UGANDA - GTZ - CIP

SWEET POTATO PROJECT REPORT

1989-1992

JUNE, 1992

NAMULONGE RESEARCH STATION
KAMPALA

ACKNOWLEDGEMENT

The Government of the Republic of Uganda acknowledges with thanks the continuing valuable support of GTZ (Germany) administered by CIP. The donor support has enabled the government to significantly strengthen its research and development program on sweet potatoes.

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I. PROJECT SUMMARY

Sweet potatoes are a major staple food in Uganda, the leading producer in Africa, and one of the four largest producers in the world. The crop is cultivated throughout the country, and is especially important in densely populated areas of the south and west. Annual production is about 1.7 million tons. Although sweet potatoes are a rustic, low-input crop, yields are declining in many parts of the country.

The major constraints are the shortage of high yielding, early maturing varieties of acceptable qualities and tolerance to viruses and weevils; shortage of clean, high quality planting material; viruses, weevils and other pests and diseases; lack of appropriate agronomic practices for specific agroecological zones, perishability and short shelf life; and a limited range of utilization.

The Sweet Potato Research and Development program at Namulonge Research Station near Kampala has been working on a range of projects designed to help farmers overcome these constraints. Donor support provided by GTZ through CIP and support covering operational costs from USAID/MFAD is being used to strengthen research activities in the following key areas:-

1. A baseline survey of sweet potato producers and consumers in nine districts. Information collected by an inter-disciplinary team is being used to set priorities for research and technology transfer, and the data will serve as a baseline against which to measure future impact.

2. Germplasm collection, maintenance, evaluation and breeding. Twelve cultivars have been selected out of 450 accessions collected in 1986. They are being evaluated in different agroclimatic zones. Breeding populations are screened and evaluated for weevil and virus resistance/tolerance and agronomic characteristics. Generation of breeding populations, collection, maintenance and evaluation will continue, followed by importation and screening of improved germplasm.

3. Research on agronomic practices is leading to a systematic evaluation of the declining yields widely reported in the country.

4. Virus symptoms are widespread. Six viruses have been identified using serological techniques. Further research will benefit farmers in selecting and obtaining cleaner planting material.

5. Demonstration plots have been established as one of the methods of transferring improved technologies to farmers.

II. INTRODUCTION

Uganda produces about 1.7 million tons of sweet potatoes from 400,000 hectares per year, and it ranks first in Africa and fourth in world production of the crop. Average per capita production is about 75 to 100 kg/person/year. Sweet potatoes are the third most important food crop in the country after bananas and cassava.

The crop is grown throughout the country, mainly by peasant farmers. Sweet potato is a basic food crop in the diet and it plays a major role in the food security of the rural population. Although marketing problems exist the crop is widely sold as a ready source of cash income in rural and urban markets. The importance of the crop is expected to increase in areas where close substitute crops in the diet like cassava and bananas are affected by serious pest and disease problems. Research on root and tuber crops (RTC), in Uganda started during the colonial era but was given low priority.

The government of Uganda has significantly strengthened its research and development program on sweet potatoes with donor support of GTZ (Germany) and FICAH, channelled through CIP since 1989. The program is building and expanding work on sweet potatoes initially within the RTC program which had assistance mainly from IDRC and IITA. Consolidating of a working team of scientists, rehabilitation of research facilities and training have been the major emphasis. Significant progress made in research projects in key areas being strengthened in collaboration with scientists from CIP's regional office in Nairobi, major objectives and plans for 1992 to 1995 are reported in this document.

PROGRAM PERSONNEL

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REPORT FOR 1989-1991: (A) RESEARCH

Baseline Survey: Sweet potatoes in the food systems of Uganda.

The major objectives of this project are:-

1. Document the current roles of sweet potatoes in the major producing regions, and the major constraints to increased production and utilization.

2. Analyze the current patterns of marketing in both rural and urban areas.

3. Catalyze interdisciplinary research to bring farmers and other potential users of new technology into the process of developing improved technology.

The project commenced in 1989 with pretesting of the questionnaire in Mpigi - Mukono areas and surveying Apac and Mbale districts. Results of the survey were analysed and reported in 1990. Kabale, Gulu and Iganga were also surveyed and preliminary reports of the survey were written. The remaining districts, Mpigi, Luwero, Kabarole and Arua were covered by the end of March 1992.

Salient survey findings are:-

Variety

- need for improved, early maturing, disease and other pest resistant/tolerant, and high yielding cultivars
- high incidence and severity of sweet potato virus in some districts
- low yield levels

Agronomic

- prevalence of intercropping in some districts
- insufficient knowledge on optimum planting and harvesting dates
- declining soil fertility
- shortage of high quality planting materials

Socio-economic

- heavy reliance on family labour
- minimum use of chemicals, fertilizers and pesticides
- limited or no access to credit facilities
- declining trend in sweet potato per capita consumption

Post-harvest

- limited utilization of sweet potato by-products like animal feed complements
- poor storage and high pre- and post-harvest losses
- limited processing and utilization opportunities

GERMPLASM COLLECTION, EVALUATION AND BREEDING

The major objectives of the overall evaluation and breeding programme are to:-

1. collect, characterize and maintain useful germplasm.

2. evaluate local and introduced germplasm and improved populations for yield, resistance/tolerance to major pests and diseases and desirable agronomic traits.

3. generate breeding populations for screening and develop suitable cultivars that combine desirable traits.

A sweet potato germplasm collection is maintained at Namulonge. The accessions have been screened for storage root characteristics, yield and tolerance to virus. Twelve superior cultivars with root yields of over 15 t/ha were selected out of the initial germplasm of 450 accessions and are currently being evaluated under different agro-ecological zones. Results of the performance of various cultivars including IITA *in vitro* material in yield and multilocational trials, generated clones and populations are presented below.

(a) Yield Trials: Materials and Methods

(1) The most popular cultivars described by farmers as high yielding in Gulu and Jinja districts were multiplied at Namulonge Research Station. Performance of the cultivars was evaluated in a replicated yield trial in 1991.

