

Emergency Programme to Combat the Cassava Mosaic Disease Pandemic in East Africa

A SYSTEM-WIDE WHITEFLY IPM AFFILIATED PROJECT



Second Quarterly Technical Report

Phase 2

January-March 2000

International Institute of Tropical Agriculture

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I. Executive Summary

Quarterly Report

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Programme title: Emergency Programme to Combat the Cassava Mosaic Disease Pandemic in East Africa

Cooperative Agreement/Grant No: LAG-411-G00-3042-00

Country(ies)/Region(s): UGANDA, KENYA and TANZANIA

Disaster/Hazard: East African CMD Pandemic

Time Covered by This Report: January-March 2000

Activities Summary

Virus diagnoses were completed for samples collected from 15 sites in western Kenya and 8 sites in Mara region, Tanzania. UgV/EACMV-Ug occurred throughout Western Province, northern Nyanza and in southern Nyanza between Kisumu and Homa Bay. Only EACMV and ACMV occurred in areas along the Kenya/Tanzania border, suggesting that there was as yet no spread of UgV/EACMV-Ug to Tanzania through this route. In Kagera region, severe CMD and large populations of whiteflies were recorded from the border between Biharamulo and Muleba districts, Kagera region. In the zone to the south of this, CMD incidence was typically less than 10% and symptoms were moderate or mild. These data suggest that by February 2000, the Muleba / Biharamulo border represented the southern limit of expansion of the CMD pandemic. The 76ha of cv. SS4 currently under multiplication in Rakai and Masaka districts in Uganda was maintained during the quarter. In Kenya, the area under primary multiplication sites of 45.2ha was maintained and new primary sites covering an area of 50ha were prepared. Secondary multiplication sites covering > 300ha were identified in each of the districts of Western and Nyanza Provinces. 2ha of new multiplication plots were established in Mara region, Tanzania, using varieties TMS 4(2)1425 and TMS 83/01762(6). Existing multiplication sites at Nyakasanga, Masalakulangwa and Maruku were maintained. Sites for farmer participatory evaluation trials were identified in Project target zones in Uganda and Kenya. Evaluations were completed for 172 cassava clones introduced to KARI-Alupe from the EARRNET regional germplasm development programme based at Serere Uganda. Yields ranged from 10-37t/ha and selections were made for multi-locational on-station trials to be planted in April/May. Evaluations of 15 varieties were completed in Bukoba district, Tanzania. Four varieties provided acceptable yields across the three evaluation sites. These included: TMS 4(2)1425, TMS 81983, TMS 83/1762(6) and the local cultivar 'Lwakitangaza'. This trial was replanted with the same varieties at the same locations in February 2000. The 510 clones introduced from the EARRNET programme to the open quarantine site at ARI-Maruku, Bukoba, Tanzania, were maintained, and the open quarantine station was inspected by quarantine officials. The condition was judged to be satisfactory, although a number of recommendations for improvement were proposed. A major farmer training exercise was conducted in western Kenya, including more than 1,500 farmers targeted for participation in the secondary multiplication programme. In Nyanza Province, division extension officers were trained at the outset to facilitate this process. District-based cassava steering committees were established for each of the districts of western Kenya. 22 participants from 12 institutions in the three target countries participated in a regional stakeholders meeting for the Project. Progress was reviewed, new implementation plans for the phase 2 developed and the results presented in a 74-page proceedings document.

II. Programme Overview

A. Goal and Objectives of the Programme

Project Goal: To improve food security and alleviate poverty in the East African region through enhancing the sustainable production of cassava

Project Purpose: To strengthen sustainable production of cassava in areas of Uganda, Kenya and Tanzania most affected by the CMD pandemic through the exchange and development of cassava germplasm and the accelerated multiplication of CMD resistant varieties

Project Objectives:

1. **Monitoring and Diagnostics:** Provide up to date information on the extent of spread of the CMD pandemic and associated viruses and vectors in target areas, and develop forecasts and risk assessments to guide the implementation of control activities
2. **Multiplication:** Accelerate the multiplication of well adapted CMD resistant varieties and facilitate their distribution to farmers impacted by the CMD pandemic
3. **Germplasm diversification and exchange:** Increase the range of cassava materials available to farmers in areas targeted by the Project thereby reducing future risk of production collapse
4. **Training and technology transfer centres:** Provide options for the sustainable development of cassava production in the region through participatory germplasm evaluation and farmer training in pest and disease management and improved processing methods
5. **Project management, monitoring and impact assessment:** Build on links established with a wide range of stakeholders to facilitate effective co-ordination both within target zones and at regional level. Monitor Project impact.

B. Geographic Locations of Major Programme Activities

Country: Uganda

Site/Institution	District	County	Latitude	Longitude	Activity
IITA-ESARC	Mpigi	Kyadondo	0° 31.2' N	32° 32.7' E	Regional co-ordination
IFCD	Rakai	Kyotera			District-based co-ordination
DFI – Rakai	Rakai	Kooki	0° 40.5' S	31° 25.9' E	Multiplication
DFI – Masaka	Masaka	Kalungu	0° 18.3' S	31° 39.6' E	Multiplication/Germplasm
ICR	Rakai	Kakuuto	0° 48.5' S	31° 30.0' E	Germplasm

IITA-ESARC International Institute of Tropical Agriculture – Eastern and Southern Africa Regional Centre

IFCD Irish Foundation for Co-operative Development

DFI District Farm Institute

ICR International Care and Relief

B. Geographic Locations of Major Programme Activities (cont.)

Country: Kenya

Site/Institution	Province	District	Latitude	Longitude	Activity
KARI-Kakamega	Western	Kakamega	0° 17.0' N	34° 46.1' E	Co-ordination, Multiplication, Germplasm
KARI-Alupe	Western	Teso	0° 29.9' N	34° 7.5' E	Multiplication, Open quarantine, Germplasm
KARI-Kibos	Nyanza	Kisumu	0° 2.4' S	34° 49.0' E	Multiplication
FTC-Bungoma	Western	Bungoma	0° 36.0' N	34° 37.3' E	Multiplication
FTC-Siaya	Nyanza	Siaya	0° 5.0' N	34° 19.0' E	Multiplication
FTC-Busia	Western	Busia	0° 27.5' N	34° 6.9' E	Multiplication
FTC-Bukura	Western	Kakamega	0° 13.4' N	34° 37.3' E	Multiplication

KARI Kenya Agricultural Research Institute
FTC Farmer Training Centre

Country: Tanzania

Site/Institution	Region	District	Latitude	Longitude	Activity
Ukiriguru ARI	Mwanza	Mwanza	2° 43.1' S	33° 1.0' E	Co-ordination, germplasm
Maruku ARI	Kagera	Bukoba	1° 25.0' S	31° 46.8' E	Germplasm, Multiplication, Open Quarantine
Nyakasanga	Mwanza	Mwanza	2° 46.3' S	32° 56.6' E	Germplasm, Rapid multiplication
Masalakulungwa	Mwanza	Kwimba			Multiplication

