Appendix II: Survey Report

OCCURRENCE OF CASSAVA BROWN STREAK DISEASE IN UGANDA

PROJECT A1150

TECHNICAL REPORT

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National Cassava Programme

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Background

Cassava brown streak disease (CBSD) is caused by *cassava brown streak virus* (CBSV). The disease was first described in Tanzania during the 1930s and is the second most important virus disease of cassava (*Manihot esculenta* Crantz.) to-date in Africa after cassava mosaic disease (CMD). Unlike CMD which is widely distributed wherever cassava is grown in the African Continent, CBSD has been restricted mostly along the East African coastal cassava-growing regions and hence considered for a long time as a low altitude (< 1000 masl) problem.

CBSD first appeared in Uganda in the 1940s on materials introduced from Tanzania. The affected crops were destroyed and the problem was not noticed until 1994 when symptom typical of CBSD was observed in a field near Entebbe on the northern shores of Lake Victoria. A decade later symptoms of CBSD was again observed on cassava in some locations in central Uganda this time in relatively higher incidence, albeit localized, on some of the popular CMD-resistant varieties being grown countywide by farmers. This caused serious concern as cassava production in the country has just been restored through use of CMD-resistant varieties following devastation by the unusually severe CMD epidemic in the 1990s. There was therefore need to establish the prevalence of the disease in the country in order to institute corresponding mitigation strategies. An immediate intensive survey of the CBSD in the country was therefore recommended in a planning meeting convened at Namulonge Agricultural and Animal Production Research Institute (NAARI) on 16 May 2005 and attended by scientists from NARO, IITA, NRI and Root Crop Programme of Tanzania. The highlights of the survey are contained in this report.

Countrywide survey of CBSD

The survey was conducted between July 2005 and September 2005 in 18 major cassava producing districts of Uganda (Fig. 1) to assess the occurrence of CBSD in farmers' fields and to establish the status of CMD and abundance of cassava whitefly in the locality. A total of 720 cassava fields were assessed-30 for above ground symptoms and 10 for tuberous root symptoms per district. Fields were selected at regular intervals of 6-7 km for above ground symptoms and 18-21 Km for tuberous symptoms along major and feeder roads traversing the districts. Within each field sampled for above ground symptoms, 30 plants along two diagonals were examined for presence or absence of CBSD and noted. Symptom severity were recorded on the same selected plants on a scale of 1 (no symptoms) to 5 (very severe symptoms) (Table 1). Coloured pictures of CBSD foliar symptoms were presented to the field extension staff to familiarize with

during and even after the survey. For the root symptoms 10 plants per field were uprooted and the tuberous roots sliced and checked for root necrosis. Root