(2) Popular cultivars grown in two different agroecological zones collected from farmers were evaluated in yield trials at the respective testing sites at Nakabango Variety Trial Centre and at Tororo District Farm Institute in 1991.

The plots in the yield trials in (1) and (2) were 32.4 m^2. Cuttings about 30 cm long, without disease symptoms were planted on ridges 1 m apart at 0.3 m between plants within the row on the ridge. Each entry had 6 rows, 5.4 m long. The trials were planted in a randomized block design with four replications. Record taking was done at 2 and at 4.5 months after planting.

(3) Three varieties Kawogo, Tanzania and TIS9237 from Namulonge with 4 others from Mbarara District were evaluated by the South West Region Agricultural Rehabilitation Project (SWRARP) at Rubare near Mbarara in 1990/91. The trial was planted in a completely randomized design with 2 replications. Planting was in October 1991 and the trial was harvested at 6.5 months after planting. Plot size was 5.0 m^2. Vine cuttings were planted on ridges 0.9 m apart at 0.5 m between plants within the row.

(4) Fourteen sweet potato varieties received as *in vitro* plantlets from the International Institute of Tropical Agriculture (IITA) were multiplied in a glasshouse at Namulonge. The material was evaluated in replicated trials at Namulonge and Mubuku near Kasese.

Results and Discussion: Yield Trials

(1) Results of the yield trials are shown in Tables 1 to 5. Total root yield ranged between 8.2 to 17.0 t/ha. Cultivar Odey can gave the highest root yield and Ocwara Opok had the least yield (Table 1). Although the root yields were higher than the national average of 4 t/ha they are still low compared to potential yields. Effects of factors like virus infection and soil fertility status partly explain the low yields. Weevil attack was not severe. The trial was discontinued because plants showed severe virus symptoms.

(2) Performance of the local popular cultivars at Nakabango and Tororo was generally good (Tables 2 and 3). Total fresh root yields varied between 17 and 30 t/ha at the two sites. Tanzania gave the highest yield at Tororo while the unknown local check cultivar gave the lowest yield. Although virus diseases were more severe at Nakabango, average yields were higher than at Tororo.

Nakabango has more fertile soils than Tororo and the varieties grown in the two trials were different except for Tanzania. Weevil damage was greater at Tororo than at Nakabango. The two trials were replanted in october 1991 to confirm results of the first season.

(3) Results of the evaluation by the SWRARP at Rubare are shown in Table 4. Tanzania gave the highest yield, 45 t/ha and the IITA variety TIS 9237 had the least yield, 6 t/ha. Four of the varieties had more than 20 t/ha. Although the plots were small the yield potential of sweet potato was shown to be relatively high under Rubare conditions.

(4) The varieties (tissue culture material) received from IITA including several listed as highly resistant succumbed to viruses within two seasons at Namulonge in 1989/90. Although performance of 13 entries in the 1989 first season was good (Table 5) at Mubuku further testing of 6 selected varieties was phased out because of degeneration of the varieties due to viruses and poor taste.

Table 1. Yield trial at Namulonge planted in May 1991*

Entry	Source of planting material	Weevil score	Virus score	DMC (%)	Marketable yield (t/ha)	Total yield (t/ha)
Kotido (=Tanzania)	Gulu	3	5	30	7.0 b	13.5 ab
Odeyo cani	Gulu	3	5	26	11.2 a	17.0 a
Kampala (=Kyebandula)	Gulu	3	5	27	7.8 bc	8.7 bc
Bwom Dege	Gulu	5	5	30	8.9 bc	12.0 bc
Cwara opoko	Gulu	3	5	26	3.9 c	8.2 c
Sula Oluti	Nakabango	3	3	31	6.5 bc	10.1 bc
Un	Nakabango	3	7	31	7.1 bc	11.8 bc
Mean		-	-	-	8.1	11.6
CV (%)		-	-	-	22.9	21.3

* Means with common letters within a column are not significantly different at 5% level according to Duncan's Multiple Range Test.
Virus and weevil scores scale 1-9
1 - no damage or not present
9 - severe effect or very high numbers
DMC = Dry matter content
Harvested at 4.5 months after planting

Table 2. **Yield trial at Nakabango planted in May 1991***

Entry	Weevil score	Virus score	Marketable yield (t/ha)	Total yield t/ha)
1. Mpaeifumbiro	1.0 b	3.5 b	18.2 b	24.3 ab
2. Kawogo	1.5 ab	3.0 b	19.4 b	22.9 ab
3. Wagabolige	1.0 b	3.5 b	23.5 a	26.7 a
4. Tanzania	2.5 a	4.5 ab	19.4 b	24.2 ab
5. Sulaoluti (check)	1.0 b	7.0 a	14.1 c	21.1 b
6. Silk	1.5 ab	5.0 ab	15.7 bc	22.4 ab
Mean	1.4	4.4	18.4	23.6
CV (%)	48.8	24.4	13.7	11.1

* Means with common letters within a column are not significantly different at 5% level according to Duncan's Multiple Range Test

Virus and weevil scores, scale 1-9

1 - no damage or not present

9 - severe effect or very high numbers

Harvested at 4.5 months after planting

Table 3. **Yield trial at Tororo planted in May 1991***

Entry	Weevil score	Virus score	Marketable yield (t/ha)	Total yield t/ha)
1. Tororo 2	4.5	3.0	19.0	23.4 ab
2. Tororo 1	3.5	3.0	15.7	16.7 b
3. UNDFI	4.0	3.0	14.8	17.4 b
4. Check (UN)	4.0	3.5	17.1	27.3 a
5. Tanzania	4.5	3.0	19.9	30.1 a
6. Tororo 3	3.5	3.0	22.2	28.6 a
Mean	4.0	3.1	18.1	20.0
CV (%)	24.7	18.5	25.2	24.1

* Means with common letters within a column are not significantly different at 5% level according to Duncan's Multiple Range Test.
Virus and weevil scores, scale 1-9:
1 - no damage or not present
9 - severe effect or very high numbers
Harvested at 4.5 months after planting

Table 4. **Sweet potato variety trial planted in October 1990 at Rubare***

Variety Name	Source of planting material/ comment	Yield (t/ha)
1. Tanzania	Namulonge Research Station	45.0
2. Kawogo	Namulonge Research Station	32.0
3. Ntahansi	Rubare/Local cultivar	29.0
4. Bikira Maria	Rubare/Local cultivar	24.5
5. Kyebandira	Rubare/Local cultivar	22.0
6. Kashoga	Rubare/Local cultivar	8.7
7. TIS 9237	Namulonge/IITA Tissue culture material	6.2
Mean		24.0

*Harvested in October 1991 at 6.5 months after planting.
2 replications. $5m^2$ plots.