ARI Agricultural Research Institute

III. Programme Performance

A. Progress in Attaining Programme Objectives

Objective # 1: Monitoring and Diagnostics

Kenya

Virus diagnoses were completed for the CMD diseased samples collected from 15 sites in western Kenya. The diagnostic procedure comprised an initial PCR test using primers specific for ACMV and for UgV/EACMV-Ug, followed by RFLP analysis of full length virus fragments using the restriction enzymes: EcorV and MluI. Most samples collected from sites in Western Province and northern Nyanza were found to contain UgV/EACMV-Ug. Mixed ACMV+UgV/EACMV-Ug infections were frequent (9 out of 11 samples) at locations in the Kisumu area, a zone relatively recently affected by the pandemic. Samples were diagnosed from 9 locations in southern Nyanza. The pandemic-associated UgV/EACMV-Ug was identified from samples collected along the Lake Victoria shoreline between Homa Bay and Kisumu (figure 1). Further south, there was low CMD incidence in most fields and EACMV only was detected in virus diseased samples. The pattern of occurrence of EACMV in areas of western Kenya bordering Tanzania mirrored the situation on the Tanzania side of the border (described below). These results continue to suggest that the progress of the CMD pandemic in western Kenya has been slowed by physical barriers, but that spread of severe CMD associated with UgV/EACMV-Ug HAS begun.

Tanzania

Two survey activities were completed in Tanzania during the current quarter. The first was the virus diagnosis of samples collected during the Kenya/Tanzania survey in October 1999, and the second was a new survey in February conducted along the Lake (Victoria) shoreline in Kagera region. Results obtained from PCR and RFLP analysis of virus diseased samples from Tarime district, Mara region are illustrated in figure 1. UgV/EACMV-Ug was not detected in any of the 24 samples analysed, suggesting that the pandemic has yet to reach Tanzania through the Kenya border. This absence of UgV/EACMV-Ug was associated with a generally low incidence of moderate to mild CMD (figure 2). In the eastern side of the sampled area, ACMV was predominant, and two distinct strains were detected. ACMV-1 provided RFLP results corresponding to those expected for a sequenced ACMV strain obtained from Nigeria. ACMV-2, by contrast, provided results typical of sequenced ACMV strain obtained from Kenya.

The second survey done in February 2000 included an assessment of CMD incidence and severity at 20 sites along the Mwanza to Mutukula route (via Biharamulo and Bukoba). Adult *B. tabaci* were collected for dispatch to the University of Arizona for characterization. Very low levels of CMD were observed in cassava between Mwanza and Biharamulo (0-10%). Incidence increased abruptly at the border between Biharamulo and Muleba districts. A concomitant dramatic increase in the abundance of whiteflies was also observed at this location. This appeared, therefore, to mark the southern limit of the CMD pandemic in Kagera region. Samples were collected for virus diagnosis. Results will be presented in the next quarterly report.

Progress in the whitefly characterization work is reported in detail in Annex 4.

Indicator: Risk levels, spread described: Ke – south Nyanza; Tz – Mara, Kagera
Pre/post epidemic whiteflies characterized; > 100 whiteflies characterized

Current Quarter's Measure: Pandemic progress in Kagera updated; Whiteflies collected from 16 locations in Tanzania; whitefly characterization on-going

Cumulative Project Measure: Pandemic progress in south Nyanza/Mara/Kagera updated
Whiteflies collected from 26 sites. Characterization on-going

Objective # 2: Multiplication of CMD resistant varieties

The January to March quarter corresponds with a period of dry weather throughout most of the Project's target zones, and little new planting therefore took place. An update is provided on the status of multiplication sites in each of the three Project countries.

Uganda

- No new planting sites were established during the current quarter. Maintenance operations and roguing of CMD diseased plants continued in plots ratooned in October/November 1999, plots planted in April 1999 and yet to be ratooned and plots planted in November 1999. A proportion of the farmers contracted to plant SS4 multiplication blocks in November 1999 intercropped the cassava with other crops, principally beans. Following discussions between IITA and IFCD, the local co-ordinator of multiplication activities, it was agreed that the practice of intercropping in future plantings would be discouraged, and in current plantings, following harvest of the current intercrop, no further intercrops would be planted.
- The total area under SS4 multiplied through the Project remained at 76ha. The first major distribution to farmers will take place in September 2000, immediately prior to the end of the second phase of the Project

Kenya

- No new planting sites were established during the current quarter. Potential new sites for primary multiplication were identified, however. These included: Siaya FTC (2ha), Bungoma FTC (4.8ha), Homa Bay FTC (2ha), KARI-Alupe (10.5ha), Busia FTC (2.4ha), KARI-Oyani (8ha) and ICIPE (20ha). A major new collaborative link with a partner international centre (ICIPE) was established, and the identification of a large area for cassava multiplication at ICIPE will provide significant additional impetus to the initiation of multiplication in southern Nyanza. All existing primary sites were weeded and rogued during the quarter.
- Secondary multiplication sites to cover 20ha in each of the 17 districts of Western and Nyanza Provinces were identified. Collection of materials for planting began and planting of secondary sites to total more than 300ha should be completed in the second quarter of the year, bringing the total area under CMD resistant materials in the Project target area to more than 400ha.

Tanzania

- New multiplication plots were established in Mara region during the current quarter, using cuttings taken from the rapid multiplication site at Nyakasanga, Mwanza. The Mara plantings covered approximately 2ha and comprised varieties TMS 4(2)1425 and TMS 83/01762(6).
- A small portion of the multiplication block at Maruku was ratooned and used to replant 0.65 ha of TMS 4(2)1425.
- The multiplication of SS4 at the open quarantine site at Maruku continued. In February, the percentage plant population was estimated at 50%. This was substantially lower than the initial sprouting percentage, and losses have been attributed to the unusually dry weather conditions experienced at Bukoba during the November to March period. Double density planting, however, means that the total population of plants will still be the standard recommended for cassava of 10,000 plants/ha.
- Management of multiplication sites at Nyakasanga, Masalakulangwa and Maruku was sustained and all sites were maintained in good condition.

Indicator: Ug, Ke. - 3 million stems; Tz. - 2 million stems

Current Quarter's Measure: Tz. - 26,500 stems

Cumulative Project Measure: Ug. – 760,000 stems; Ke. – 450,000 stems;
Tz. – 216,500 stems

Objective # 3: Germplasm Diversification and Exchange

Uganda

- Plans were developed during the January-March quarter to establish two technology transfer centres in each of the two target districts. Varieties to be planted were identified. Site identification, establishment of farmer groups and planting of participatory evaluation trials and demonstration blocks will be done in the April-June quarter.

Kenya

- Seven sites were identified for the multi-locational evaluation in farmers' fields of the 14 best performing clones identified from the material introduced from the EARRNET germplasm collection in Uganda. Sites were identified based on contrasting agro-ecological characteristics and included: Muhuru Bay (Migori), Kehenchu (Kuria), Oyugis (Rachuonyo), Siaya (Siaya) and sites in Teso, Busia and Butere-Mumias districts. At least seven entries will be planted per farmer and there will be four farmers per site. All fourteen entries will be present at each site. The technology transfer centre approach will be combined with the multi-locational trials.
- Evaluations were completed for the 172 clones in the preliminary evaluation trial at Alupe. Final assessments included yield, dry matter and cyanide content. Yields averaged 10-37t/ha.
- On-station trials for the multi-locational evaluation of clones advanced from the preliminary evaluation trial at Alupe will be planted at six sites including: KARI-Alupe, KARI-Kakamega, KARI-Oyani, Siaya FTC, Homa Bay FTC and ICIPE-Mbita Point.

