:00 -0000
Organization:	IITA

Dear Richard,

This email is to confirm that, in addition to the statistical training that I received as part of my B.Sc. and M.Sc. at Makerere University, the sweet potato project also ensured that I attended the course on 'Handling data from participatory studies' at the University of Reading in 2003. The training was on aspects like participatory rural appraisal tools, generating qualitative data, dealing with ranks and scores and sampling procedures among others. This has proved very useful and appropriate for ensuring we can handle the kind of data we obtain from the project activities, especially given that I can always get further help if necessary from IITA or Makerere statistician .

Sincerely,

Byamukama Emmanuel