(b) **Multilocational Trials: Materials and Methods**

Twelve cultivars selected from a germplasm collection of 450 accessions were planted in a multilocational trial in May 1991 at Namulonge, Nakabango and Tororo. Cuttings of each entry were planted on 4 ridges one meter apart and 0.3 m between plants within the row. The trial was replicated 4 times in a randomized block design.

Results and discussion

The trial was harvested in October 1991 and the results are summarized in Table 6. Two of the entries 39 and 29 performed consistently well at the 3 locations (Table 7). Virus and weevil attack were more severe at Namulonge than at the other two locations. Most of the entries have high dry matter, 30 to 36%, a character highly correlated with good taste and acceptability by consumers. The trial was replanted in October 1991 to confirm results of the first season and to select superior cultivars for on-farm testing.

(c) **Intermediate Yield Trial**

Sixty clones out of an initial population of 50,000 seedlings raised in 1989/90 were advanced to intermediate yield trial in October 1991.

(d) **Clonal Evaluation**

A total of 32,000 clones from a population of 60,000 seedlings raised in 1989/90 were planted in a clonal evaluation trial in september 1991.

The breeding materials at the intermediate yield trial and clonal evaluation are being screened against viruses, weevils and for agronomic traits.

Table 5. First season results of IITA tissue material planted at Mubuku in 1989[1]

Variety	Establishment	Sweet Potato Virus	Alternaria	Erinose	Weevil damage	Cracking	Yield t/ha
1. Kawogo*	good	1	-	-	1	+	2.60
2. TIB 10(3)	poor	1	-	-	1	-	29.90
3. TIS 8401	very vigorous	1	+	+	1	-	20.25
4. TIS 3290(46)	fair	5	-	-	5	+	38.07
5. TIS 2544/28	good	1	-	-	3	-	27.87
6. TIS 5125	poor	1	-	-	1	+	20.20
7. TIS 8441	poor	1	+	-	3	+	17.87
8. TIS 83/176	vigorous	1	-	-	1	+	28.84
9. TIS 70357	poor	1	-	-	3	-	25.93
10. TIS 2534	vigorous	1	-	-	5	-	30.15
11. TIS 9265	vigorous	1	-	-	3	+	18.72
12. TIS 2498(17)	fair	1	+	-	5	+	21.80
13. TIS 82/0395	poor	3	-	-	5	+	27.62
14. TIS 9465	vigorous	1	-	-	5	+	29.83

[1] Results are of 4 replications
Disease and weevil score: 1 = no damage, 9 = severe effect or large numbers present
+ = present - = absent
* = Long term local cultivar

Table 6. Sweet potato multilocational trial planted in May 1991*

Location	No.of entries	DATA								
		Weevil score		Virus score		Marketable root yield		Total yield (t/ha)	Root	Dry matter (%)
		Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range
Namulonge	12	3-7.0	4.5	3-7.5	6.0	4-11	6	7-16	12	29-36
Nakabango	12	1-3.0	1.5	3-5.3	4.3	8-23	14	11-27	18	-
Tororo	12	3-5.3	4.0	3-5.3	3.9	6-11	8	8-14	11	-

* Weevil and virus score: scale 1-9, 1 - no symptoms, 9 - severe effect or very high numbers present. Results are of 4 reps.

Table 7. Sweet potato multilocational trial planted at three locations in 1991[1]

	NAMULONGE					NAKABANGO				TORORO			
Entry	Weevil Score	Virus Score	Market Yield (t/ha)	Total Yield (t/ha)	DM(%)	Weevil Score	Virus Score	Market Yield (t/ha)	Total Yield (t/ha)	Weevil Score	Virus Score	Market Yield (t/ha)	Total Yield (t/ha)
1. 2	5.5	7.0	4.6	10.3	32.0	1.5	4.5	8.0	14.9	4.0	3.0	9.7	12.8
2. 8	4.5	7.0	4.6	7.2	29.6	1.0	4.5	8.7	12.9	5.0	4.5	6.4	9.1
3.13	4.0	7.0	5.7	5.9	32.0	1.0	6.5	14.5	19.6	4.5	4.5	6.9	9.4
4.16*	6.0	6.5	8.5	14.2	36.5	1.0	4.5	14.3	16.6	3.5	4.5	6.9	10.1
5.20	2.5	5.0	8.0	13.7	30.3	1.0	4.0	16.6	21.5	3.0	3.5	8.6	11.9
6.21	4.0	7.5	4.9	7.5	30.3	1.5	4.5	11.3	13.6	3.0	3.5	9.4	11.8
7.23	4.0	7.5	5.6	10.3	29.4	2.0	4.5	7.9	14.9	3.5	4.5	10.4	13.4
8.24	4.0	7.0	8.5	14.7	31.0	1.5	4.5	8.6	15.9	3.5	4.5	8.9	12.0
9.27	7.5	6.5	5.4	12.2	29.0	3.0	4.0	19.0	25.0	6.0	4.5	8.2	11.7
10.29	3.5	3.0	8.0	15.1	31.5	3.0	3.0	22.1	26.8	3.0	3.5	9.1	11.4
11.39	5.0	4.0	10.8	16.1	30.9	2.0	3.0	23.1	27.1	4.5	3.0	11.2	14.2
12.40KA	3.0	4.0	3.9	7.2	31.9	1.0	4.0	10.9	11.3	4.0	3.0	5.9	7.5
MEAN	4.5	6.0	5.8	11.5	31.2	1.6	4.3	13.8	18.3	4.0	3.9	8.5	11.3
LSD(5%)	1.5	1.5	2.1	3.1	4.3	1.1	0.8	5.2	6.0	1.7	0.9	2.9	4.1
CV (%)	23.7	17.3	23.2	18.9	9.5	48.0	13.6	26.6	22.7	30.5	15.4	24.6	24.9

[1] Weevil and virus score scale 1-9: 1 - no damage, 9 - severe effect or very high numbers present
Market yield = marketable yield
DM = Dry Matter
* = Local Check

(e) Generation of Breeding Populations

A total of 128,650 open pollinated high density seeds were collected in 1990 (Table 8). These hybrid seeds will provide genetic materials for seedling screening for high dry matter content and yield and improved tolerance to viruses this year.