Tanzania

- The first evaluation trial, in which the performance 15 cassava varieties was evaluated at three sites in Bukoba district, was harvested in January 2000. Results are reported in detail and yield data presented in Annex 2. Four varieties gave consistently the best yields across the three sites. These included three improved IITA-derived varieties (TMS 83/01762(6), TMS 4(2)1425, TMS 81983) and one local variety (Lwakitangaza). Whilst none of these four varieties were amongst the most resistant to CMD infection, all expressed only mild to moderate symptoms when infected. Observations of the second evaluation trial including 11 varieties suggested that all were susceptible to the severe CMD characteristic of the pandemic, but that some expressed relatively mild symptoms. These included UKG 94/232, UKG 94/069 and Konyo. This trial will be harvested in April 2000.
- A repeat of the first evaluation trial was planted at the same three sites (Bushasha, Gera and Maruku) in February. Results will be used to confirm the patterns of performance recorded against CMD in the first trial and to produce a publishable dataset.
- Varieties imported from IITA-Ibadan were maintained at the Nyakasanga site during the current quarter. These will be multiplied further before distribution for evaluation and multiplication in the third quarter of the year.
- The 510 clones introduced from the EARRNET regional germplasm programme, Serere, Uganda, were maintained through the quarter at the open quarantine site at Maruku. CAN fertilizer was applied just prior to the first rains in March to boost growth. The first evaluation will be done by a joint Tanzania/Uganda team in May.
- The open quarantine site was inspected by officials from the Plant Protection Department (PPD) and the Tropical Pesticides Research Institute (TPRI) in February. The inspection report is provided as Annex 3.

Indicator: Clones introduced: Tz > 100 Vars. evaluated: Tz > 25; Ke > 15;
Vars to multiplication: Ke > 5; Ug > 5
Open Quarantine (OQ): Tz > 2ha SS4; Regional meeting

Current Quarter's Measure: Vars. evaluated: Tz = 11

Cumulative Project Measure: Clones introduced: Tz = 510; Ke = 245
Vars evaluated: Tz = 26; OQ: Tz > 3ha SS4 + meeting

Objective # 4: Training and Technology Transfer Centres

Uganda

- Plans were developed for the establishment of technology transfer centres (TTCs) in two locations in each of Rakai and Masaka in April. Four key components of the TTCs were identified. These comprised: farmer participatory evaluation trials for varieties yet to be released, demonstration plots for already released varieties, the provision of small quantities of cv SS4 for each of the 50 participating farmers per group for multiplication and the implementation of a village level baseline survey to assess levels of farmer knowledge and practice at the outset of the exercise. TTCs were to be identified, farmers groups established and trials planted in April.

Kenya

- A major farmer training exercise was completed in both Western and Nyanza Provinces, targeting principally farmers expected to be involved in the secondary multiplication. Topics of training included: cassava agronomy, pest identification, control of pests and diseases, rapid multiplication, utilization, storage and postharvest technology and selection of planting materials. Farmers were also provided with specific information which would allow them to receive, plant and manage the CMD resistant varieties being multiplied by the Project.
- More than 100 farmers were trained in Kakamega district, 136 were trained in Lugari district, and more than 50 in each of the other districts of Western Province.
- In Nyanza Province, all Division Extension Officers were trained at the outset of the programme. These then provided training at the divisional level (level below district) to farmers.
- More than 790 farmers were included in the list of secondary multipliers in Nyanza and these were all provided with training.

Tanzania

- No training activities were conducted in Tanzania during the current quarter. In the April-June quarter plans were developed to establish an early warning system to monitor expansion of the CMD pandemic through the training of groups of farmers located immediately ahead of the affected area.

Indicator: Tech. Trans. Centres: Ug, Ke, Tz: 4 each
Farmers trained: Ug, Ke, Tz: > 400 each
Ag. Workers trained: Ug, Ke, Tz: > 50 each

Current Quarter's Measure: Farmers trained: Ke > 1,500
Ag. Workers trained: Ke > 25

Cumulative Project Measure: Farmers trained: Tz = 9; Ke > 1,500
Ag. Workers trained: Ke = 160

Objective # 5: Project Management, Monitoring and Impact Assessment

Uganda

- Discussions were held with local project partners, IFCD, on the implementation of the Project and guidance provided on the use of inter-cropping within multiplication plots.
- As a response to difficulties with management of new (October 1999) multiplication plots in view of the large size of many of them, the Project agreed to provide additional support for the weeding of the larger plots. Provision of funds for this purpose had an immediately beneficial effect on the multiplication programme.
- A regional stakeholders meeting for the Project was held in Kampala from January 12-13. 22 participants were involved from 12 institutions from the three partner countries including representatives of research, extension, NGOs and plant quarantine services. The Project's progress was reviewed and proposals for future activities developed. Results of the meeting are described in a 74 page proceedings document.

Kenya

- District level steering committees were formed in each of the districts of the two target provinces of Western and Nyanza.
- District steering committees met during the quarter and developed implementation plans for the secondary stage of the multiplication programme. Locations were identified for secondary multiplication sites, and lists developed of farmers for each of these locations. These farmers subsequently received training.
- Links were established with the International Centre for Insect Physiology and Ecology (ICIPE) out-station at Mbita Point, and plans developed to provide direct funding to ICIPE for the multiplication of 20ha of cassava at their Kuja River site.
- The incorporation of ICIPE, KARI-Oyani and FTC Homa Bay into the multiplication programme represented an important expansion in the stakeholder participation in the Project.

Tanzania

- IITA scientists visited both ARI-Ukiriguru and ARI-Maruku during the current quarter to monitor progress in the implementation of the Project. Discussions were held with the acting Zonal Director, based at Ukiriguru and the Officer-in-Charge of ARI-Maruku. It was agreed that a Tanzanian Steering Committee for this and related projects should be established along the lines of the one currently existing in Kenya. Changes in staff working with the Project were also discussed, and following the departure of the scientist most principally involved in Project implementation, a replacement was identified, Mr. Innocent Ndyetabula. The leader of the root crops research team left for another job during the previous quarter, and was formally replaced in the current quarter by Dr. Edward Kanju.
- A group inspection was made of the open quarantine site at Maruku. This included Mr. Mero, a quarantine officer with the Tropical Pesticides Research Institute (TPRI), Dr. Mohamed of the Plant Protection Department (PPD), Mr. Nkuba, Officer-in-Charge, ARI-Maruku, and Dr. Legg of IITA-Uganda. Recommendations on management were provided by the plant quarantine officers from PPD and TPRI. These included the strengthening of the site's fencing, the establishment of a disinfectant foot dip at the point of entry, the widening of the vegetation-free border around the perimeter of the plot and the improvement of roguing activities for the removal of CMD affected plants.