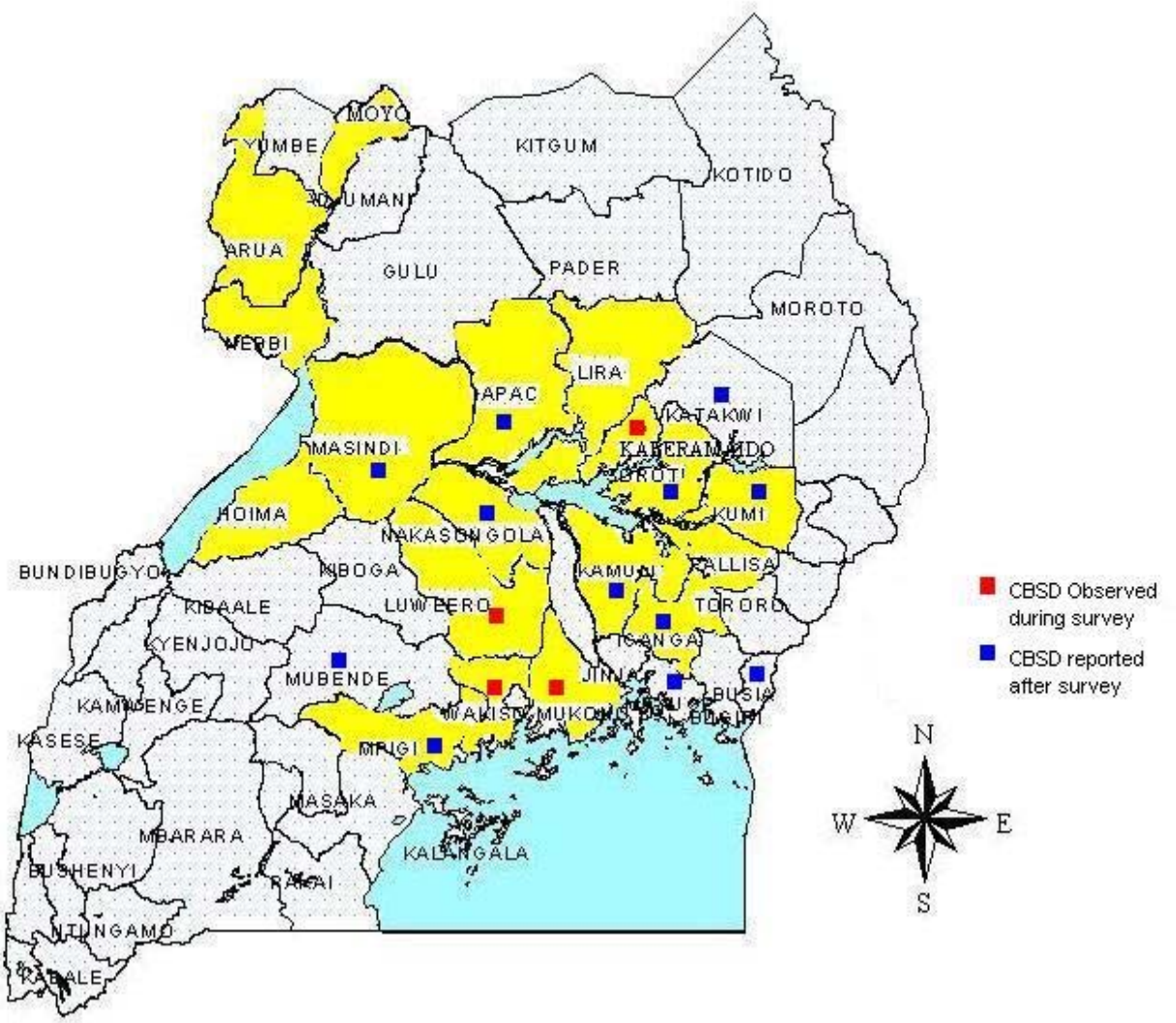

Fig. 1. Map of Uganda showing surveyed districts (yellow) and districts where CBSD was observed (red square) and reported (blue square) during and after the survey, respectively.

symptoms were scored on a scale of 1 (no necrosis) to 5 (> 25% root necrotic) (Table 2). The incidence of CBSD was calculated from the number of affected plants as a percentage of the total number of plants assessed in a field. Scores of 1 for symptomless plants were omitted in the calculation of mean severity per field.

Table 1. Scale used for CBSD foliar symptoms

Score	Description of above ground symptoms
1	No apparent symptom
2	Slight foliar mosaic, no stem lesions
3	Foliar mosaic, mild stem lesions, no die back
4	Foliar mosaic, severe stem lesions, no die back
5	Defoliation, severe stem lesions and die back

Table 2. Scale used for CBSD tuberous root symptoms

Score	Description of above ground symptoms
1	No apparent necrosis
2	Less than 5% of root necrotic
3	5-10% of root necrotic
4	10-25% of root necrotic, mild root constriction
5	> 25% of root necrotic, severe root constriction

The CMD status was assessed on the same 30 plants on which CBSD was assessed. CMD symptom severity were recorded on a scale of 1 (no symptoms) to 5 (very sever leaf distortion, chlorosis and stunting). Likewise scores of 1 for symptomless plants were omitted in the calculation of mean severity per field. For whitefly abundance adult populations were rated (see Table 3) on every other plant assessed for above ground symptoms giving a total of 15 plants per field.

Table 3. Scale used for rating whitefly populations

Score	Description of adult abundance
1	No whiteflies
2	0-20 adults per leaf
3	21-50 adults per leaf
4	51-100 adults per leaf
5	> 100 adults per leaf

Prevalence, Incidence and severity of CBSD

Cassava brown streak disease was found only in four districts out of the 18 districts surveyed countrywide between July and September 2005 (Table 4). The magnitude of the disease in the affected districts was low with prevalence ranging from 3.3-16.6% (Table 4). Three of the districts, Mukono, Wakiso and Luwero, out of the four affected are located in central Uganda. This apparently indicated that by the time of the survey CBSD was more prevalent in the districts situated in the northern shore of Lake Victoria Crescent (Fig. 1). The fourth affected district Kaberamaido is situated in north-eastern Uganda. The material planted in Kabermaido that has showed CBSD symptoms was reportedly obtained from Mubende district which is also located in central Uganda. The risk of spreading the disease through use of infected material cannot therefore be overemphasized.

