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East Africa Root Crops Research Network (EARRNET)

Annual Technical Report

1993/94

International Institute of Tropical Agriculture

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EXECUTIVE SUMMARY

Food production has not kept pace with population growth in the East African region. Root crops, especially cassava is becoming an important staple after banana and maize by providing a stable base for the food production system. Despite the increase in its competitive advantage, production is low due to diseases and pests, low yielding potential of local cultivars and poor crop management practices prevailing in the low input farming systems. COSCA has observed that improvement in production techniques is unlikely to lead to expansion in production if it is not matched with improvement in postharvest technologies. Processing technology is rudimentary in East and Southern Africa. To make cassava competitive with food grains in the market would require development of technologies that will reduce processing costs, improve product quality and diversity.

Significant progress has been made at IITA in development of cassava clones and populations with pest/disease resistance, high potential yields and quality characteristics. The biological control program has reduced the destructive effects of the cassava mealybug to non-economical levels while different phytoseiids continue to be released in different countries in an attempt to control the cassava green mite. The establishment of ESARC will facilitate the generation and distribution of technologies to increase cassava production commensurate with national needs. ESARRN created the foundations for the establishment of national root crops improvement programs to facilitate the transfer and exchange of technologies on improved varieties, agronomic practices, postharvest technologies and training. The process of consolidating and strengthening NARS research capacities to address problems that will improve production, farmers income and food security is the goal of EARRNET. Oversight of EARRNET activities is provided by the SC and the RDC. EARRNET collaborates with all institutions that contribute to strengthening national program capacities to address their research objectives.

Progress has been made on all five collaborative research and cross country activities agreed upon by the SC and RDC. The major constraints identified in implementation of these programs include shortage of professional personnel and inadequate financial support to perform national/regional activities. The two year life of the project does not augur well with post graduate studies, so emphasis has been placed on improving the technical skills of researchers and technicians through their participation in courses conducted at IITA, within the region or in-country. Available documentation on numbers and levels of training of scientists indicate an increase in most NARS of the region over the last two decades during which root and tuber crops never received its fair share. For instance, Madagascar, though new to the regional root crop grouping has existing challenges in development of human resources and germplasm development. Uganda's strength in germplasm development, pest management and technology transfer has continued to build up. Formal release of varieties was announced for the first time this year in Uganda. There were significant opportunities for exchange of information and interaction between NARS scientists and staff of IITA, the executing agency. Financial backing of national program has been low. Most governments are only able to provide salaries with virtually nothing for running cost, making national programs dependent on EARRNET and other projects to implement their cassava TDT activities.

The future of EARRNET looks bright based on the outlined research development and transfer plans. However, efficiency in the implementation of EARRNET's programmed activities will be strongly influenced by the capability of ASARECA (RDC) to resolve the issue of manpower development, funding national research expenditures and maintenance of physical facilities available within the region.

1. INTRODUCTION

Food production in East and Southern Africa has not kept pace with the region's high rates of population growt for several years. Drought, wars, political instability and rural-urban migration have contributed to the increasin dependency on food imports by governments to avoid food shortages and the consequent human hardship: Malnutrition and poverty are widespread and several countries have experienced famine. Root crops, especiall cassava, is becoming an important staple food in the region after banana and maize, with high potential fc livestock feed and industrial use. Most of the cassava, however, is produced by poor small scale farmers usin traditional farming systems on marginal soils.

The severe drought in the early 1980s raised the competitive position of cassava as a food security and cash crop However, the increase in cassava production in the region during the last decade has been marginal, and in som countries production is either stagnant or declining. Annual production per country varies between 560,00((Rwanda) and 3,350,000 (Uganda) metric tons (Table 1). The low average yields recorded are due to diseases an pests, low yield potential of local cultivars and poor crop management practices prevailing in the low inpu farming systems. The absence of improved post harvest transformation techniques, storage and marketin difficulties do not favour increase in their production.

The food economy of East and Southern Africa region with a population of over 100 million now depend, to a considerable extent, on cassava for daily energy and nutritional requirements. Consumption per capita in 1990 wa estimated at 26.2, 73.7, 107.8, 121 and 154.6 kg/year for Kenya, Rwanda, Burundi, Madagascar and Uganda respectively. Except Madagascar where some cassava used to be exported, most of the region's production is usec domestically as food. Data on the state of cassava production and utilization in Africa, collected through the "Collaborative Study of Cassava in Africa (COSCA)", show that famine rarely occurs in areas where cassava is widely grown since it provides a stable base to the food production system. Cassava, thus has the potential fo eliminating food crisis and famine.

Cassava is grown in association with other crops such as maize, legumes (peas/beans), sweet potato, and sorghum/millet. Average cassava root yield in the region is 10.5 tons/ha. The main cassava products include cassava chips/flour and fresh root.

Governments within the region are seeking to increase food production to consolidate self sufficiency, ensure food security and improve the nutritional status of their people. To achieve and sustain these, priorities are being given to developing more efficient extension services, promoting peasant production, encouraging agro-industrial enterprises, improving availability of agricultural inputs, marketing channels, social services and emphasizing agricultural research.

1.1. International Institute of Tropical Agriculture (IITA)

The Ministry of Agriculture of the Government of Uganda invited IITA to establish a regional centre for East and Southern Africa located within the premises of the Namulonge Agriculturai and Animal Research Institute (NAARI), near Kampala. IITA accepted the challenge. The overall objective of the regional centre on cassava is to generate and distribute technologies which can facilitate increased production of cassava commensurate with national needs. In order to achieve this objective, the centre is designed to strengthen national research capacities in the development of high yielding and stable varieties for the mid-altitude ecologies of East and Southern Africa and in the development and implementation of sustainable plant production strategies. Close links will be maintained with research on cassava taking place at other stations of IITA to ensure rapid germplasm development and other technologies for the region.

IITA has a continental mandate for cassava improvement in sub-Saharan Africa and uses an interdisciplinary approach to cassava research which cuts across the different research divisions of the institute. Plant Health Management Division (PHMD), Resource and Crop Management Division (RCMD) and Crop Improvement Division (CID). The Root and Tuber Improvement Program (TRIP) of CID has four units dealing with aspects of cassava physiology/agronomy, tissue culture, biochemistry/food technology and breeding. The International Cooperation Division (ICD), oversees collaboration with National Agricultural Research Systems (NARS) among other things.

Significant progress has been made at IITA on the development of improved clones resistant to cassava bacterial blight and African cassava mosaic virus disease, the development of rapid multiplication methods for cassava planting materials and biological control of the cassava mealybug. The major current research directions are to diversify cassava genotypes to meet the needs of diverse environments, farming systems, farmer and consumer requirements.

IITA as the executing agency has a number of technologies which are almost ready for transfer to the East African region through the network. These are discussed in more details in section 4.1. With the head office for the EARRNET located at ESARC. the coordinator of EARRNET maintains contact with the Research Team Leader of ESARC. ESARC, with EARRNET's concurrence, may use the network as means of maintaining structured contact with NARS Directors in East Africa. The aim would be to optimize the efficiency of regional contact. Feedback from EARRNET and SARRNET to ESARC in the initial two years of ESARC's operation would have a major bearing on establishing priorities and formulating plans for the cassava component of ESARC.

Once fully functional, ESARC will play an increasing role in sustaining activities of the network. Results from COSCA and socio-economic studies will provide basis for refined regional priorities on research and technology transfer processes. Technical support to improve capacities and capabilities of NARS through exchange of germplasm, farming systems research, post-harvest technologies, integrated pest management, training and information exchange will be provided. Effective collaborative linkages with universities, private sector, policy makers will further strengthen the association that is being built through the regional networks.

1.2. East Africa Root Crops Research Network (EARRNET)

1.2.1. Goal

Contribute to increased cassava productivity and total production by resource-poor farmers in Eastern Africa, which will lead to increases in income and improved food security.