Indicator:

Steering Committees: Ug, Tz
Stakeholder implementation plans: Ug, Ke, Tz
Impact reports: Ug, Ke, Tz

Current Quarter's Measure:

District Steering Committees : Kenya
Regional SC with implementation plans for Ke, Tz and Ug

Cumulative Project Measure:

Stakeholder workshops, Districts SCs: Ke (Nyanza and Western)
Implementation plans: Ke (Nyanza and Western); Regional: Ke, Tz, Ug
Stakeholder meeting, implementation plan: Ug; Regional SC

B. Programme Success Stories

Regional stakeholders meeting strengthens Project vision and focuses plans

The Regional OFDA CMD Project stakeholders meeting was held in Kampala from January 12-13 2000. It provided the first opportunity during the lifetime of the Project for representatives of all the major stakeholder institutions from each of the three target countries to come together to review progress and plan for the future. It provided participants with an excellent opportunity to see the 'global picture' of the CMD problem they are involved in tackling, and in considering how the portion of the Project with which they are involved fits into the overall plan. Participants, almost without exception, found this to be an important experience, and for most, the opportunity to interact with colleagues from neighbouring countries working on the same problem was also extremely valuable.

The meeting began with a series of presentations on progress achieved by various partners in Phase 1 and the first part of Phase 2. This was followed by working group discussions. The three working groups were: monitoring and diagnostics, germplasm development, and multiplication and training. The principal task of these working groups was to develop implementation plans for the remainder of Phase 2, and reports developed by the groups have served as an important tool for Project management. It is considered that this meeting was an invaluable component of the second phase of the OFDA CMD project, and a meeting of this type should be a central part of any future phase.

C. Problems in Achieving Programme Activities

Only minor difficulties were experienced in the implementation of the Project during the quarter, although seasonally dry weather meant that the scope of field activities was limited. Minor problems included:

1. Continued intercropping in cassava multiplication plots in Rakai and Masaka districts, Uganda. This was addressed during the quarter as guidelines on the use of this practice were established consisting essentially of the allowance for the planting of a single row of beans between rows of cassava at first planting. Other crops were not allowed and similarly no second crop of beans was to be planted.
2. During the previous quarter, the lack of transport in both Tanzania and Kenya was a major constraining factor to Project success. Funds were available for the purchase of a vehicle for Kenya, but impediments to its purchase remained since the IITA/Kenya Government Memorandum of Understanding, which would allow duty-free importation, was yet to be signed. This problem also prevented the immediate importation of equipment and chemicals for the Plant Quarantine Station (PQS) and the Jomo Kenyatta University postharvest team.
3. The arrival of a new IITA-ESARC Project Manager during the quarter meant that there were some changes in systems used for transfer of funds. Accounting rigour was strengthened which improved the security of the transfers but led to a slight increase in the duration of the transfer process.

Figure 1. Cassava Mosaic Geminivirus distribution in western Kenya and north-western Tanzania, October 1999

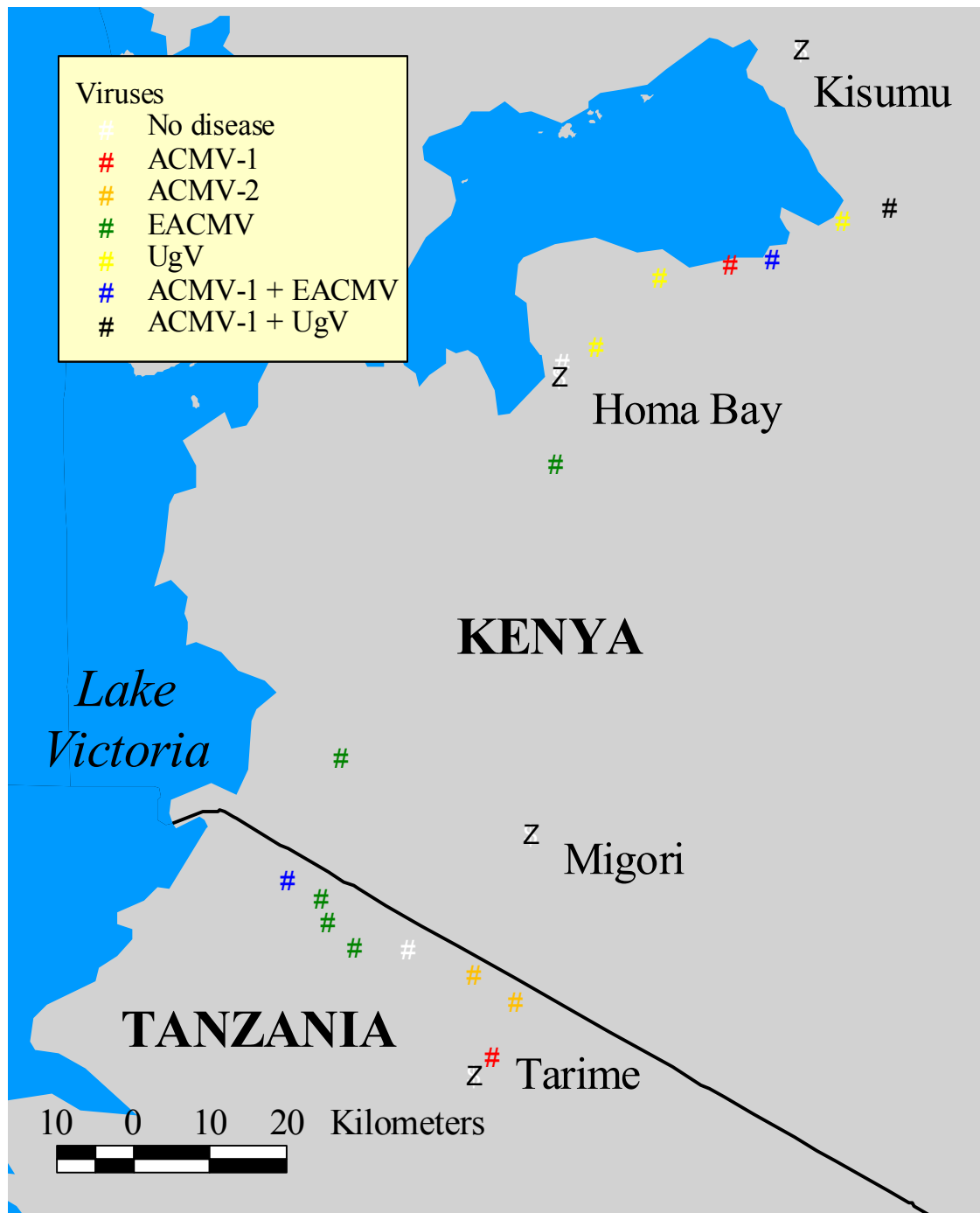
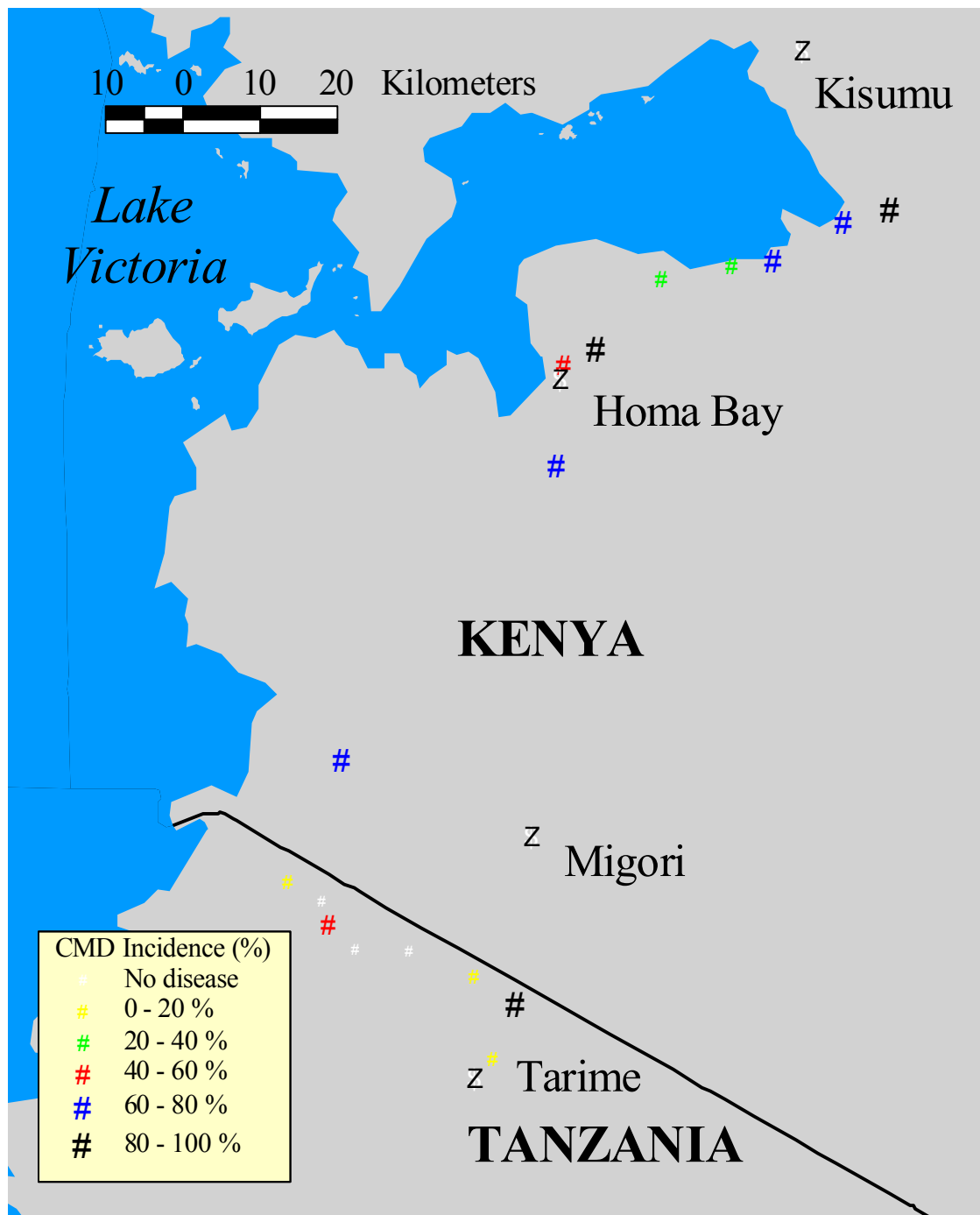