Table 8. **Number of hybrid seeds produced in 1990**

Parent/Source	Number of high density seeds harvested
Entry 2	2,769
8	12,783
21	1,392
20	1,691
23	1,046
16	3,036
24	3,482
27	2,053
29	530
39	321
Kawogo	4,188
Bulk	15,247
Bugerere	1,507
Ocwar Opok	897
Clonal Evaluation 1991	38,659
PYT 1991	25,773
Tanzania	12,989
Kyebandula	287
Total	128,650

RAPID MULTIPLICATION AND PRODUCTION OF PLANTING MATERIALS

Shortage of good quality planting materials due to virus degeneration and drought is a major problem in many areas. Evaluating the potential benefits of the various rapid multiplication techniques and developing appropriate schemes for the distribution of planting material is part of the on-going interdisciplinary research approach.

The most popular high yielding cultivars like Kawogo, Kyebandula, Tanzania and Ecuru are multiplied rapidly using two-node cuttings when needed for experimental purposes. Varieties received as tissue culture plantlets from the IITA namely, TIS 83/170, TIS 5801, TIB 5801, TIB 2(26), TIS 5125, TIB 2544/28, TIS 3290(26), TIS 8401, TIB 10(3), TIS 8250, TIS 70683, TIS 1487, TIB 11(102) and TIS 9237 were rapidly multiplied in 1988/89 for evaluation at Namulonge. The 14 IITA accessions, however, succumbed to viruses.

The planned tissue culture facility to be set up at Namulonge Research Station will initially be used to produce disease free plants and micropropagation of desirable genotypes as a major component of planting material production activities.

IDENTIFICATION AND EPIDEMIOLOGY OF VIRUSES

The most serious and common disease problems of sweet potato in Uganda are viruses (Aldrich 1963, Nyiira 1980, Mwanga and Wanyera 1988). There are field experiment reports showing 57% or more crop loss due to viruses (Mukiibi 1977) and 66% (Aldrich 1963). Crop loss depends on cultivar, stage of infection and prevailing environmental conditions and can be devastating on

highly susceptible cultivars. However, significant genetic variations have been observed and these range of variations in tolerance levels to viruses in the germplasm can be utilized in breeding programs as one of the strategies for minimizing virus induced crop losses.

The objectives of this project are to:

1. survey the viruses found in the different agro-ecological zones.

2. identify the viruses using serological techniques developed at CIP.

3. measure the yield losses.

4. establish the dynamics and rates of re-infection in different areas, depending on the populations of the vectors, environmental conditions, host plant resistance and other factors.

5. set up effective clean-up procedures to provide virus-free stocks for rapid multiplications.

In collaboration with CIP, random samples from surveyed areas of Namulonge Research Station, its vicinity and from Mukono were taken for virus assay to the Kenya Agricultural Research Institute (KARI). Immunosorbent electron microscopy (ISEM) or more usually, the nitrocellulose membrane form of enzyme-linked immunosorbent assay (NCM-ELISA) was used to identify the viruses present in sweet potato or in *Ipomoea setosa* after graft infection from sweet potato. The samples were examined using 7 specific immunoglobulins (IgGs) of sweet potato feathery mottle virus (SPFMV), sweet potato latent virus (SPLV), sweet potato mild mottle virus (SPMMV), sweet potato chlorotic stunt virus (SPCSV), sweet potato ring spot virus

(SPRSV), cucumber mosaic virus (CMV) and sweet potato caulimo-like virus (SPCV).

Results of the analysis indicated that all the 7 viruses (Table 9) tested for were present in the surveyed locations except SPRSV.

Table 9. Percentage of samples with different viruses and virus complexes for different locations

Location in Uganda	No.of samples	SPFMV	SPLV	SPMMV	SPCLV	SPRSV	CMV	SPCSV
Namulonge Res. St.	58	71	53	62	33	0	50	71
Namulonge vicinity	49	67	65	53	16	0	67	78
Mukono	54	87	57	59	39	0	39	67

These results help to explain why the 14 sweet potato varieties from IITA including several described as highly resistant succumbed to viruses within two seasons at Namulonge in 1989/90. Under the IITA conditions in Nigeria only two infective agents as compared to six at Namulonge were separated from a sweet potato virus disease (SPVD) complex by Schaefers and Terry in 1976. In addition to the virus complexes at Namulonge and IITA being different the environmental conditions also differ.

INTEGRATED PEST MANAGEMENT (IPM)

Entomopathogens of Sweet Potato Weevils

The sweet potato weevil is a major pest in Uganda, especially during dry periods. Two surveys were conducted in eastern and central Uganda in collaboration with the International Institute of Biological Control (IIBC), Kenya, in 1989 and 1990. In July, 1989 G.B. Allard and B. Odongo sampled in the eastern and central regions of Uganda, and in 1990, G.B. Allard, M.J.W. Cock and P.S. Nemeye sampled near Kawanda. Sites were taken at random and observations were made of insect species on and under the foliage and on the ground. Destructive sampling was not done. The main objective was to search for entomopathogens. A summary of the major observations made during the two surveys is presented in Table 10.