1.2.2. Purpose

- Provide a forum for the rapid exchange of technologies such as improved varieties, biological control of pests, agronomic practices and postharvest processing derived from the participating national programs or other institutions.
- Foster collaborative approach to the setting of regional priorities for research and training needs.
- Minimize duplication of efforts and share complementary scientific research responsibilities among member NARS based on their respective comparative advantage.
- Provide technical and financial support that will enable NARS with lead roles to effectively discharge their research responsibilities.
- Strengthen NARS to conduct root crops research.

1.2.3. Characteristics, structure and organization

EARRNET, housed within IITA's East and Southern Africa Regional Centre (ESARC) works with the National Root Crops Improvement Programs (NRCIPs) in Burundi, Kenya, Madagascar, Rwanda and Uganda. In recognition of the lead roles NARS must play in the management of the network, with IITA playing a supportive role, management of EARRNET is assured by two committees: Committee of Research Directors (CRD) and Steering Committee (SC) (Annex 1). The CRD is now integrated with the Association for Strengthening Agriculture Research in East and Central Africa (ASARECA). The CRD had overall responsibility in the general functioning of the network. It established general policies and priorities of cassava research and approved the annual work plan and budget through suggestions submitted by the SC. The SC, made up of heads of national programs of each collaborating country, the coordinator and regional scientist constitute the technical arm of EARRNET.

EARRNET collaborates with institutions that contribute to strengthen capacities of national program capacities to address their cassava research objectives. EARRNET should thus be considered as an amalgamation of all entities (research institutes, universities, non-governmental organizations, private sector) conducting research in all the member countries and their linkages to major client groups (policy makers, technical assistance and donor organizations, extension services, producers, consumers and international agricultural research organizations). Its effectiveness depends on the ability to contribute to and benefit from information and technologies generated.

Root crop programs within the different EARRNET countries are at different stages of development, vary in structure, manpower strength, research infrastructure and capacity to develop linkages with extension agencies. Since the network is heterogeneous in terms of capacities of its members, the levels and quality of contribution will differ. By tapping on the comparative advantage of each collaborating program, the network is able to attract other interesting parties such as NGOs and the private sectors to strengthen and enhance NARS ability to respond to the growing concern of governments for increased use of cassava especially in drought-prone areas.

1.2.4. Human Resources

Tables 2 show the staff of each national cassava program.

1.2.5. Financial Resources

The International Cooperation Division supervises project imprest and procurement for EARRNET. Table 3 provides the breakdown of fund allocation to the different national cassava programs to implement their collaborative regional activities for the year. Funds for the technology transfer and impact assessment activities were not apportioned. This was partly utilized towards an impact assessment training course targetting socio-economists. National programs are being equipped to effectively carry out monitoring, evaluation and impact studies. Funds from IDRC are earmarked as direct support to national programs.

Financial disbursements from USAID funds were made in April, 1994 to all member countries. The cheque for Rwanda was returned due to the outbreak of the civil war. Total funds for Rwanda (USAID and IDRC) are being used as seed money for the inter-CGIAR centres initiative on the 'Seeds of Hope for Rwanda'. The Uganda Program receives some bilateral funding from Gatsby Charitable Foundation and national funding for its research and development activities. In Kenya, GTZ provides supplementary funding to the work on plant protection. Apart from these, most programs depend to a large extent on funds received through EARRNET (IITA) for running costs while salaries are paid by national governments.

1.2.6. Network activities

EARRNET's TDT activities, as agreed upon by the SC and approved by the CRD during the coordination meetings held 3 - 5 May 1993, fall under four categories:

- Research
- Training
- Information exchange
- Institutional capacity-building

The objectives for the research component are to:

- Introduce improved cassava populations with high frequency of desirable genes adapted to the mid-altitude ecologies and other major cassava areas of Eastern Africa;
- Establish effective national plant health activities within existing plant protection units of root crops programs and encourage an ecologically sustainable approach to managing pest and disease problems;
- Conduct surveys on cassava-based cropping systems in member countries in order to establish production constraints, adoption rate and impact of released varieties;
- Develop post-harvest technologies with the aim to increase labor use efficiency, minimize food losses and improve the quality of food products and food security through identification, develop and adapt post-harvest technologies at the household, market and village level, establish food processing and demonstration centers, and conduct training programs for users and extension workers;
- Establish multiplication, distribution, and monitoring systems in all collaborating countries in order to hasten the distribution and adoption of improved technology by farmers.

Two forms of research activities are planned for the network: collaborative regional research and national research. Most of the collaborative research projects are conducted by individual member countries on behalf of the network and results from such activities are expected to have regional impact. The coordinator also carries out research in area of competence as an integral part of the network's program.

Five collaborative research activities[1] which reflect the goals and objectives of member countries in addition to cross-country acvtivities covering training, information exchange and institutional capacity building were planned, discussed and approved by both EARRNET management committees (Table 4).

Participating countries allocate land, office space, research personnel and other resources to establish and maintain network activities. Each participating country is expected to make provision in its annual budget as a direct contribution to the network effort. To the extent possible, effort is made to seek bilateral funding support for national programs.

Impact assessment

Due to lack of information on the scope of activities involved in monitoring, evaluation and impact assessment among heads of programs, the SC proposed that training courses be organized to upgrade national capacities to

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[1]East Africa Root Crops Research Network (EARRNET): Annual Steering Committee meeting, ILRAD, Nairobi, Kenya, February 17 - 18, 1994. 87pp.

do monitoring and impact assessment. USAID, in partnership with the East African networks sponsored and conducted two impact assessment courses targeting socio-economists (11-22 July,1994) and biological scientists (20-30 September 1994) at the CMRT facility in Egerton University in Kenya.

The goal for the socio-economic course was to assist participants in formulating case studies at the national level. Key topics covered included the following: definition of evaluation research - characteristics, purpose and limitations; process of evaluation - techniques of evaluation including contents and utilization; role of evaluation in project management; recent concepts in technology development and transfer; planning for an evaluation - long and short term programs including research and development activities; strategies and approaches for impact assessment; analytical techniques for impact analysis including intermediate product analysis, multicriteria analysis, effectiveness analysis and the logical framework, environmental impact analysis and methods of obtaining estimates; impact assessment techniques including cost/benefit analysis, economic surplus approach in analysis, production function approach to analysis; rate of returns calculations with and without analysis techniques; case studies on rates of returns on investments in maize research in Zambia, Zimbabwe and Kenya; adoption studies and impact assessment; crop management (agronomy) research and its impact on rates of return, sampling for adoption studies; spill over effects - framework for regional analysis; risk analysis and impact assessment; types of evaluations - in-house, external and collaborative; valuation questionnaires; institutionalization of impact assessment at national level and its implications; overview and lessons learned from past rates of return studies. Additional subjects covered included economics of natural resources management, economic valuation of natural resources and applications of natural resources and environmental valuations.

The course for biological scientists broadly evaluated the practical approaches to monitoring and evaluation - principles and procedures; planning and priority setting; understanding and responding to farmers' needs and priorities; ex-ante analysis of probable research impact; linking with economists and monitoring and evaluation units; base line and diagnostic studies; measuring progress towards adoption and impact and research project monitoring.

In addition to the above format for improving capacities and capabilities among member countries, a socio economic study on root crops (cassava, sweet potato) was initiated in Rwanda to:

- assess adoption and impact of root crop research results with particular attention to the improved root crop varieties released by the Institut des Sciences Agronomique du Rwanda (ISAR)
- assess root crop commodity food systems from production to consumption with emphasis on fresh root marketing and
- provide socio economic backstopping to root crop research in EARRNET and the Southern Africa Root Crops Research Network (SARRNET) member countries.

Due to the situation in Rwanda, the socio-economist has relocated to Malawi and would continue to provide backstopping to the two netwrks.