Figure 2. CMD incidence in western Kenya and north-western Tanzania, October 1999



Annex 1

Multiplication activities in Uganda – First quarter, 2000 Irish Foundation for Co-operative Development

Review of Activities

The cassava cuttings planted between October and December 1999 have been monitored and they are doing well at most of the sites. The plants are over 1m high with a low incidence of cassava mosaic virus disease (CMD). The extension workers have continued to monitor these sites so as to advise farmers on the need not to inter-crop, to weed in time and rogue infected plants. Most of the sites have had the first weeding.

The ratooned crop of October-December 1999 (planted in November 1998) is also doing very well at all sites. The only problem with the ratooned sites is their maintenance since there is no financial provision for this.

Approved multiplication sites

Multiplication sites established during previous quarters were maintained, and no new sites were set up during the current quarter. The January to March quarter in Rakai and Masaka districts is the hottest and driest of the year.

Constraints encountered

The first 50% funding received was not sufficient, as the activities undertaken during this land preparation period are capital intensive. The first and second weeding activities also fall within this period thus demanding a higher financial outlay leave alone the ratooning costs. Some of the first and second weeding, at several sites, have been done on credit with the hope of paying off these costs when the second fifty percent disbursement is received from IITA.

Due to the high maintenance costs, some farmers inter-cropped the cassava plants with beans, groundnuts etc. during the previous season. This practice is now being discouraged.

Financial report

The International Institute of Tropical Agriculture (IITA) disbursed the first fifty per cent of the funds for the cassava mosaic resistant cassava multiplication programme. The two districts, Masaka and Rakai received these funds in November 1999. The funds were used for opening up new land (land clearing, 1st and 2nd ploughing, planting) and implementing the ratooning exercise.

Annex 2

OFDA CMD Project activities in Tanzania – First Quarter 2000 Tanzania Root and Tuber Crops Programme

1. Cassava Variety Evaluation Trial

The first variety evaluation trial was planted for the second season. The same list of varieties was planted at the same three sites used during the previous season i.e. Bushasha, Gera and Maruku. Previous season's data for the first set of 15 varieties evaluated at Gera and Bushasha (Table 1) indicated that highest yields were obtained from variety Lwakitangaza and the lowest from variety TMS 90057(2). Data on the second set of 11 varieties evaluated continued to be recorded. Results suggest that all varieties were susceptible to severe CMD. The only varieties showing moderate resistance were UKG 94/232, UKG 94/069 and Konyo. The trial will be harvested during the next quarter (April) and yield data will be obtained and compared with those of the first set of varieties.

2. Open Quarantine field

The OQ field was weeded and CAN fertilizer applied to boost growth of the plants. Fencing was completed (bubbled wire) and there are plans for live fencing to strengthen it. Roguing was implemented at 3-day intervals and a total of 353 plants of cv. SS4 were uprooted and 462 plants from amongst the 510 EARRNET clones. Some clones have remained with only 3 plants after being infected with CMD. Staff from PPD, PGRI (TPRI) and IITA-ESARC visited the open quarantine field for inspection and other observations during February. This inspection is described in more detail in Annex 3.

3. Multiplication of Resistant Varieties

Multiplication of resistant cassava varieties continued at Ukiriguru and Maruku during this quarter. Varieties multiplied at Ukiriguru are at Nyakasanga where an expansion of the multiplication field is underway. At Maruku, TMS the multiplication plot of TMS 4(2)1425 has been ratooned to add another 0.65ha. In Mara region, two sites were selected and planted with TMS 4(2)1425 and TMS 83/01762(6). The area covered is about 2ha, which is expected to provide a total of 22,950 plants. Biharamulo district has agreed to provide one million Tanzania Shillings (USD 1,200) for multiplication of TMS 4(2)1425 which was planned for Maruku. This district is particularly concerned about the potential impact of the CMD pandemic, since large parts of the district depend heavily on cassava as a major staple. This is in relative contrast to Bukoba and Karagwe districts where cooking bananas represent the main staple.