Some entomogenous fungi, *Beauveria bassiana* were found on weevils *Cylas puncticollis* and *C. brunneus* and *B. brogniartii* were found on the rough sweet potato weevil, *Blosyrus* sp. Some micro-pathogenic fungi (to be identified) were also found infesting larvae and pupae of the sweet potato butterfly, *Acrae acerata.*

An IPM technique, based on the use of crop rotation, plant resistance, earthing up to prevent storage root exposure or control of alternate *Ipomoea* hosts, has been initiated in collaboration with Makerere University, at Kabanyolo. Continuous trapping of weevil males in sex pheromone-baited traps will be incorporated in the technique when the pheromone becomes available.

Table 10. **Major observations on sweet potato pests made in July 1989 and October 1990**

PEST	LOCATION SURVEYED	COMMENTS
1. Weevils		Major pest
*Cylas puncticollis**	C.R: Kabanyolo, Kamengo, Nangabo subcounty, Nakitoma E.R: Tororo DFI, Jinja, Bugiri, Nakabango DFI	
C. brunneus adult*	C.R: Gayaza, Kiwenda Kabanyolo, Nangabo subcounty E.R: Nabusere, Tororo	
*Blosyrus obliquatus**	C.R: Gayaza, Kiwenda, Nangabo subcounty, Namulonge Res. St. E.R: Namulesa	
Blosyrus scopulifera	Bugiri, Tororo	
2. *Acerea acerata* (larvae)	Tororo DFI, Gayaza	can cause complete defoliation during dry periods

3.	*Synanthedon* sp.** (larvae & pupae)	Jinja, Nangabo	Heavy infestation. cause swelling of root collar, permit entry of secondary infection + *P. citri*
4.	*Planococius citri* (mealybug)	Kiwenda, Jinja, Nabusere, Bugiri, Kibimba, Nakabango	found in live swollen stem, status: primary/ secondary pest. High incidence contributes to stress yield loss/ dry season?
5.	*Nematocerus castaneipennis*	Kiwenda	status not established
6.	TORTOISE BEETLES:		Status not established (not major pest)
	Aspidomorpha sp (P)	Kabanyolo	
	A. cincta	Tororo	
	A. nigromaculata	Tororo, Namulonge	
	A. strigosa	Namulonge	
7.	*Alcidodes dentipes*	Tororo, Bugiri, Buluri, Nangabo, Namulonge	Status not established (not major pest)
8.	*Laccoptera corrugata*	Tororo	Status not established (not major pest)

L. montivaga	Namulonge	-do-
9. *Chiridopsis?* *aubei*	Namulonge	-do-
10. Millipedes	Jinja, Namulonge Iganga	Feed around roots (not verified, white grubs also implicated)
11. Root rats: *Croptomys* sp. *Techoryctes* sp.	Kabanyolo, Tororo	Major pest in some districts

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* Some specimens were infected with entomopathogenic fungi

** Ants were found attacking larvae of *Synanthedon* sp. in the stems.

Identification was made by the International Institute of Entomology (IIE).

E.R. = Eastern Region C.R. = Central Region

Vine Collar Damage by Clearwing Moth

Studies conducted in 1991 at the Makerere University Agricultural Research Institute, Kabanyolo (MUARIK), indicated severe damage to vine collars by the clear wing moth, *Synanthedon dasysceles* and the sweet potato weevil, *Alcidodes dentipes* Ol. not previously reported.

Nematodes of Sweet Potatoes

Sampling for nematodes in sweet potato experimental fields at Namulonge Research Station was done during a survey for nematodes of root and tuber crops in Uganda in March 1991 by John Bridge of the Natural Resources Institute in the U.K. Identification by J. Machon of the International Institute of parasitology revealed the presence of very large populations of the semi-endoparasitic nematode, *Rotylenchulus reniformis*, in roots and soil. The nematode is known to be a pest of sweet potato in the U.S.A. and other places causing significant yield losses. Other known serious nematode pests of sweet potato, partialarly, *Meloidogyne incognita*, were not detected in the survey although they have been reported associated with the crop in Uganda (Macdonald 1963).

AGRONOMIC TECHNOLOGY

The main aim of the programme is to generate improved production technologies appropriate to farmer circumstances for sustainability. Increasing yield per unit of productive land and improving tuber quality for market and consumer acceptability are among the major objectives of the programme.

Between 1989-1991 some improved agronomic packages have been developed and are briefly outlined below:

(a) **Vine placement and plant density interaction effects on the yield of sweet potato**

The position of the vine on the mound (centrally or triangularly placed) has no significant effect on tuber yield and quality although yield was higher in the former. At a high population density (44,000 plants/ha) competition for nutrient is very acute, resulting into low tuber yield. Highest yields were obtained at a population of 22,000 plants/ha.

(b) **The effect of seedbed preparation on tuber yield and quality of sweet potato and the economic implications**

Flat seedbeds were more weedy, difficult to weed and required more time to weed. harvesting tubers from flat seedbed was more difficult because the tubers were deep seated and were frequently damaged.

Total yields of sweet potatoes were highest and lowest from ridged and flat seedbeds, respectively. Ridged seedbeds gave superior quality tubers but there was no significant difference in quality.

It was found out that planting on ridges was the best method of growing sweet potatoes both in ease and monetary terms.

(c) **In-ground storability studies of four sweet potato varieties**

Location: Namulonge Research Station

Introduction

Sweet potato roots do not "ripen" but would continue to enlarge and eventually mature as long as conditions favourable for growth exist. One technique for setting an optimum distribution of tuber sizes is the timing of harvest. A large quantity of sweet potatoes is eaten piecemeal from the ground when grown for home consumption. Surplus may be harvested and sold. If grown for commercial purposes the whole field is usually harvested at once. Sweet potato storage roots have very short shelf life. Excess harvest may be thrown away due to root rot as farmers' method of storage is very inefficient. Long period of in-ground storage may prolong consumption pattern as well as maximise yield and hence attractive cash return to the producer. The experiment was therefore designed with the following objectives:-

1. To establish the optimum harvest dates for optimum tuber yield and high tuber quality

2. To create awareness among farmers that some sweet potato varieties can store safely in the soil much longer than expected

3. To prolong in-ground storability period, hence consumption pattern and subsequent availability of planting materials for the following season.