2. ACHIEVEMENTS: COORDINATION/MANAGEMENT

The present physical location of the Coordination Office within the premises for the Uganda National Cassava Improvement Program has created a strong bond between the coordinator and the national program. This linkage ensures the participation of the coordinator in national program activities as it relates to priority setting, planning and implementation of programmed activities such as consolidating the breeding and selection program, refining ecological demarcations and technology transfer (training, on-farm testing, multiplication, distribution). The regional agronomist is yet to come on board.

The Memorandum of Understanding (MOU) between IITA and two member countries (Uganda, Burundi) have been signed. That between IITA and Madagascar is being processed through the Ministries of Agriculture, Finance and Foreign Affairs in Madagascar. It is hoped to be signed before the end of the year. A very long gestation period is being encountered on the MOU with Kenya.

2.1. Steering Committee meeting

Meeting took place 17-18 February, 1994 at ILRAD, Nairobi, with all heads of programs from member countries attending. In addition, 8 persons participated from IITA representing the following divisions: CID, RCMD and ICD. USAID and IDRC were also represented at the meeting (in English and French). Two versions of the minutes of the meeting have been issued to permit full comprehension by persons from both English and French speaking member countries.

The following are highlights of the meeting:

- Mr. Michael Ntimpirangeza assumed the chairmanship of the SC in accordance with its governing bye laws.
- Meeting took 3 days instead of the 2 days originally planned to allow heads of programs to revisit and readapt their national reports and workplans in line with the format transmitted to them earlier.
- Increase efforts to have all countries sign the memorandum of understanding with IITA.
- Steering Committee was challenged to reverse the decreasing trends in cassava production irrespective of the current unpredictable weather patterns and enhance its utilization.
- Financial inputs from governments and donors need to be multiplied as outputs.
- Technical and financial reporting to coordination office needs improvement.
- Information on COSCA, socio economic study (Rwanda), and TRIP, were provided.
- Monitoring and evaluation was discussed at length. Considering its necessity for national or regional technology TDT activities and the lack of knowledge or experience on the subject, a training course was proposed to be undertaken in collaboration with the Southern Africa Root Crops Research Network (SARRNET).
- **EARRNET** and **IITA** should help **NARS** develop project proposals and seek financial support from donors.
- The next meeting of Steering Committee to be held in Madagascar, 16-20 January, 1995. Coordination office and head of Madagascar program to arrange for the meeting.

One of the major weaknesses identified during the SC meeting with the management of commodity networks is that the SC members are normally made up of researchers with a particular discipline, especially breeders. Research agenda are thus biased towards crop improvement. Essential disciplines such as plant protection, socio-economics, post harvest technology, are mostly excluded. Although EARRNET is endowed with crop protectionists and breeders, it was recommended to explore the possibility of including scientists of other disciplines, stake holders, producers and consumers on the SC to fully exploit the objectives of the network.

A bye-law was proposed to permit the coordinator co-opt persons of specialized disciplines as deemed fit. The bye-law proposed by Kenya, seconded by Uganda and adopted by participants is as follows:

> **"Depending on issues in the agenda, for an SC meeting and should the coordinator think that there is deficiency on the committee in disciplines to be discussed, the SC proposes that the coordinator coopts scientists/experts in the deficient areas to attend the subsequent meeting"**

2.2. Research Directors Committee meetings

Three meetings have been held by the RDC since February 1994:

- ILRAD, Nairobi, Kenya, 21-24 February, 1994
- KARI, Nairobi, Kenya, 26 April, 1994
- IAR, Addis Ababa, Ethiopia, 5-10 September, 1994

The first meeting in Nairobi involved RDCs of all the four USAID-funded networks (EARRNET, EABRN, PRAPACE, AFRENA) in East Africa and a team from ISNAR. The ISNAR team had been given an assignment to (a) help the RDCs establish a framework for their collaboration, including the development of mechanisms that would support this collaboration (b) assist the RDCs, individually and as a group, to develop strategies to integrate regional research network activities with national programs and plans and (c) help the RDC develop a strategy to coordinate regional activities across networks. The chairman of each network, together with donor representatives, attended the meeting.

Subsequent meetings held at KARI and IAR has resulted in the establishment of the Association for Strengthening Agricultural Research in East and Central Africa (ASARECA). Prof. J.K. Mukiibi, Director General, National Agricultural Research Organization (NARO), Uganda, has assumed the chairmanship of the association whilst Dr. Mugerwa, Dean, Faculty of Agriculture is the interim secretary. The Secretariat of the association is provided by NARO.

2.3. Training

IITA's Group Training Unit (GTU) participated in the SC meeting to assist and provide guidelines for planning and designing training courses to meet EARRNET's priorities and needs. A committee composed of SC, the coordinator and representatives of GTU discussed group and in-country training courses for EARRNET. Members considered network goals and how training could contribute to human resource and institutional development. It was agreed that training could be used as a mechanism to improve the capacity of research staff to implement their research activities, produce training materials, conduct training and farmers field days. Thus, research and training may be linked to effect institutional development.

IITA offers four categories of training on cassava: crop management, rapid multiplication, post harvest technology and other specialized courses. The crop management course is part of those which IITA is decentralizing to be conducted in collaboration with NARS. It is hoped that NARS with requisite capacities and capabilities will take over the conduct of such courses in the long term. The rapid multiplication course is normally organized in-country. Three types of post harvest technology courses are organized which fall under improvement of research skills, technology adaptation, processing and utilization. Breeding of root crops, virus indexing (tissue culture) and training the trainer are examples of specialized courses organized at IITA.

Since IITA's decentralized training was initiated in 1993, more time has been devoted to course planning and development with networks. Training accomplishments have received strong backstopping from IITA's training program. The program has provided assistance in planning and conducting courses which include course planning meetings with resource persons assistance in coordination and management of courses (preparation of course outline, facilitation of presentations, logistic support, supply of training materials, delivery of presentations, evaluation and documentation of courses). Course planning workshops have been conducted with resource persons to improve the quality of the courses and strengthen NARS training capacitites. IITA training program staff and national resource persons collaboratively identify skills, trainees neds, develop course objectives and activities, specify time allocation of resource persons for each activity and identify and/or prepare training materials. Course participants then link the training course to post-training research and training activities through action planning, review the design and production of training materials and develo9p a sense of shared ownership of the course.

Heads of programs requested the participation of their staff in the IITA organized courses. From requests made, it was noted that post harvest technology is a major constraint to cassava production in their respective activities. In addition to the regional training courses and those to be held at IITA, Burundi, Kenya, Madagascar and Rwanda national programs opted to organize in-country training courses with special emphasis on rapid multiplication and distribution of planting material.

Table 5 provides courses conducted with participation from EARRNET member countries. The Kenya and Madagascar participants in the breeding course stayed for an extra week at IITA to get more acquainted with the integrated approach to cassava research. The Uganda participant stayed for another week to take part in a Genotype x Environment workshop held by the CID. This workshop brainstormed on the major issues related to G x E interaction on the major crops under IITA's mandate. All three participants returned to their respective countries with seed populations of some varieties and tissue culture material to be used in regional trials scheduled for next year onwards.

Training in post harvest technology for researchers took place at IITA in which 2 Kenyans participated. Unfortunately, application for 2 participants from Uganda were received too late for consideration. The overall goals of the course was to improve skills for post harvest food crop research and to stimulate post harvest research in Africa. The course covered the general principles of post harvest technology including chemistry, biochemistry and microbiology of food deterioration; biology and control of storage pests; drying methods; storage and processing of selected food crops; post harvest equipment design and development; socio-economic implications of post harvest technology and technology transfer principles and training methods.

Only two technicians from Uganda could attend the Root and Tuber Crops Production and Technology Transfer Training Course held in Malawi since it targeted English speaking countries. Other courses had been arranged for the francophone countries, however, these were canceled later due to political disturbances within the host country.