Monitoring and Diagnostics

One monitoring and diagnostics exercise was done from Mwanza to Bukoba using the Biharamulo – Bukoba road. Samples taken from the Muleba-Biharamulo border area, where a high incidence of severe CMD was recorded were presumed to contain the Uganda variant cassava mosaic geminivirus (UgV/EACMV-Ug) associated with the CMD pandemic (see main body of this report). Additional more comprehensive monitoring and diagnostics surveys are planned for Kagera and Mara in June-July. These results will be compared with those from surveys conducted in the same regions a year previous to gauge the change in the pandemic that has occurred over the last year.

Stakeholder Linkages

A national Steering Committee Meeting is planned for the next quarter. This will involve all the main stakeholders in cassava activities in the Lake Zone, and will be held at ARI-Maruku. The purpose of the meeting will be to evaluate the activities done in the last year, and to plan for the future.

Future plans

- Monitoring and diagnostics surveys to be done in all threatened zones
- Expansion of multiplication of CMD resistant varieties both at Nyakasanga and Maruku
- Planting of CMD trials (NRI trials in April)
- Sensitization of farmers on CMD management strategies in threatened areas of the Lake Zone
- Multiplication of tissue culture materials at Ukiriguru

Table 1a. Yield data and farmer evaluations of cassava varieties tested in Bukoba district, Kagera – January 1999 to January 2000. Bushasha site.

No. of plants	Variety	Yield (kg)			Farmer's assessment		
		Rep I	Rep II	Rep III	Taste	Resistance	Acceptance (rank)
18	TMS 90057(2)	3.5	0.5	0.25	B		
19	106	3.5	9	1	S		3
3	Var X	4	12.5	4	S		
34	Ukg 94/146	3	18	7	S	4	4
36	Aipin Valenca	12	6	7.5	S		
33	TMS 83/01762(6)	19.5	17	14	B		1
8	TMS 30337	2	0.5	3	S	1	
22	TMS 30572(6)	5	15	9	S	2	
36	Rushura	9	7	2.5	S	14	
41	Ukg 94/047	6	4.5	4	S	15	
39	TMS 4(2)1425	12	18.5	7	S	6	
27	TMS 42029	8	4.5	8	S		
23	TMS 81983	10	11	12	B	3	
34	Lwakitangaza	16.5	11	18	S	5	2
36	Msitu Zanzibar	6	14	14	S		

S = sweet; B = bitter

Table 1b. Yield data and farmer evaluations of cassava varieties tested in Bukoba district, Kagera – January 1999 to January 2000. Gera site.

No. of plants	Variety	Yield (kg)		
		Rep I	Rep II	Rep III
18	TMS 90057(2)	0	2	0.3
19	106	4.5	0.25	1.5
3	Var X	2	3	0
34	Ukg 94/146	9	6	4
36	Aipin valenca	11	9	2
33	MS83/01762(6)	10	8	8
8	TMS 30337	1.2	0	0
22	TMS 30572(6)	1	1.5	2
36	Rushura	1	0	1.5
41	Ukg 94/047	3	0.25	5
39	TMS 4(2)1425	8	18	5
27	TMS 42029	6	3.5	2.5
23	TMS 81983	12	4.5	19
34	Lwakitangaza	11	28.5	23
36	Msitu zanzibar	4	3	4

Table 1c. Yield data and farmer evaluations of cassava varieties tested in Bukoba district, Kagera – January 1999 to January 2000. Maruku site.

Variety	Yield (kg)		
	Rep I	Rep II	Rep III
TMS 90057(2)	17	19	35
106	13	15	15.5
Var X	34	4	34
Ukg 94/146	23	26	6.5
Aipin valenca	20	19	7
TMS 83/01762(6)	36	20	16.5
TMS 30337	2	9	2.5
TMS 30572(6)	15.5	12	24
Rushura	14	22	6
Ukg 94/047	5	18	22
TMS 4(2)1425	31	5	27
TMS 42029	21	32	15
TMS 81983	6.5	9	12
Lwakitangaza	16	7	2.5
Msitu zanzibar	4	3.5	6

Annex 3

THE UNITED REPUBLIC OF TANZANIA

MINISTRY OF AGRICULTURE AND CO-OPERATIVES

REPORT OF FIELD INSPECTION OF OPEN QUARANTINE
AT A.R.I. MARUKU, FEBRUARY 22, 2000

*Dr. Rose-Anne Mohamed, Plant Protection Services
P. O. Box 9071, Dar es Salaam*

- TO: Director of Research Development, Dar es Salaam
Director of Crop Development, Dar es Salaam
Director, Tanzania Pesticide Research Institute, Arusha
Zonal Director, Research and Development, Lake Zone, Mwanza
I/C Plant Protection Services, Dar es Salaam
- CC: Dr. James Legg, IITA-ESARC, P.O. Box 7878, Kampala, Uganda
Officer-in-charge, A.R.I. – Maruku, Bukoba
Dr. Regina Kapinga, Director of Research Co-ordination and Promotion
Commission for Science and Technology, P.O. Box 4302, Dar es Salaam

REPORT OF FIELD INSPECTION OF OPEN QUARANTINE AT A.R.I. MARUKU, FEBRUARY 22, 2000

Introduction

The outbreak of the severe form of CMD caused by UgV/EACMV-Ug in Kagera Region in November 1998 prompted quick action to combat the disease. Experience from Uganda, where the disease was reported for the first time in the late 1980s, revealed that the use of CMD resistant cultivars was the most feasible method of managing the problem. According to Otim-Nape *et al* (1997), in Uganda three IITA materials, TMS 60142, TMS 30337 and TMS 30572 were released in northern and central districts of the country. Several other resistant cultivars including SS4 were released in southern and central districts of Uganda. Cultivar SS4 (Serere selection 4) is reported to be high yielding, highly resistant to CMD and has low cyanogenic potential.

Immediately after the outbreak of severe CMD was reported in Bukoba district, Kagera, Tanzania, several methods of managing the disease were employed. These included strict Plant Quarantine directives that were enforced in the affected region to contain the spread of the disease. Prior to the pandemic, there were small quantities of

CMD resistant materials in the Lake zone of Tanzania, which were subjected to rapid multiplication. It was inevitable that much larger quantities of resistant materials would be required, hence CMD resistant materials were ordered from Nigeria and Uganda. In May 1999, 10,000 tissue culture plantlets were introduced from IITA, Ibadan, Nigeria, which were planted at ARI Ukiriguru. In December 1999 an open quarantine (OQ) facility was established at ARI Maruku that facilitated the importation of 48,600 cuttings of cultivar SS4 and more than 500 elite clones from the Serere, Uganda based regional germplasm development programme of the East Africa Root Crops Research Network (EARRNET).