4. To establish post-maturity in-ground storage periods for the popular varieties

Materials and Methods

Four most popular and commonly cultivated varieties Kawogo, Kyebandula, Tororo 1 and Tanzania, all with different agronomic characteristics were planted on ridged seedbeds laid in a complete randomised block design (CRBD) replicated four times. Data for the short-term variety, Tanzania was analysed separately. The experiment was planted during the second season of 1990 and is being repeated.

Results and discussion

Varieties Kawogo and Kyebandula are late maturing requiring 8-10 months while variety Tororo 1 is early maturing but attains its optimum yield at the same time with variety Kawogo at 10 months after planting (Table 11). Variety Tororo 1 significantly (P=0.05) outyielded the others.

Table 11. **Mean yields t/ha at different harvesting dates**

Variety	Months after planting (MAP)					Mean
	6	7	8	9	10	
Tororo 1	21.6	23.4	29	26.4	37.4	27.6
Kawogo	7.1	12.0	10.8	15.8	29.9	15.0
Kyebandula	10.1	17.9	25.6	19.3	21.7	18.9
Mean Monthly	12.9	17.8	21.8	20.5	29.4	

C.V. 33.3% significant (P = 0.05)

Variety Tororo 1 is highly susceptible to weevil attack and the weevils invade storage roots right from 6 months after planting and the severity increased with in-ground storage period. Kawogo is relatively tolerant to weevil attack and appreciable attack began at 9 MAP while Kyebandula succumbs to weevil attack as early as 8 MAP and the severity increased with time. Tuber quality (% marketable tubers) varies among varieties and tended to increase until a point then declined. The decline in quality is partly attributed to weevil infestation and damage and tuber rot diseases which render tubers unacceptable by market standard.

Table 12. **Varietal susceptibility to weevil infestation**

Variety	Months after planting					Mean
	6	7	8	9	10	
Tororo	1.5	1.5	5.0	7.0	7.0	4.4
Kawogo	1.0	1.0	1.0	3.0	3.0	1.8
Kyebandula	1.0	1.0	2.5	5.0	5.0	2.9

CV 25.1%

Weevil damage (score 1, 3, 5, 7 and 9)

1 = no damage

9 = severe

Table 13. **Relationship between yield, tuber quality and weevil damage**

Mean	Variety		
	Tororo	Kawogo	Kyebandula
Yield t/ha*	27.6	15.0	18.9
Marketable tuber (%)	56.4	62.7	63.9
Weevil damage** (score)	3.9	1.8	2.7

* Significant (P = 0.05)

** Significant (P = 0.01)

Considering the storage root yields, tuber quality (marketable tubers %) and the damage caused by weevils over an extended period of five months after the expected (farmers perception) maturity period of 6 months after planting, it is likely that a commercially-oriented farmer may benefit more when he harvests the December planted sweet potato crop of varieties Tororo 1, Kawogo and Kyebandula at 6, 8 and 8 MAP, respectively under a similar environment to Namulonge.

Variety Tanzania reported to mature at 3-4 months after planting was also studied and the results showed that storage root yields, quality, dry matter content and weevil damage increased with in-ground storage period (Table 14).

Table 14. **Relationship between yield, tuber quality and weevil damage in variety Tanzania**

Mean	Months after planting					
	4	5	6	7	8	Mean
Yield t/ha***	4.8	12.5	19.9	19.3	34.9	18.3
Marketable tubers*** (%)	12.8	24.5	43.8	51.3	58.5	38.2
D.M. %	-	26.8	30.0	34.0	35.0	31.5
Weevil damage*	1.0	1.0	2.5	4.0	6.0	2.9

* Significant (P = 0.05)

*** Significant (P = 0.01)

The general farmer perception of variety Tanzania is that the variety is early maturing at 2-3 MAP. When planted in December in a sandy loam soil, even after four months yield and quality are still the lowest. However, at 2-3 MAP, the first one or two tubers formed would be big enough for piece meal harvest but this does not indicate maturity per se.

The storage root yield and quality are relatively high at 7-8 MAP. Despite high level of weevil damage at 7 and 8 MAP, nearly 50-60% of the total tuber yield could be marketed. Results showed a positive (r = 0.116) but non significant correlation between in-ground storage and weevil damage to storage root. However, the weevil population is dynamic depending on soil type and season and therefore it is risky to prolong in-ground storage beyond the optimum period.

When grown for piecemeal purposes, the consumption pattern for variety Tanzania can be as long as 8 months from 2-8 MAP. This may be possible because there is evidence that weevils tend to attack relatively mature tubers than immature ones. Sinc the older tubers would be removed for piece meal variety Tanzania grown for commercial purpose could still be harvested at 7-8 MAP since more than 50% of the total yield with high DM % is marketable.

Conclusion

No definite conclusion can be drawn as yet and the experiment is being repeated.

(d) **Effect of vine storage on establishment, growth, yield and quality of sweet potato**

Location: Namulonge Research Station

Introduction

One of the common practices among farmers is either planting of vines on the same day of cutting or planting after storage for 3-7 days. Planting on the same is common in areas where the hand is used to plant the vines. The method minimises breakage of freshly cut vines. Planting after vines have withered is a common practice in areas where forked sticks are used to plant the vines. Besides being flexible withered vines are believed to establish quickly and give high yields. Delayed planting may also be due to lack of labour. However, there is no documented evidence that withered vines establish faster and hence give better yields. The study was therefore designed with the following objectives:-

(a) To study the effect of vine storage on establishment, growth, yield and quality of sweet potato

(b) To study the physiological and biochemical changes that occur during storage and how they influence the nutrient composition of the subsequent storage root.

Materials and Methods

A common and popularly grown, fairly short term and most suitable for piece meal harvest variety Tanzania was used. Vines of 0, 1, 3 and 7 days after cutting were planted on the same day in a complete randomised design (CRD) in six replicates. Ridged seedbed was used and the crop was hand weeded and no fertilizer or irrigation was applied. The crop was harvested after four months after planting and data were taken on storage root yield, vine yield, tuber quality and weevildamage.