The disease was mainly observed on improved CMD resistant cultivars throughout the country and on only one landrace (Kabwa) being grown in Mukono (Table 5). The most affected cultivars were TME 204 and TME 14 with CBSD incidences ranging from 58.5-100% and 3.3-91.5%, respectively. Tuberous root deformation and root necrosis (Fig. 2) were observed only in Kaberamaido district and 100% of the harvested tuberous roots were affected. The damage levels (scale 1-5) were very high with average severity score of upto 4.6 (Table 5). A colossal loss of this magnitude warrants careful choice of cassava varieties to promote if cassava production in the country is to be upheld and famine averted especially in communities where cassava is a major source of food.

Figure 2. Root constrictions and corky necrosis arising from CBSD effect

Incidence and severity of CMD

Cassava mosaic disease status varied across the districts surveyed but the incidence and disease severity were generally high, > 60% and > 2.5 respectively, in most of the districts (Table 4). CMD incidence was low (< 50%) only in Pallisa, Kumi, Soroti and Nebbi. It is clear from the present survey that CMD is still prevalent in the country. Local cassava varieties are still common in most districts (Table 6) and their continuous growing by farmers is a probable reason for the sustained high level of CMD in the country. Most of the districts surveyed had < 40% of the improved CMD resistant varieties (Table 6).

Whitefly populations

The population of whiteflies were generally low and the relative abundance ranged from 2.0 to 3.0 (scale 1-5) (Table 4). None-the-less, moderate populations (score 2.5 – 3.0) were recorded in Pallisa, Kumi, Kaberamaido, Soroti, Lira and Mpigi districts with the highest score (3.0) occurring in Soroti. The very low numbers of whitefly observed in the present survey could have been mainly due to the advanced age of the cassava since most of the crops sampled were > 6 months old. Being a phloem feeder, whitefly normally prefers younger cassava crops (1- 4 months old) which are more nutritious than the older crops.

The role of cassava whitefly in the spread of CBSD seemed to be apparent especially after the successful transmission, for the first time, of CBSV using *B. tabaci* at NRI. This scenario causes great worry especially with the current unusually high whitefly populations on cassava in Uganda.

Table 4. The incidence and severity of cassava brown streak disease (CBSD), cassava mosaic disease (CMD) and whitefly abundance on cassava in 18 districts in Uganda, July-September 2005

District	CBSD			CMD		Whitefly population
	% fields infected	Incidence per field (%)	Severity (1-5)	Incidence (%)	Severity (1-5)	Adults score on lvs (scale 1-5)
Mukono	16.6	34.7	2.3	56.0	2.5	2.1
Wakiso	3.3	3.3	3.0	55.3	2.5	2.2
Iganga	0.0	0.0	0.0	71.1	3.0	2.0
Kamuli	0.0	0.0	0.0	75.5	3.1	2.2
Pallisa	0.0	0.0	0.0	34.9	2.7	2.5
Kumi	0.0	0.0	1.0	26.0	2.9	2.5
Soroti	0.0	0.0	1.0	19.0	2.7	3.0
Kaberamaido	3.3	100	2.6	65.0	3.3	2.5
Lira	0.0	0.0	1.0	84.0	3.5	2.4
Apac	0.0	0.0	1.0	76.0	3.5	2.2
Hoima	0.0	0.0	1.0	85.0	3.0	2.1
Masindi	0.0	0.0	1.0	63.0	2.7	2.0
Luwero	10.0	67.8	2.3	86.0	2.7	2.1
Nakasongola	0.0	0.0	1.0	66.0	2.7	2.1
Mpigi	0.0	0.0	1.0	61.0	2.7	2.4
Nebbi	0.0	0.0	1.0	46.0	2.7	2.0
Arua	0.0	0.0	1.0	64.0	3.0	2.1
Moyo	0.0	0.0	1.0	62.0	3.3	2.0

Table 5. The incidence and severity of cassava brown streak disease (CBSD) on cassava cultivars commonly affected in four districts in Uganda, July-September 2005

Infected cultivar	*Fields sampled	CBSD (foliar)		CBSD (roots)		Crop age (Month)
		Incidence	Severity	Incidence	Severity	
Mukono District						
TME 204	6 (2)	58.5	2.9	0.0	0.0	7
TME 14	7 (2)	26.7	2.0	0.0	0.0	7
Kabwa (landrace)	2 (1)	3.3	3.0	0.0	0.0	7
Wakiso District						
TME 14	10 (1)	3.3	3.0	0.0	0.0	7
Luwero District						
TME 14	9 (2)	91.7	2.3	0.0	0.0	6
00057 (Omongole)	3 (1)	20.0	2.3	0.0	0.0	5
Kaberamaido District						
TME 204 &TME 14	**1 (1)	100	2.6	100	4.6	8