In-country courses planned for Kenya and Burundi are yet to be carried out.

2.4. Information exchange

Provision of opportunities for free exchange of information among collaborating NARS, IARCs and other relevant organizations can lead to more efficient priority-setting, less duplication of effort and reduction in time required for execution of projects. Information on technologies generated by IITA continues to be disseminated to NARS through its usual channels such as meetings and workshops, training courses, exchange visits, library services, publications and the popular media. IITA hosts meetings, including the triennial Root Crops Collaborators meeting, and symposia which provide opportunities for root crops researchers in Africa to exchange views, standardize methodologies and update their knowledge through discussions and field visits. Training, as described above has been an effective means for information dissemination. In addition to IITA's participation in the SC meeting, the Director of CID and the Projects Coordinator (ICD) participated actively in the joint network RDC research planning/review meeting in February 1994. Similarly, NARS scientists have

influenced the research agenda to be followed at ESARC[1]. The Chairmen of the two networks are members of ESARC's SC while the coordinators are ex-officio members.

The following activities have characterized EARRNET's quest to strengthen information exchange within the region:

- Three information updates from the Coordination office have been issued, with copies to all national programs
- This first issue of the "ROOTS" newsletter is completed and distributed. It was earmarked for July printing but for some few communication problems between Uganda, Malawi and Mozambique. Although one newsletter ws suggested at the SC meeting, two issues are earmarked for the year. The first publication provides general information on the EARRNET and SARRNET with a few technical papers while the second will be more technical.
- Archival reports for the last five years covering activities of TRIP have been provided to all national programs
- Information is awaited from national programs to produce a booklet on cassava researchers in E. Africa which will include basic information on research activities being undertaken, profile of scientists, etc.
- The 7th issue of the Tropical Root and Tuber Bulleting jointly published by IITA has been distributed to member countries.
- For ease of consultation by the French speaking countries, the minutes of EARRNET's annual steering committee meeting held at ILRAD, Nairobi, Kenya on 17 - 18 February, 1994 has been translated inot French and distributed.
- The Gatsby Charitable Foundation, London sponsored two Ugandans to the 10th symposium of the International Society for Tropical Root Crops scheduled for 13-19 November 1994 in Brazil. IITA facilitated one Ugandan to the same symposium on sponsorship from the Rockefeller Foundation.
- Proceedings of the 9th symposium of the International Society for Tropical Root Crops held in Accra, Ghana, has been published. Distribution is in progress.
- Proceedings of the 5th Triennial symposium of the International Society for Tropical Root Crops - Africa Branch, held in Uganda, 22-28 November, 1992, has been published. Distribution to members of the society has been initiated.
- Coordinator participated in the ESARC, SARRNET and PRAPACE SC meetings in Kampala (Uganda), Lilongwe (Malawi) and Mukono (Uganda), respectively. He had the opportunity to discuss with members on fostering and facilitating training and other collaborative activities within the region.
- Coordinator participated in all three RDC meetings which has resulted in the establishment of ASARECA.
- Coordinator made visits to the Rwanda, Kenya and Madagascar programs to familiarize himself with national program activities, evaluate progress and meet with their research and administrative personnel (Annex 2).

2.5. Capacity building

As earlier mentioned, root crop programs in member countries are at different stages of development (structure, manpower, infrastructure) and vary in their capacities to develop external linkages. In many instances research and extension do not adequately cooperate to carry out diagnostic activities, adaptive research, review of research results and impact evaluation. In all network related operations, emphasis is placed on the use of a team approach among donors, national collaborating scientists, extension staff, private sector, non-governmental organizations and farmers to create an environment for effective linkages.

Shortage of professional manpower in the NARS continue to be a major weakness. Since human resource development in NARS constitute the foundation of long term sustainable agricultural research, a high premium needs to be placed on the development of high calibre staff. Both formal and informal training courses with focus on particular production problems or research methodologies have been identified by the SC to be implemented at several levels. Making increased use of regional resource persons and institutions have been proposed to develop the manpower necessary for strong national root crops research programs and for building an effective network within the region. Given the two-year life and funding schedule of this phase, training at or beyond the Masters level is not envisaged under EARRNET's funding. This is being achieved through other IITA implemented projects and activities.

The Coordination Office has started assembling and gathering baseline information on present status of national program development and transfer system of member countries to measure NARS performance.

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[1]ESARC (1994) Proceedings of the inaugural meeting of the East and Southern Africa Regional Center of IITA

The technical capacities of the national programs to assume greater responsibilities in the network TDT activities are being improved either through provision of improved germplasm, NARS participation in workshops, symposia and meetings and financial disbursement to national programs participating in other collaborative activities for which IITA is the implementing agency.

To date, the following EARRNET member countries have benefitted from PHMD's initiative to develop national biological control programs in the East African region. In Burundi, a collaborative agreement was signed between IITA and ISABU for 1992 and 1993. An extension is now pending due to internal developments in Burundi. Due to the continuous technical support received, cassava mealybug (CM) is no longer a problem in Burundi. ISABU nevertheless continues to rear natural enemies of CM for supplying neighboring countries. Collaboration with Burundi now centers on cassava green mite control. Experimental releases of predatory mites shipped from Cotonou and their follow-up are supported. A second screenhouse for local mass rearing of phytoseiids is near completion. Two vehicles and rearing equipment as well as operational costs to the value of US$ 70,000.00 has been provided by PHMD with Austrian and German funding.

The main collaborators of PHMD are located at KARI's Division for Entomology and Biological Control in Muguga Research Station. A collaboration agreement signed in 1991 between IITA and KARI, assures five years of project support for biological plant protection in Kenya. CM is now contained while experimental releases of predatory mites continues. They are reared locally from new strains imported from Cotonou. Funds made available for the country by GTZ through IITA amounts to US$ 200,000.00. These were used for the purchase of office and laboratory equipment, 4 four wheel drive vehicles and operation costs.

Biological control activities in Rwanda started with a cooperative agreement between ISAR - Butare and IITA to cover the period May 1991 until end 1995. IITA-PHMD strengthened the program with financial and technical assistance. In 1992 advice was given for mounting one rearing facility in Butare and starter culture of the parasitoid *Epidinocarsis lopezi* was shipped to Rwanda. The national program had since increased its output of this natural enemy to 25,000 per month for releases in Northern Rwanda. In 1993, a countrywide survey of CGM was undertaken. Since 1991, IITA has spent US$ 150,000.00 for equipment and operating charges from GTZ.

In 1991, a project agreement was signed between IITA and Uganda's Ministry of Agriculture and Forestry covering collaboration with their National Biological Control Unit at Namulonge Research Station until 1993 and extended till end of 1995 under the Secretary for Research of the NARO. Technical support has been provided since late 1991, when cassava mealybug entered Uganda, for the release of predatory mites. This continued through the middle of 1994 when the local rearing of *E. lopezi* was started in Namulonge. A screenhouse has now been mounted for the operation. Financially, GTZ granted IITA about US$ 220,000.00 for supporting the Biological Control Unit of Uganda with equipment, training and operations. An additional amount of US$ 60,000.00 was made available for degree related training for national personnel.

2.6. Development of project proposals

To assist in execution of regional activities, the following project proposals have been developed for the different national programs and submitted to donor agencies for funding consideration. Madagascar has been targeted because of the present development stage of their cassava research program relative to the importance of the crop as food and cash crop.

- Baseline study of cassava production, utilization and marketing in Madagascar

  Aim: Collect baseline data on cassava in Madagascar using Collaborative Study of Cassava in Africa (COSCA) framework to provide a basis for research, policy or extension plans on the cassava crop as well as form the basis against which the impact of any research, policy or extension intervention will be evaluated.

  Donor: USAID/REDSO/ESA
  Funds requested: US$25,000.00

- Development of Madagascar Root Crops Improvement Program

  Aim: Increase cassava productivity by developing production systems suitable and acceptable for use by resource poor farmers through provision of improved germplasm, development of crop and pest management systems, appropriate post harvest technologies and impact assessment.