Establishment of the Open Quarantine (OQ) facility

The field allocated to the OQ facility is approximately 5 ha of which 3.0 ha are planted with cultivar SS4 and 0.75 ha planted with 510 CMD resistant clones from the EARRNET germplasm programme, Serere, Uganda. Land preparation for the establishment of the OQ was facilitated by OFDA and the Kagera Agricultural and Environmental Management Project (KAEMP) following transfer of planting materials from Uganda and several other management operations.

Inspection of CMD resistant materials at Nyakasanga, Mwanza

These include the tissue culture materials from Ibadan, which were initially cared for at Ukiriguru from May to November 1999. They were transferred to the field in Nyakasanga where they can be irrigated during the dry season. The plants were found to be growing well despite the drought which coincided with the time of the visit. Some of the plants were infested with cassava mealybug and some had cassava green mites, although levels of infestation by these two pests are anticipated to drop following the resumption of the rains in March/April.

Inspection of OQ at Maruku

It is planned to conduct field inspections after every two months and for a period of one year, after which the materials will be released for primary multiplication. The first field inspection was made on 22 February 2000. Generally the field was well maintained. Cuttings had been planted in December 2000 and three weeks later sprouting had been ranked excellent. During the February inspection plant survival was estimated at 65%. The young plants had been hit by drought from January, which had reduced the plant population. The field is constantly being checked and all CMD infected plants rogued. By January 17, a total of 716 plants had been rogued. From the initial population of 48,600 SS4 cuttings planted, 258 had been removed due to CMD infection.

Problems observed in the field

1. Fencing

The field is secured with only three lines of barbed wire, which are inadequate to prevent trespassing and theft of the introduced CMD resistant materials. Additional barbed wire and live fencing materials are required urgently before stems mature.

2. Gate and disinfection trough

The gate currently being used is very temporary mainly to keep off grazing animals. The unit also lacks a disinfection trough which is a requirement in OQ to minimize the introduction of pests from surrounding areas.

3. Buffer zone

A buffer zone 6m wide was recommended to be ploughed around the field as a firebreak and also to minimize pest invasion from vegetation in the vicinity of the OQ.

4. Biotic stresses

Incidence of CMD. An inspection was carried out on 2 rows after every 10 rows of plants. The total number of sampled plants and CMD infected plants in the sample area was counted and recorded. A sample of 2,690 plants of cultivar SS4 was inspected and from these only 8 plants equivalent to 0.3% of the total were diseased. In the elite clone population a total of 1,079 plants were sampled of which 29 plants (3%) had symptoms of CMD.

Insect pests. Some plants were infested with cassava green mite (CGM). The drought prevailing at the time of inspection explains the CGM abundance on some plants.

5. Abiotic stresses

Drought. There was a period of drought from December 1999 to the time of the inspection that had clearly affected plant vigour. It was recommended to discontinue weeding until the rains resumed.

Low soil fertility. The OQ field is located in an area of grassland known locally as 'Rweya' where soil fertility is low. Some plants showed clear symptoms of nutrient deficiency. The recommendation was to apply Calcium Ammonium Nitrate (CAN) after it had rained.

Other matters

We met briefly in the office of the Officer-in-Charge to discuss some issues related to CMD. The following attended:

Mr. Nkuba	Officer In charge	ARI Maruku
Mr. Ndege	Crop Officer	ARI Maruku
Dr. R. Kapinga	Director, Research Co-ordination and Promotion	Commission of Science and Technology (COSTECH), Dar es Salaam
Dr. James Legg	Regional Representative	IITA-ESARC (OFDA Proj.) Kampala, Uganda
Mr. Shebe	Farm Manager	ARI Maruku
Mr. H. N. Mero	Quarantine Officer	Tanzania Pesticide Research Institute, Arusha
Dr. R. A. Mohamed	Agric. Officer	PPS HQ, Dar es Salaam

Staffing of CMD

After the departure of Mr. Joseph Ndunguru (virologist) who was temporarily working with CMD-OFDA in Kagera, his position has been vacant since December 1999. While efforts are being made to employ another staff, possibly a virologist, it was considered necessary to assign a permanent researcher to work with the Root and Tuber Section at Maruku. This person will be able to co-ordinate all the activities in this section including CMD. The name of Mr. Innocent Ndyetabula was proposed but the final nomination is subject to the Zonal Director's approval.

National Steering Committee

Dr. Legg proposed the formation of a National Steering Committee. He had earlier on explained the effectiveness of the Kenyan National Steering Committee especially in drawing up implementation plans for future activities. Members agreed to establish a National Steering Committee and proposed that the first meeting to be convened in the first week of April 2000. The list of proposed members was as follows:

Name of the person/ Title	Organization
Research/Plant Protection	
Lake Zone Research Director/ Representative	ARI Ukiriguru
Root and Tuber Representative	ARI Ukiriguru
CMD supervisor	ARI Maruku
Dr. R. Abdallah	TPRI Arusha
Dr. R.-A. Mohamed	PPS Dar es Salaam
Government Regional projects	
KAEMP rep.	KAEMP
Mara Farmers Initiative Project rep.	Mara-FIP
Regional Extension Advisor - Kagera	Extension service
Regional Extension Advisor - Mara	Extension service
Farmer rep. – Kagera	
Farmer rep. – Mara	
NGOs / CBOs	
NGO rep. – Kagera	Kolping
NGO rep. – Mara	Care
Observers	
OFDA CMD Project - Dr. J. Legg	IITA-ESARC
IFAD Co-ordinator	IFAD Regional Office - Nairobi
EARRNET Co-ordinator – Dr. J. Whyte	EARRNET
SARRNET Co-ordinator – Dr. J. Teri	SARRNET

Extent of CMD spread in Kagera region

Drs. Kapinga and Mohamed had the opportunity to travel from Mwanza through Sengerema, Geita Districts (Mwanza Region), and Biharamulo, Muleba and Bukoba Districts (Kagera Region) with Dr. Legg. Along the way cassava fields were sampled

close to the road after every 20 km checking on CMD infection and whitefly populations. Dr. Legg took samples of infected cassava leaves and whiteflies from the inspected fields for analysis. Whitefly populations were very low and symptoms caused by UgV/EACMV-Ug were not observed in Mwanza Region and Biharamulo District but the first field immediately upon entering Muleba District had severe CMD symptoms characteristic of UgV/EACMV-Ug infection. Whitefly populations were also high in this field. The forest reserve between Muleba and Biharamulo may delay the spread of severe CMD to Biharamulo but the disease may spread from Muleba to Biharamulo along the shores of Lake Victoria because of the absence of a physical barrier in this area.

The post-epidemic situation in Bukoba District

UgV/EACMV-Ug was first reported in Bukoba District and despite efforts to advise farmers to uproot infected cassava plants, after almost a year, fields remain with infected plants. Planting cassava has almost ceased except in a small number of fields where few cassava plants were planted in between other crops. Some of the plants had CMD symptoms arising from planting infected cuttings and very few had no symptoms. It was not clear whether the symptomless cassava plants were resistant or whether it was a matter of time before visible symptoms developed. Samples of CMD infected leaves and whitefly adults were collected for analysis.