* Numbers of fields infected by CBSD are in parentheses

** A small plot with only 10 plants of TME 204 and 1 plant of TME 14

Table 6. The Prevalence of different cassava cultivars grown by farmers in 18 districts in Uganda

Sampled cultivar/landrace	Prevalence (%)	Overall prevalence (%)	
		Improved cultivar	Landrace
Mukono District			
Njule	14.3	67.7	32.3
Kabira	3.6		
Unknown (local)	3.6		
Gombolola	3.6		
Kabwa	3.6		
Mitimyero	3.6		
00056	14.0		
TME 14	25.0		
Unknown (improved)	3.6		
0067 (Akena)	3.6		
TME 204	17.9		
Nase 4	3.6		
Wakiso District		63.3	36.7
Njule	6.8		
Unknown (local)	13.3		
Kamesa	3.3		
Kirimupale	13.3		
0057 (Omongole)	3.3		
TME 14	26.7		
0056	26.7		
0067	3.3		
TME 204	3.3		
Apac District		20.0	80.0
Atim atim	3.3		
Unknown (local)	6.7		
Ogunu	3.3		
Derodero	23.3		
Apac apac	3.3		
Bao	33.3		
Nyaraboke	6.7		
00067	3.3		
TME 14	13.3		
Nase 12	3.3		

Lira District		16.7	83.3
Ogwang ogwang	3.3		
Aporo	3.3		
Derodero	10.0		
Gamente	3.3		
Egabu	10.0		
Apwony Ogwok	6.7		
Nyadanya	3.3		
Olibo	23.3		
Bao	3.3		
Mogo atar	3.3		
Adejo	3.3		
Bu	3.3		
Mel	6.7		
Nyaraboke	3.3		
Nase 10	3.3		
Nase 3	3.3		
TME 14	6.7		
Kumi District		90.0	10.0
Unknown (local)	6.7		
Njule	3.3		
0057	3.3		
TME 14	3.3		
TME 204	3.3		
Nase 3	80.0		
Soroti District		90.0	10.0
Unknown	3.3		
Elog elog	3.3		
0067	3.3		
Nase 3	90.0		
Kaberamaido District		46.7	53.3
Unknown(local)	6.7		
Kevina	3.3		
Egabu	43.3		
TME 204	3.3		
0067	10.0		
Nase 3	33.3		
Kamuli District		67.8	32.2
Mfumba chai	16.1		

Mutesa	3.2		
Unknown (local)	3.4		
Tereka	12.9		
Kikapa	29.0		
Bao	3.2		
TME 14	3.2		
Nase 3	22.6		
Nase 2	3.2		
TME 204	3.2		
Iganga District		30.9	69.1
Local (unknown)	17.4		
Njule	10.4		
Magana	13.9		
Budongo 29	3.4		
Tereka	3.4		
Budungoza	3.4		
Mivule	3.4		
Mfumba chai	10.4		
Bao	3.4		
Nase 3	17.3		
Nase 4	3.4		
0067	3.4		
Nase 1	3.4		
0057	3.4		
Pallisa District		100	0.0
Nase 3	93.0		
TME 204	3.5		
0057	3.5		
Nebbi District		40.0	60.0
Nyamitu	26.7		
Nyarateka	3.3		
Bisimenge	6.7		
Nyararokh	3.3		
Nyamatia	6.7		
Angaruba	3.3		
Nyarunega	6.7		
Ocola	3.3		
Nase 3	40.0		

Arua District		10.0	90.0
Ariwala	6.7		
Mabulu	3.3		
Zakayo	3.3		
Bali	6.7		
Bisimenge	3.3		
Musa	3.3		
Godiri	3.3		
Abiria	23.3		
Basumagi	6.7		
Nyarunega	6.7		
Omoo	10.0		
Gilgil	3.3		
Nyapamitu	10.0		
TME 204	6.7		
0067	3.3		
Moyo District		30.4	69.6
Unknown (local)	3.3		
Tegabanat	3.3		
Karuka	13.3		
Ebwana tereka	3.3		
Sanje	3.3		
Alfasio	3.3		
Cenje	6.7		
Joyo	6.7		
Tongolo	3.3		
Kabana	3.3		
Tikabanat	3.3		
TME 14	3.3		
TME 204	3.3		
0067	3.3		
Nase 3	13.3		
Hoima District		3.3	96.7
Unknown (local)	30		
Kidino	20		
Bukalasa	6.7		
Kirimupale	3.3		
Mulyandongo	3.3		
Nyamatia	3.3		
Nuru Kalisa	3.3		
Sibampali	3.3		
Gwalanda	6.7		