  Donor: Ministry of Cooperation, France
  Funds requested: US$ 2,450.420

Accelerated multiplication and distribution of healthy planting materials of the best high yielding varieties of cassava and sweet potatoes in Kenya, Burundi and Madagascar.

Aim: Improve production and output of cassava and sweet potatoes through rapid multiplication and distribution of healthy planting materials of superior clones to smallholder families in Kenya, Burundi and Madagascar who are often affected by food shortages and insecurities in adverse climatic conditions

Donor: African Development Bank
Funds requested: US$ 958,700 (Kenya)
US$ 782,300 (Burundi)
US$ 758,700 (Madagascar)

2.7. IITA backstopping and NARS exchange visits

All IITA divisions (scientists and senior management staff) have actively provided technical and managerial support to EARRNET through visits to update themselves with progress and offer advice (Table 6). Staff of ESARC has provided some local support. IITA staff participated actively in EARRNET's SC and RDC meeting and the in-country training course in Madagascar.

Dr. Marc Ngendahayo, Director of Crop Production Department, ISABU visited Uganda to discuss, among other things, issues related to Burundi national cassava program and EARRNET and have an overview of TDT activities being implemented by the Uganda national program. Presently based in Uganda, Mr. P. Ntawuruhunga is actively involved in the "Seed of Hope for Rwanda" initiative. Dr. S. Ranomenjanahary spent 5 days in Uganda during the evaluation of USAID funded East African networks to interact with Dr. J. Sentz and be updated with the Uganda national program activities. As earlier stated, Mr. J.M. Kamau and Ms. Isabelle Ralimanana stayed at IITA for an extra week to be more acquainted with IITA's cassava research while Dr. B.W. Khizzah participated in the Genotype x Environment workshop at IITA.

NARS participants from both EARRNET and SARRNET member countries to the inaugural SC meeting of ESARC held a meeting to update each other on activities pertaining to root crops in their respective countries and their expectations from the networks to root crops research and development activities within the region.

TRIP has been instrumental in the supply of improved germplasm, either as seeds or in tissue culture, to the different national programs for selection under their local conditions. TRIP has provided seed and tissue cultured material (Table 7) to participating member countries in an effort to increase diversity of available germplasm for selection under their specific environmental conditions.

In addition to provision of germplasm material, TRIP has financially backstopped the Ugandan program with a total of US$ 4,000.00 towards the collaborative evaluation of cassava seeds and tissue cultured material.

3. HIGHLIGHTS OF ACTIVITIES IN NATIONAL PROGRAMS

An update of national program activities are presented in this section.

3.1. Burundi

The following varieties; Gitamisi, Creolinha, TMS 16013, Maguruyinkwale and Mpambayabashengera are being multiplied for distribution to farmers. Other populations are being screened for resistance to diseases and pests, high yield potential, good agronomic and quality traits.

3.2. Kenya

3.2.1. Germplasm introduction, evaluation and multiplication

The root and tuber crops section at KARI's National Dryland Farming Research Centre (Katumani) continued with the maintenance of germplasm and multiplication of planting material at the centre, Masongalani and Kiboko (sub-centers). The KME1 multiplication plot planted in 1992 is being maintained while a new plot of about 0.3 ha was planted in June. Observations on the advanced and preliminary yield trials planted in November 1993 continues. At Kiboko, a seed nursery of 14 families was established. The seeds have germinated and seedlings havew been transplanted in the field. The seedlings will be evaluated for their various agronomic characters and disease/pest resistance. Multiplication of KME1, Mucericeri and KME61 started at Kiboko. The acreage of these varieties will be increased using rapid multiplication techniques. Maintenance of KME1 and KME61 multiplication plots in Masongaleni continues, however, due to maintenance cost, further multiplication will be concentrated at Kiboko.

Three locations (Alupe, Siaya, Kakamega) are basically used for germplasm evaluation in western Kenya. Advanced yield trials consisting of 11 promising varieties (Adhiambolera, Tereka, CK 01, CK 02, CK 03, CK 04, CK 06, CK 08, CK 09, Serere and 12200) were planted at Alupe and RRC-Kakamega, respectively, during the long rains of 1994. Assessment of the African Cassava Mosaic Virus (ACMV) disease has been done. Plants at Alupe range between 1 - 2 metres in height while those at Kakamega are less than 50 cm. The 1993/94 trials planted at Alupe, Siaya and RRC-Kamega was harvested in June 1994 and the data are being analyzed.

Ten cassava varieties (Tereka, CK 09, CK 01, L1, L11, L111 Serere, 12200, CK 02, and Adhiambolera) were planted at the Siaya Institute of Technology (SIT) in April, 1994 to determinew varietal responses to secondary sources of ACMV infection in the low midland zone of western Kenya. Results of the cassava spacing trial planted in 1993 to determie the optimal planting densities for branched and erect cassava varieties within the upper midland zone are being analyzed.

Cassava multiplication plots were established in collaboration with extension staff at RRC-Kakamega (1.6ha) and SIT (0.6ha) in June 1994 using the following varieties: 12200, Adhiembolera, Serere, CK 01, CK 06, Kibandameno and Tereka. The crop stand at the two sites is generally poor, but maintenance continues. Collaborating extension staff were trained on disease identification to effectively carry out roguing of plants showing symptons at Siaya. Presently, 1.6ha is being prepared at the RRC-Kakamega for further bulking of planting material.

3.2.2. Ecologically sustainable plant protection

Cassava mealybug

Between June - August 1994, monitoring of released CM natural enemies, *E. lopezi*, and of transferred CM mummies in western Kenya continued. Field samplaing was done at intervals of 10km and CM population, damage and infestations were recorded. Each field was stratified and 50 plants randomly selected. These were then examined for CM, CM mummies and local natural enemies. Ten centimeter tips (10-20) were collected, kept in well-ventilated jars and taken to laboratory to determine the composition of the natural enemies.

Percentage infestation of CM in western Kenya ranged from 0-34. Damage due to CM was low in most of the fields. The highest infestation of 30 CM per tip was found in new infestation sites in Busia and Bungoma districts (Table 8). The reduction in CM population in south Nyanza, Busia and Bungoma may be attributed to the presence of *E. lopezi* since the parasitoid emerged from mummies collected from these sites. The parasitoid had dispersed over a radius of 25 km from Busia and Siaya. The new outbreak site reported in June 1993 in Bungoma showed a population increase to over 21 CM per tip and a damage score of 3.0. However, a single *E. lopezi* was recovered (Table 9). This may have been transferred to this site from the release sites in Busia through the exchange of planting materials or from Uganda where the parasitoid was released in May 1992. Subsequent monitoring conducted in June in western Kenya indicated that the infestation dropped due to rainfall.

A diagnostic survey conducted in eastern Kenya revealed the absence of CM. The field that had CM in 1993 had been uprooted and destroyed as a temporary measure to prevent the spread. In general, all sites at the coast have CM and its exotic natural enemy. However, in western Kenya, only Kisumu and Kakamega districts did not have CM.

Cassava green mite

A survey was carried out in western and eastern Kenya to assess the incidence and damage of *Mononychellus tanajoa*. This was conducted by sampling cassava plots along the main and feeder roads at an interval of 10-20 km depending on the frequency of cassava fields. At each site 30 plants were sampled by picking the upper leaves and recording the number of mites on each. Farmers fields were selected in Kitui and Embu on which the exotic natural enemies were released. Follow up monitoring was conducted after three months.

Monitoring of the released phytoseiids at Katumani continued monthly and after every three months at the coast and western Kenya. The phytoseiids were collected by picking young and mature leaves (upper and lower) from sample plants. The leaves were kept in paper bags in a cool box and were later observed under binocular microscope. The eggs, juveniles and adults were counted and preserved in 70% alcohol for species determination.