Results and discussion

The results (Table 15) showed that delayed planting had no significant effect on storage root yield, vine yield, dry matter content and tuber quality. However, observable yield reduction occured when vines were stored up to 7 days before planting. This may be explained in terms of food reserves in the cuttings. At 7 days the vines had formed roots and some buds. The food reserves meant to effect establishment in the soil were therefore utilized pre-maturily. This has also been reflected in vine yield and dry matter content of the storage root.

Table 15. Mean yields and quality of sweet potato (var Tanzania) as affected by vine storage

Storage period (days after cutting	Storage + root yield kg/plot	Vine yield kg/plot	Marketable tubers %	D.M. %	Weevil damage
0	16.5	39.3	80.7	32.4	2.0
1	17.8	42.0	90.2	35.0	2.0
3	17.5	41.8	75.2	33.2	2.2
7	14.8	38.5	79.7	33.1	2.0

The weevil damage score was almost uniform, an indication that vine storage may not alter the maturity period of the variety used. The experiment will be repeated this season.

2. REPORT FOR 1989-1992: (B) TRAINING AND WORKSHOPS

(a) Workshops

Members of the sweet potato research team attended several workshops and presented several papers during the period of reporting. A list of the workshops and papers presented or published is in Appendix 1.

(b) **Training**

A one-week training course on the identification and management of diseases of potatoes and sweet potatoes was held in November 1990 at Kachwekano, south-west Uganda. The 18 participants from research and extension were drawn from all major zones of production. Resource personnel were from CIP's regional office in Nairobi and from the Kenya Agricultural Research Institute.

The Agronomist, Mr. Ocitti p'Obwoya had a successful three-week study tour to Region VI (Sri Lanka and India), in May 1991.

V. SUMMARY BUDGET REPORT

A total of 300,000 U.S. dollars from GTZ (Germany) and $100,000 from FICAH was provided for the period 1989-1992. The funds have been budgetted to strengthen research infrastructure at Namulonge Research Station and at Makerere University, to cover key operational costs, and to support training. The program's leaders agreed to transfer $25,000 to strengthen the Rwanda regional program. These grants have been administered by CIP's regional office in Nairobi together with the Secretary for Research in Entebbe. The funds have been provided mainly for the following:-

1. Capital: Field vehicles and motorcycles have been purchaseed or ordered to enable mobility for researchers and extension staff. Two computers, a photocopier, a camera and other audio-visual aids have been bought to support research and training.

2. Operational costs: Operational costs cover the maintenance of the vehicles, field expenses for the interdisciplinary survey, and incidental research costs on the stations.

3. Training: This covers in-country training and consultancies.

4. Services: Multi-year subscriptions to journals and periodicals have been ordered by the program in collaboration with CIP. Foreign travel by Ugandan scientists to attend international conferences and to visit other research programs has also been possible through CIP.

VI. SUMMARIES OF CURRENT AND PROPOSED RESEARCH PROJECTS

The following projects are either underway or have been proposed this year.

1. **Baseline survey: Sweet potatoes in the food systems of Uganda**
   Project Leaders: B. Bashaasha, R.O.M. Mwanga, C. Ocitti p'Obwoya
   Cooperators: P.T. Ewell, CIP

A survey of nine major sweet potato producing districts started in 1989 was completed in March 1992. Data analysis is in progress. The project has been supported with funds from GTZ, FICAH, and CIP. The main objectives are:-

- Document the current roles of sweet potatoes in the food systems of uganda, and the major constraints to increased production and utilizatin, to target research in the most critical areas.

- Catalyze interdisciplinary research to bring farmers and other potential users into the process of developing improved technology.

2. **Germplasm collection, evaluation and breeding**
   Project leaders: R.O.M. Mwanga and C. Ocitti p'Obwoya
   Cooperators: H.M. Kidanemariam and L. Sikka, CIP,
   D. Bhagsari, Makerere University

The project is divided into three sub-projects:

A. Germplasm collection and maintenance

This sub-project includes the maintenance of the collection at Namulonge, its duplication at Kalengyere and the collection of additional landraces in unexplored areas.

B. Development and Screening of breeding populations

This sub-project covers on-going screening and breeding research at Namulonge. Populations will also be screened in southwestern Uganda for adaptation to highland conditions.

C. Regional Evaluation of promising clones

Promising clones, local landraces and material introduced from other countries will be evaluated under different agroecological conditions. The program will be expanded to cover five testing sites: Namulonge, Kabale, Nakabango, Mubuku, Luwero and Tororo.

3. Multiplication and distribution of planting material

Project Leaders: C. Ocitti p'Obwoya, R.O.M. Mwanga, B. Bashaasha

Cooperators: D.R. Akimanzi, MAAIF, L. Sikka, P.T. Ewell, CIP

Planting material is often an important constraint when:

(a) farmers cannot obtain good varieties adapted to their conditions;
(b) available planting material is virus-infected; and/or

(c) planting material is not available when needed, at the beginning of the rains.

The multiplication and distribution of clean planting material will be linked to the installation of a tissue culture laboratory and clean-up facility at namulonge donated by the International Atomic Energy Agency in Vienna. Pilot rapid multiplication sites will initially be set up in Kabale and Luwero districts. Alternative schemes for further multiplication and distribution of the vines to farmers will be investigated. After establishing good procedures, it is planned to expand the program in subsequent years to include districts like Mbale, Mpigi, Mukono, Masindi and Apac.

4. **On-station Agronomic research at Namulonge**

Project Leaders: C. Ocitti p'Obwoya and R.O.M. Mwanga

Cooperators: L. Sikka, CIP; Makerere University

This project is for the support of on-going agronomic research.

5. **On-farm agronomic research**

Project leaders: C. Ocitti p'Obwoya, R.O.M. Mwanga and B. Bashaasha

Cooperators: D.R. Akimanzi, MAAIF, L Sikka, and P.T. Ewell, CIP.