Bao	3.3		
Nyakonyako	3.3		
Jenganyumba	3.3		
Nase 12	3.3		
Masindi District		20	80
Nyakibiriti	3.3		
Kidino	3.3		
Njule	3.3		
Tongolo	6.7		
Kafefei	3.3		
Unknown (local)	6.7		
Terengule	3.3		
Nyakunyaku	3.3		
Nyaraboke	36.7		
Atim atim	3.3		
Nase 3	16.7		
00057 (Akena)	3.3		
Nakasongola District		16.7	83.3
Atim atim	6.7		
Unknown (local)	23.3		
Mpologoma	3.3		
Nylon	10.0		
Nyasaki	3.3		
Njule	3.3		
Ebwanateraka	16.7		
Myufu	3.3		
Abuut	6.7		
Bao	3.3		
Para	3.3		
TME 14	13.3		
Nase 1	3.3		
Luwero District		46.7	53.3
Kirimupale	3.3		
Bukalasa	3.3		
Bao	3.3		
Njule	3.3		
Unknown (local)	16.7		
Nyaraboke	13.3		
Omweru	3.3		
Okumu	3.3		
Muwanvu	3.3		
Nase 12	3.3		

00057	10.0		
Nase 4	3.3		
TME 14	30.0		
Mpigi District		36.7	63.3
Unknown (local)	26.7		
Njule	16.7		
Bao	6.7		
Kaalo	6.7		
Kikware	3.3		
Sakabusolo	3.3		
TME 204	6.7		
TME 14	16.7		
00057	13.3		

Post-survey reports on presence of CBSD

To date new information has emerged from District Agricultural Offices and some NGOs from 11 other districts reporting the presence of CBSD (Fig. 1). All the reported cases have been verified and confirmed by staff from the National Cassava Programme (NCP). For instance up to 12 acres of TME 204 at Loro Prison Farm in Apac district were found to have CBSD incidence of > 80 % in December 2005. The same fields were inspected during the survey in July 2005 and no CBSD symptoms were observed. It is also fascinating to note that most of the "newly" affected districts were actually part of the 18 districts surveyed earlier on and no CBSD was found. The above scenarios have just elucidated the fickleness of CBSD symptom expression and this phenomenon requires careful handling to avoid spreading the disease through use of seemingly "clean" planting material.

Conclusions and Recommendations

Results from the present survey have confirmed the re-emergence and spread of CBSD in Uganda. To date CBSD has been confirmed in 15 districts in the country majority of which are located in the central and eastern regions. This clearly indicates that the rate of spread of the disease, most probably though use of infected cuttings, is alarmingly high and must be halted. The high prevalence of CBSD on CMD-resistant cultivars indicated that the cultivars were developed with no background of resistance to cassava brown streak virus. However, the almost total lack of the disease on landraces is difficult to explain and warrants in-depth investigations. The situation currently unfolding in the country raises great concern for food security and incomes for a larger population of Ugandans who

Fig. 3. Institutional multiplication of TME 204 at Loro Prison Farm in Apac District, Uganda.

depend mostly on cassava for their livelihood. There is therefore more gloom than ever before given that the country has just recovered from an epidemic of CMD through wide promotion and distribution of CMD-resistant varieties to the farmers. Unfortunately the very popular varieties are being devastated by CBSD!.

Another dimension to the current CBSD outbreak in Uganda is its implications for the wider cassava germplasm movement in the east and central African regions. There has been open sharing of germplasm in the region under the auspices of the East Africa Root crops Research Network (EARRNET). One of the most vibrant germplasm collection and testing sites for the region is at Serere Agricultural and Animal Production Research Institute (SAARI) in Soroti district (see Fig. 1) in Uganda. There is therefore need to redesign the mode for germplasm exchange in the region.

In totality, it is imperative that a realistic strategy be developed and operated in order to avert the looming crisis from escalating. This should include amongst others:

- Capacity building at higher and lower levels to handle the problem,

- Sensitization of the population on the disease and its management,
- Regular extensive surveys to continue tracking the disease spread,
- Meticulous phytosanitary measures to rid inoculum and prevent further spread,
- Institution of aggressive quality control processes to vet and certify planting material for both local and regional use,
- And as a long term strategy embark on development of cultivars with multiple resistances to CBSD, CMD and whiteflies.

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