Monitoring sites had very few mites in most of the fields in June since they were washed off the plants by rain as opposed to the normally very high mite population observed during the dry season in January - February (Table 10).

CGM infestation in western Kenya was high with moderate damage score of 1.23 - 3.00. Only 46% of the field sampled had low mites population. Siene CGM is host specific, those that fell on other crops died due to lack of food. A study is therefore recommended to evaluate the effect of intercropping on CGM abundance and to determine the appropriate time to plant the intercrop.

Follow up surveys conducted in previously established trial sites revealed that the exotic phytoseiids *Neoseiulus idaeus* did not establish in hot, humid and wet agroecological zones in western Kenya and the coast. The number of mites recorded in these regions were moderate. The most abundant predator identified in these regions is *E. fustis*. These predators have been reported to be abundant during the wet seasons. Some species of this genera are capable of reproducing without mites and can feed on pollen from other plants and not capable of reducing mite population.

N. idaeus continued to be recovered on the release sites at Katumani in eastern Kenya (Table 11). It was not only found on the release plants but also adjacent plants. It was found to have dispersed to a field which was 50m away from release site. It was recorded in another field where leaves with phytoseiids from the release sites were transferred. The predator is now confirmed to have established for a period of over 27 months since its initial release in March 1992. It was also recovered on a plant *(Ricinus cummunis L)* in association with another mite around the release sites.

Rearing of Typhlodromalus limonicus

A culture of CGM was started in January and May in preparation for *T. limonicus*. Cassava was planted in pots and after 2-3 months CGM was collected from the field and placed on the leaves. An import permit, granted by KSTCLE, allowed the introduction in mid-June of *T. limonicus* (390) and a new Brazillian strain of *N. idaeus* (314) from Benin.

To rear *T. limonicus*, a tray measuring 30cm x 5cm was washed and kept in a deep freezer for 24 hours to kill all possible contaminations. A foam measuring 22 x 0.2 cm, PVC tile measuring 20 x 20 x 0.2 cm, paper towels, and 4 pieces of hydrophilic cotton wool were also kept in a freezer for 20 hrs. The foam was placed in a tray of water until it was fully soaked and the PVC tile placed on top of it. A paper towel was placed on the 2 opposite sides of the foam, ensuring that it touched the water. Cotton wool wrapped in paper towels were then placed at the ends making sure that they touched the water and the end of the PVC tile.

Cassava leaves infested with CGM were screened for other predators. *T. limonicus* was placed on the underside of the leaf and the cut edge attached to the cotton wool. The culture was maintained at controlled room temperature of 25°C and 75% RH. The leaves were changed after 3 days, ensuring that all the actives and eggs were removed and placed on new leaves. The prey density was determined prior to introducing the predator. Maintenance and rearing of *T. limonicus* is progressing despite having low CGM cultures in the green house. Tunnel production trials of CGM will be conducted at Muguga and later at the Kenya Coast.

Maintenance of N. idaeus

Maintenance rearing is in progress. At Katumani, *N. idaeus* has established for 27 months. *N. idaeus* on leaves collected from the release plants were transferred to a new experimental site and have persisted for 8 months. However, it has failed to establish in the western and coastal cassava growing regions.

3.3. Madagascar

Cassava, the second most important carbohydrate based food crop, has existed in Madagascar since 1790. It has been adopted and grown in all regions by farmers who have given it vernacular names in each region: Mangahazo, Kazaha, Balahazo, Ambazaha, Mahogo. The cassava mosaic virus disease has continued to be the most important production constraint and as such emphasis is placed on developing and identifying resistant clones. Presently a cassava germplasm collection established at the Agronomic Research station of Ambohitsilaozana at Lake Alaotra (CALA) has 264 clones of which 199 are cultivars grown by farmers. These clones are of local, African, Asian and Latin American origin. They have been characterized and classified and their pathological status continued to be assessed until 1979. Yields, which started declining among the local cultivars is now at 5 t/ha for most clones. Any increase in national production has been due to increases in acreage (2% per annum) under cultivation.

Within the framework of varietal improvement, it was necessary to re-evaluate the germplasm, conduct epidemiology studies to determine how diseases and other parameters contribute to decreasing yield and production before undertaking research projects on cassava for a sustainable agriculture.

3.3.1. Baseline data collection

On farm evaluation of diseases

Of the one thousand farms visited in Hauts Plateaux, 220 fields were evaluated. In addition to poor acidic soils and one weeding frequency, the following criteria were taken into account in the selection of homogeneous farmer fields: vegetative growth phase, clones and type of disease. Pathogens of disease samples collected from

different parts of the plant; leaves, stems, roots, tubers, have been isolated and identified. Estimation of disease intensities on the leaves and root were assessed on the scale of 0 to 5 (Table 12).

Plants showing ACMV symptoms and those which were apparently healthy were observed in all selected fields. From a $100m^2$ plot, storage root weight of three apparently healthy plants randomly selected as checks were compared with another set of three plants with disease score of 3 i.e. the average disease score observed in that particular field. Yield reduction estimates were obtained taking into account root weights obtained from the apparent healthy and diseased plants, percentage infection and plant densities.

The exploration in ther highlands and the mid west showed the devastating effect of pathogens. The following are diseases identified in order of importance: virus (70% attack), bacterial blight (70%), cercospora leaf spot (40%), anthracnose (15%) and sooty mold (5%). The cercospora involed are *Cercospora cassavae, C. henningsti, C. carribae and C. vicosae.* The last two are being reported for the firt time. Whilst these leaf diseases were quite commonly observed in the past at senescence, they now severely attack plants at an early stage and cause early leaf dropping, which decreases yield. Disease intensity varied between 2 and 5 for virus and bacterial blight, 1 and 4 for cercospora and anthracnose and 3 for sooty mold.

Masakevoka, the most productive clone was most sensitive to virus with 94% infection compared to Madarasy and Mangahazo fotsy with 78 and 71% infection, respectively. Yield loss for all three varieties, due partly to virus, is around 79%. Generally, the yields of the three varieties are as follows; 9t/ha (Masakevoka), 5t/ha (Madarasy) and 3t/ha (Mangahazo fotsy).

Pests such as *Bemisia tabaci*, mealybugs (*Aonidomytilies albus*), red mites and *Spodoptera littoralis* were also found during the explorations. Some attack by the nematode, *Pratylenchus brachyurus*, was also observed. A possible natural enemy, *Trichotecium roseum*, a saprophytic fungus, found on all samples analyzed, could be used in biological control

Prophylactic heat treatment of cuttings

Cuttings of twenty two cassava clones were treated with hot water at 52°C for 20 minutes, as is usually done for cuttings of sugar cane, and used for the study. A trial was conducted using 10 cuttings for each clone. Five cuttings received the thermotherapeutic treatment while the 5 others served as checks. These cuttings were planted in plastic pots (18 cm of diameter and 20 cm of height) using sterilized soil and placed in the green house. Sprouting and disease incidence were evaluated.

Heat treatment proved effective for most of the accessions in eliminating most of the air-borne fungal diseases, bacterial blight, and in reducing the intensity although not eliminating the virus. It was, however, ineffective in controlling severe attacks of anthracnose and *Diplodia theobromae* which causes stem desiccation. The latter is localized between the central core and the bark, which makes it difficult to reach. It also inhibits germination, leading to loss of cuttings.

Heat treatment affected the sprouting of clones such as Hongotrakohoravina. The clones were classified according to their sprouting ability into three classes: A = good, B = average, C = poor sprouting (Table 13). The clone which reacted best to the heat treatment was Madamomialakanjo. Despite the shortcoming of this method, heat treatment of cuttings could be used if the necessary equipments: a half drum, a thermometer and firewood, are available. It would be particularly useful in the establishment of a nursery in order to have healthy cuttings.