Annex 4

University of Arizona – Progress Report. First Quarter 2000 Identity and Distribution of Whitefly Vector Variants Associated with Begomovirus Infections of Cassava in Eastern African Countries

Dr. Judith K. Brown

Project Goal and Approach. The goal of this study is to apply molecular methodologies to define the identity and distribution of the whitefly vector associated with cassava-infecting begomoviruses in Eastern Africa. The purpose is to better understand the identity, dynamics, relationships, and specific circumstances surrounding whitefly vector populations in cassava, in relation to the new begomovirus epidemic and previously studied geminiviruses (ACMV/EACMV/UgV) in cassava.

Objective: We will use a strategy recently developed in the Arizona laboratory by which variants can be identified using a PCR-based approach in which the cytochrome oxidase I gene fragment, approximately 850 bp in size, is amplified and the DNA sequence obtained (Brown et al., 1999; Frohlich et al., 1999). This sequence has been shown to be highly useful for discriminating between *B. tabaci* variants and for identification of other whiteflies, by comparative analysis with reference sequences compiled as a whitefly COI database in the AZ laboratory.

PROGRESS TO DATE

Whitefly collections. Whitefly adults and nymphs were collected from infested plants and placed live in 70-95% alcohol. Samples were received from our collaborator at IITA, James Legg. The mitochondria cytochrome oxidase I gene (COI) was targeted as an informative molecular marker for predicting biogeographic characteristics of *B. tabaci* and related whitefly genera (Frohlich et al., 1999 in press). Prior to PCR, total nucleic acids were extracted from individual female whiteflies as described (Frohlich et al., 1999 in press). Extracts were incubated at 65°C for 15 min and 95°C for 10 min and centrifuged to pellet debris. The PCR primers used for amplification of the mt COI gene were: C1-J-2195 (5' ttg att ttt tgg tca tcc aga agt 3') and L2-N-3014 (5' tcc aat gca cta atc tgc cat att a 3') obtained from the UBC Insect Mitochondria DNA Primer Oligonucleotide Set, compiled by B. J. Crespi and C. Simon (Simon et al., 1994). PCR products were obtained and cloned into the TA-cloning plasmid pCR2.1 vector (Invitrogen, Carlsbad, CA 92008). The nucleotide sequence for each clone was obtained using an automated sequencer at the University of Arizona. DNA sequences were obtained for plus and minus strands from each cloned amplicon for a minimum of three individual whiteflies per collection and three or four clones per PCR reaction. Sequences were edited using FAKTORY and a master sequence was obtained. A phylogeny was reconstructed using Clustal to align nucleotide sequences of approximately 775-805 nucleotides.

Preliminary results and discussion.

Distance analysis separated whiteflies into nine distinct groups. Five groups formed one large cluster. These groups contained collections only from Africa. The groups can be characterized as follows: (1) 29 Uganda populations from cassava in epidemic zones designated 'behind' (BH) or at the 'front' (FR) (theoretically, the invading population). Collections that seem out of place are two (of 31) collected from Ugandan cassava in the *I zone/Bukoba*, a site designated 'ahead of the front' (AH), (2) Uganda populations from cassava in zones designated 'ahead' of the front, (3) Tanzania populations (plus a Uganda collection designated *M zone/Nanywa*), (4) a population from *Asystasia spp.* in Benin (non-cassava, non-East African outgroup), and (5) three sequences for a population from sweetpotato in Uganda (non-cassava, East African outgroup). Four additional groups are present that comprise: (1) non B biotype *B. tabaci* from Northern Africa/Mediterranean/Middle East region and the B biotype separated into distinct groups, respectively, (2) All New World *B. tabaci*, (3) outgroup species: *Bemisia berbericola*, and (4) outgroup genus: *Trialeurodes vaporariorum* (Table 1).

Preliminary conclusions that may be drawn from this analysis are as follows:

1. Cassava-colonizing populations in Uganda from behind (BH), at the front (FR), or ahead of the front (AH) originated from the African continent.
2. Cassava-colonizing populations in Uganda from behind, at, or ahead of the front are not the notorious 'B biotype' of *B. tabaci*.
3. Twenty-nine of thirty-one collections from cassava designated as 'behind' and 'at the front' of the epidemic form one large, distinct group and may be viewed as the invading population that apparently displaced the 'local' or 'indigenous' *B. tabaci* known to predominate prior to the epidemic. Two collections labelled 'ahead' of the front, and expected to represent the 'local' or indigenous, were placed in this group. This may represent an 'invasion' that was not detected at the time of the collection from the site: Bukoba, I Zone, or, may provide evidence that the local population has not been entirely displaced.
4. Six of eight collections labelled as 'ahead of the front' and expected to represent the local or indigenous population known in cassava in the region prior to the epidemic are placed in a distinct group. Members of this group share only ~80% sequence identity (or less) with the group containing BH and FR collections, indicating the two sequences are highly divergent.
5. Two 'non-host' outgroup collections from Africa, one from Uganda on sweet potato, and the other from a weed in Benin (West Africa), i.e. that do not specialize on cassava, are slightly more divergent from the two cassava colonizing populations (BH/FR and AH) than are the two distinct cassava groups (putatively, *invader* and *indigenous*) examined so far.
6. A second Old World group is formed by collections from Northern Africa (Morocco, Sudan), the Mediterranean region (Spain -2 types), and the Middle East (reference population data not shown). A subgroup within this cluster contains the B biotype. This region contains the closest B biotype relatives, but many are 'non-B biotype' populations.
7. New World exemplars form a single group that is distinct from all collections from Africa and other Old World sites.
8. The two outgroups, *Bemisia berbericola* and *Trialeurodes vaporariorum* are basal to all lineages that comprise the large *Bemisia tabaci* species complex, as expected.

Outgroups diverge from members of the complex by ~29-30%(Bb) and 44% (Tv) in this analysis.

Progress in Relation to Expected Time Frame. As of March 2000, we have completed the processing and sequencing of more than two-thirds of the samples in the current collection (1998-1999), and additional samples are anticipated soon. Certain collections have proven difficult and we are repeating the PCR and sequencing for those at this time. This is probably due to some degree of degradation. In addition, sequences from the Bombo zone are slightly shorter than those obtained most recently for samples from the other two zones, because they were obtained using older sequencing technology prior to the start of this project. Those samples will be processed again during the next few months and should result in a high-quality, consistent, publishable data set.

Present funding is allocated for only one year to process approximately 50+ samples, although we anticipated that additional investigation would be needed, considering the gravity and complexity of the problem. The IITA collaborators are collecting additional samples during 2000 and completing morphological identification of whitefly specimens. As whitefly samples are provided, we will provide molecular analysis and provisional identification.

At the end of the study, it should be possible to construct a map illustrating the distribution of whiteflies and begomoviruses in cassava and other crops collected in Uganda, Tanzania, Kenya and elsewhere, as dictated by the spread of the epidemic in cassava. Whitefly sequences have been archived in the AZ database and will be made available to IITA scientists and at the GEMINIDETECTive website after results are published.