Sweet potatoes are cultivated under a wide range of agro-ecological conditions and constraints. Bringing research to the farmers is critical, so that they can participate in the process of technology development, selection, adaptation and transfer. It is planned to establish on-farm research in two areas, eventually expanding the program to all the major agro-ecological zones. The work will be in close collaboration with the district extension

personnel. The priority topics for on-farm research include:-

- performance of local and improved cultivars, in collaboration with project NO.2
- planting density and planting methods
- soil fertility and farming practices
- in-ground storability and weevil incidence
- intercropping

6. Identification and Epidemiology of viruses and yield loss assessment

Project Leaders: M.W. Ogenga-Latigo (Makerere University),
R. Mwanga, S. Kasule (Kalengyere)
E. Karamura (Kawanda)

Cooperators: L. Skoglund, CIP

Virus symptoms are widespread on sweet potatoes in Uganda and severe damage has been reported in some areas. it is critically important to:-

- Survey the viruses which occur in different agro-ecological zones,
- Identify the viruses using serological techniques developed at CIP,
- Measure the yield losses,
- Establish the dynamics and rates of re-infection in different areas, depending on factors like the populations of the vectors, environmental conditions and host plant resistance,
- Set up effective clean-up procedures for production of virus-free stocks for rapid multiplication.

The preliminary work already done coupled with field surveys and experiments will lead to a clearer definition of the scope of the problem and of the procedures to be established.

7. **Integrated Management of sweet potato weevils**

Program Leaders: M.W. Ogenga-Latigo (Makerere University), R. Mwanga

Cooperators: E. Karamura (Kawanda), N. Smith (CIP), G. Allard (IIBC)

Sweet potato weevils (*Cylas* sp.) are the single most significant pest of the crop. The project has been initiated in collaboration with Makerere University to study the effect of cultural practices on infestation and damage by weevils. The following factors will be considered:

- crop rotation and time of planting
- planting weevil-free vines
- filling cracks with soil to prevent weevils reaching the bulking roots
- adequate separation of plots from other sweet potato plots and alternative hosts,
- continuous monitoring using traps baited with sex pheromones or virgin females.

8. **Consumption patterns and potential demand for sweet potatoes**

Project Leaders: B. Bashaasha, R. Mwanga, C. Ocitti p'Obwoya

Cooperators: D. Ngambeki, Makerere University, P.T. Ewell, CIP.

After completion of the baseline survey (Project No.1), a study of consumption of and demand for sweet potatoes among different groups of consumers will be initiated. Following are the objectives of the project:

- Identify different groups of consumers, and the role of sweet potatoes in their diets and food preference.

- Analyze how the price of sweet potatoes, the prices of other commodities, and household income affect sweet potato demand.
- Evaluate potential demand for sweet potato products by households, institutions and industries.

Plans for Program Development through 1995

Development of the program over the next four years will be in the following key areas:

1. Complete baseline and socioeconomic studies and identify priorities for research and technology transfer.

2. Screen and select genetic material, both Ugandan landraces and introduced cultivars, in the major sweet potato growing agro-ecological zones. It is planned to eventually work in seven sites covering the 4 major agro-ecological zones.

3. Select, clean up, and distribute varieties which respond to the needs of farmers and consumers.

4. In priority target areas of uganda, organize a system of rapid multiplication and distribution to farmers of planting material of selected cultivars. Overall targets and realistic goals will be set after the initial work in target areas has commenced.

5. Conduct on-station and on-farm agronomic trials to generate improved technologies for increased yields and quality.

6. Document the virus, disease and insect pests of sweet potatoes, document yield losses and develop clean up and integrated control measures. Virus clean-up procedures in the tissue culture laboratory at Namulonge will be fully worked out and reasonable goals for research on other diseases and pests set.

7. Initiate research on post harvest storage and processing of sweet potatoes, to broaden utilization and develop new markets.

Plans for Training and Workshops

1. In-country training for research and extension technicians
2. Participation in regional and international workshops and conferences
3. Specialised training for 2 technicians abroad
4. Degree training: 3 PhDs
   2 MSc

Appendix I

1989-1992: WORKSHOPS ATTENDED AND PAPERS PRESENTED

Workshops:

The following workshops were attended by members of the sweet potato research team and the number of participants from the team is indicated:

1. "Sweet potatoes in the food systems of Eastern and Southern Africa", Nairobi, Kenya, 8-12 October 1990 (3 participants).

2. Fourth Eastern and Southern African Regional Root Crops Workshop, Mansa, Zambia, 29 October - 2 November 1990 (2 participants).

3. First National Scientific Conference in Agriculture, Kampala, Uganda, 10-15 December 1990 (3 participants).

4. International Workshop on "Dialogue and training for the promotion of root, tuber and legume crops in Africa" Mombasa, Kenya, 26-30 November 1990 (1 participant).

5. On-farm Data analysis, Interpretation and Reporting Workshop for Agronomists, 1-12 July, 1991. University of Zimbabwe, Harare (1 participant).

Ocitti p'Obwoya C.N. and W. Emokol 1989. Optimum number of vine cuttings for optimum tuber yield in sweet potato (*Ipomoea batatas*). *In*: M.N. Alvarez and S.K. Hahn (eds). Root Crops in Low Input Agriculture. Proc. 3rd Eastern and Southern African Regional Workshop on Root and Tuber Crops. 7-11 Dec. 1987. pp 213-218.

Papers presented at 4th Eastern and Southern African Regional Root Crops Workshop, Zambia 1990 (In print):

Ocitti p'Obwoya: The effect of seedbed preparation on tuber yield and quality of sweet potato and the economic implications.

Mwanga R.O.M.; Ocitti p'Obwoya, W. Otim-Nape and B. Odongo: Sweet potato improvement in Uganda.

Paper presented at the 1st national Scientific Conference in Agriculture Dec. 1990

Mwanga, R.O.M. and O.B. Zamora: Biochemical responses of sweet potato (*Ipomoea batatas*) (L(Lam) to varying levels of shade.

Papers presented at the 9th Int. Soc. Trop. Root Crops, Accra, Ghana, October 1991.

Ocitti p'Obwoya - Factors limiting sweet potato production and utilization in Uganda.

Bashaasha, B. and R.O.M. Mwanga - Sweet potato: A source of income for low-income rural families in Uganda.

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