3.3.2. Germplasm improvement

The Kianjasoa station is located in the Mid-West of the Hauts-Plateaux at 800 m asl with rainfall of 1600 mm per annum. The soil is ferallitic, poor and acidic. Of the 183 clones obtained from CALA, only 138 sprouted and were evaluated using the same methodology as that employed for the farmer field evaluations. Fifteen clones were attacked by viruses, 8 proving very susceptible, and 7 showing some systemic resistance to ACMV; 2 accessions had complete resistance to all the diseases; 29 were susceptible to bacterial blight; 44 were susceptible to cercospora leaf spot (*C. henningsii*) and 3 were susceptible to stem canker caused by *Gloeosporium manihotis*. These diseases were noted together on some germplasm accessions. The pathogens inventoried and maintained in pure culture are:

- *Bacterium roboci* from bacterial blight. It has been partially identified biochemically. Continuation of this work will require the provision of a special plant bacterial pathogen diagnostic kit;
- *Gloeosporium manihotis*, causal agent for anthracnose;
- *C. cassavae, C. henningsii, C. carribae* and *C. vicosae*, causal agents for cercospora leaf spots;
- *Sclerotium rolfsii, Fusarium* spp. and *Pythium* spp., causal agents for root and tuber rots;
- *Diplodia theobromae* which causes stem desiccation;
- Sooty mold, transmitted by mealybugs, ants and probably other insects.

A fungal collection is available for further study. In order to maintain this, periodic purification of the strains is necessary.

Evaluation for virus resistance and identification of virus strains

Fifteen out of the 138 clones in the germplasm evaluation at Kianjatsoa, which showed different levels of resistance to cassava mosaic disease, were used for the study. Cuttings from the 15 clones were planted in 12 m^2 plots with 4 replications. Each plot had two rows of 10 cuttings planted at density of 1 m x 0.65 m. The 20 cuttings of each plot contained 10 diseased cuttings planted adjacent to another 10 from apparently healthy plants of the same clone. The sprouting percentage and disease infection were evaluated. Estimation of disease intensity was done at 3 months using the scale of 0 - 5. Statistical analysis was done using variance analysis and Newman-Keuls test at 5% level.

Pathogen identification was done using the ELISA method. Antigens were obtained from raw extracts of entire leaves with mosaic symptoms from the 15 clones. The causal strain of cassava mosaic in Madagascar was carried out with anti-serum provided by IITA.

The serological diagnosis of the strain of virus in Madagascar gave a positive reaction to anti-ACMV from IITA's Biotechnology Laboratory. The Madagascar strain is therefore an ACMV. The analysis helped to identify 8 accessions (Variaty, A28, Montomaso, P66, L46, Vira Barco, Itu 192 and H66) which are very susceptible and responded positively to the anti-ACMV anti-serum from IITA. Generally, clones with infection intensities of 3-4 reacted positively while those inferior to 3 did not react to the anti-serum. This shows that the serological test is not able to detect small quantities of viral particles. However, the ELISA diagnostic method is very useful in purifying clones with good levels of systemic resistance to the mosaic viruys. The laboratory does not have enough anti-serum to carry out ll the necessary analysis for purification. To overcome this problem, it is suggested that local anti-serum be produced to begin purification.

Generally, the higher level of resistance to ACMV, the higher the sprouting percentage. Though the statistical analysis of the results did not include two clones due to poor establishment, sprouting percentage of apparently healthy clones were significantly higher (74.9%) than infected clones (68.5%). Four classes of clones were distinguished from the analysis (Table 14).

Germplasm collection/introduction, maintenance, evaluation and multiplication

Local and exotic germplasm (139) are being maintained at Maitra-Kianjasoa. Out of this, 6 clones are being multiplied for distribution in 1995. Two sub-stations in the Middle west, Tsiroanomandindy and Ankazobe, are to receive 10 local clones each for characterization, evaluation and then purification. All germplasm (264) available at CALA have been replanted in a maintenance plot. A number of the CALA germplasm has been duplicated at the Tulear station. A duplicate copy of the same CALA germplasm is yet to be planted at Kianjavato.

In addition to 13,650 seeds introduced by the EARRNET Coordinator in May 1994, the national cassava breeder introduced 20,670 seeds in August, 1994. These would be planted in Betsizaraina.

In-vitro plantlets of twenty clones out of 31 received for the EARRNET/SARRNET genotype x environment interaction study recovered from their post flask management and are presently with the quarantine station at Nanisana. The loss of some of the tissue cultured plantlets were due to defective establishment.

3.3.3. Training

Research on cassava in Madagascar has been at a standstill until the last two years when the ESARRN Coordinator visited. This resulted in the organization of a training course on Agronomy and Rapid Multiplication of Cassava sponsored by EARRNET. The course was organized by CENRADERU (FOFIFA), in collaboration with EARRNET and IITA. The aim of the course was to improve capacity of participants to use improved agronomic practices for cassava production, identify major diseases and pests and use appropriate control measures, apply rapid multiplication techniques to produce planting materials and communicate knowledge skills to colleagues and farmers. Eighteen participants made up of technicians and research officers, including six females, attended the course.

Seventy percent of the time was devoted to practical sessions on agronomy, rapid multiplication, survey of farmers' fields and farmers field day while the remaining time was devoted to lectures and discussions. The participants carried out a successful farmers' field day at Mandriabbero village. Only few farmers attended the field day but the fact that the participants were able to demonstrate knowledge and skills gained in the course to others was an indicator of achieving the set objective. The action plan presentations were more of group

presentations than individual. This was because most of the participants came in from different stations and planned to work as a team on their return.

As a result of the low level of research on cassava in Madagascar, only few resource persons in the NARS participated covering mainly diseases, pests and socio-economic importance of cassava. The EARRNET Coordinator and Training Specialist for root crops (GTU) assisted in covering the rapid multiplication of cassava, informal survey, farmers' field day and agronomy practical.

Benchmark and post-test evaluations were carried out. The benchmark showed that the level of the participants' knowledge on cassava was low. The average was about fifteen percent. The post-test showed that there was substantial gain in knowledge which is an indicator that the course was successful. The end of course evaluation showed that the participants found the course very useful, valuable to their professional goals and of relevance to their jobs. Some of the complaints by the participants in the final evaluation were discussed in an open forum at the end of the course.

The course was successful despite the logistical problems and has laid a good foundation of cassava research upon which to build in the country. With the commitment from FOFIFA about the action plans of the participants, there should be a strong follow-through and follow-up programs for the participants in executing their plans. The following suggestions are made to improve future runs of this course: good transport arrangement must be made before course commencement; participants should stay together in a place for better interaction, evening group work and avoid regular late coming to classes; field practical activities should be arranged in a place close to the training site and should not be on farmers' fields where other activities will be done.

As a follow-through with this, similar training courses were offered to technicians and officials of the agricultural extension services in Antananarivo province as follows:

Moramanga	-	15 participants	-	26 and 27 July 1994
Miarinarivo	-	19 participants	-	20 and 21 September 1994

Four participants from an NGO, FAFIALA, were trained at Ambohimangakely on 22 September, 1994 and 11 October, 1994. Fifteen other participants are expected to be trained from Antananarivo north and south (22 September and 11 October 1994, respectively) with assistance of the World Bank.

3.4. Rwanda

Prior to the outbreak of civil war in Rwanda, the following activities had been planned, initiated or established at ISAR's Karama and Butare stations in fulfillment of its national and regional responsibilities.

- A maintenance, screening (green mite resistance)/evaluation, characterization plot with 256 local and exotic clones. Due to the long dry season at Karama station, growth of clones was severely affected. CM was observed at the station with 8 clones showing symptoms. The preliminary results obtained allowed the collection to be classified into three groups based on their susceptibility/resistance level rated on a scale of 1-5 whre 1 = no symptom expression and 5 = high symptom expression. Clones in class 1 had high resistance to green mite with scores of less than 2. In class 2 were the moderately resistant clones with scores between 2 and 4. The susceptible clones wer grouped in class 3 with scores greater than 4. The susceptible clones showed high damage with few or high number of green mites whilst the resistant ones indicated low damage even with high number of mites.

- Seedling nursery (15,500 seedlings), clonal evaluation (500 clones), preliminary yield trial (100 clones), advanced yield trial (20 clones) and multilocational trials at 3 locations with a total of 21 clones. The evaluation of 158 clones introduced from CIAT was conducted in collaboration with the Kigali-North project in Musasa commune 9150 m asl). The objective was to select varieties adapted to high altitude and acid soil. Sprouting was very poor due to the climatic conditions (temperatures below 20°C) and poor soils. A few clones ahd good vegetative growth whilst most had bery poor growth and consequently, poor tuberization and yield (400 to 500gm storage roots per plant). From selection, 37 clones were retained. All selected clones had a common female parental line (M.Col 1413/60). Clones selected were replanted at 1750 m asl in the same region for revaluation.

- 5 clones (4 improved and a local check) had been established in 44 on-farm trials.

- An adoption study in 3 communes (Gashora, Ngenda, Kanzenze) of Bugesera region had been initiated for the 3 varieties (Creolinha, Karama 1 and Eala 07) which were being multiplied for distribution. A hundred farmers were chosen for the impact study. Preliminary analysis of data collected and information gathered through discussion showed that all three varieties have been adopted to varying degrees. Yields were higher than those of the local cultivars. It was however noted that Creolinha was least grown by farmers, possibly due to its bitter taste which farmers attribute to presence of a "poison" ie. cyanogenic compounds.

- Sixty clones found to be resistant/tolerant in previous studies had been established in Bugesera to confirm their resistance to the cassava green mite.

- Prospection and release of *E. lopezi* in newly mealybug infested zone had been initiated in addition to a country wide survey to determine the efficiency in control of the predator on the mealybug. The latter activity was carried out in seven of the eleven prefectures of Rwanda. These include Gisenyi, Kibuye, Cyangugu, Kigali, Kigali ville, Gitarama and Butare. Gitarama was most infested by CM. Generally, high infestations were observed along the periphery of the original CM infested areas. These were later reduced by *E. lopezi* as and when they move into the infested areas. Presently, Gitarama, Kigali and Butare show significant reduction in CM population to 1 CM per tip.

- Mass production and release of phytoseiids had been initiated for the high infestation zones in Rwanda. About 200,000 *E. lopezi* were produced in 1993 and released. Trials had been established to estimate yield losses due to green mite.

- The 6 most highly disease/pest resistance varieties with high yields and good agronomic and quality characteristics were being tissue cultured at Rubona while 10 others were being positively evaluated in the screenhouse to determine their levels of resistance to ACMV and bacterial blight.

- Agronomic trials had been established to study effects of planting and harvesting dates (5) on yields of 3 clones (Eala 07, Creolinha and Karama 1), planting methods and density with Eala 07, Creolinha and Kilyumukwe and methods of conservation of planting material.

- The established crossing block in Karama had been improved with the introduction of more clones to increase probability of obtaining genotypes with higher levels of resistance

- Multiplication of Creolinha, Eala 07 and Karama 1 had been established on 6 ha plot at Karama with additional plots in farmers' fields in collaboration with extension personnel of the Ministry of Agriculture.

- An in-country training program for extension personnel and farmers had been planned whilst arrangements had been initiated to have 2 technicians participate in the Regional Root and Tuber Crops Technology Development and Transfer course in Malawi.

- A survey was conducted in six communes in Gitarama (Mugina, Musambira, Runda, Nyamabuye, Ntongwe and Tambwe) to determine how farmers appreciated the biological control activities conducted in their fields since 1987. Sixty farmers were randomly chosen and interviewed. It was noted from discussions that the farmers knew about the biological control activities and reported the presence of mealybug in 1988 as the most important pest of cassava in the region. Leaves, tubers, roots and planting material were destroyed by the pest specifically during dry season period. Only 42 farmers had been informed about the release of the predator and 99% reported that biological control was efficient. They knew the importance of selecting healthy planting material, early planting and uprooting plants infested within the field, as possible methods of mealybug control. Though they realized that the *E. lopezi* had significantly reduced mealybug damage, the farmers were of the opinion that the quantity released was not enough to completely control the pest. Request for further releases were made in addition to supply of resistant varieties and use of farm manure to improve the soil fertility. At all the survey sites, infestation was rated at 2 using a scale of 1 - 5, where 1 = no infestation and 5 = heavy infestation. The population density was low (under one mealybug per apex) except at Nyaruteja where infestation percentage was around 30% (Table 15). The low CM density and damage were attributed to control by *E. lopezi*. The parasitism rate was generally low in the first 4 months after release. This increased with reduction in CM population until an equilibrium was established. CM population was maintained at low levels and parasitism rate varied as a function of mealybug population. Hyperparasitism did not change as a function of the parasitism observed or infestation percentage. The variation depended on the presence of *E. lopezi* and the hyperparasitoid species (*Chartocerus* spp.) which was the main hyperparasitoid found.

3.4.1. IITA/NARS and the Seed of Hope (SOH) initiative for Rwanda

With the outbreak of war in Rwanda, the CGIAR Centers operating within the East Africa Region in collaboration with NARS developed an initiative to provide planting materila of the major crops to Rwanda. The initiative is designed to implement a regional network of seed suppliers with the technical back-up to mitigate the impact of the disaster. Key objectives include restoration of farm productivity and domestic food production, decrease in food aid costs, restoration/maintainance of germplsm diversity, protection of investment in prior research and food sector development and shortening of time from relief to restoration of development.

EARRNET's participation in the SOH initiative focuses on three major areas: multiplication/distribution, training and human resource rehabilitation. The training component will be undertaken to improve the process of multiplication/distribution and enhance the exploitation and adoption of varieties for improved crop production. Two main groups are targeted: (1) extension personnel of the Ministry of Agriculture and NGOs and (2) farmers. The extension personnel would be trained to participate and provide supervision to farmers who will be involved in the multiplication scheme. Each country will organize both courses in order to speed up the initial phase of the multiplication scheme. Once the multiplication shceme moves into its second phase, farmer groups would be constituted in Rwnada and trained on the rapid multiplication techniques to further the activity in-country.

The goal of the two stage multiplication scheme is to produce adequate quantities of basic seed material in neighbouring countries as foundation stock. These would then be transported into Rwanda for further multiplication and distribution. As much as possible the rapid multiplication technique will be used. The first stage of the multiplication activity will be carried out in collaboration with national cassava programs in Uganda, Tanzania and Burundi whilst the second phase will be implemented inside Rwanda (conditions permitting). Multiplication in Uganda and Tanzania have already started whilst that in Burundi will start in March 1995. From initial survey conducted along the borders of these participating countries with Rwanda, the following varieties are to be multiplied in Burundi, Tanzania and Uganda;

Uganda:

Rutamizi	same as Eala 07
Machunda	planted both sides of border
Nase1(TMS 30337)	Ugandan release, adapted to border zone
Mygyera(TMS 30572)	Ugandan release, adapted to border zone

Burundi:

Gitamisi	same as Eala 07, released in Rwanda
Creolina	released in Rwanda
Maguruyinkware	originally from Rwanda

Tanzania:

Local bitter varieties:	
Rubona	of Rwanda origin
Rushigiwinkuba	of Rwanda origin
Kumalampunu	of Rwanda origin
Local sweet varieties:	
Mlekimani	of Rwanda origin
Imidebe	of Rwanda origin
Bukalasa	of Rwanda origin
Kahinji	of Rwanda origin
Nusurupia	of Rwanda origin

Considering that stocks from the initial multiplication sites will have to be moved across borders, it is assumed that quarantine regulations would be adjusted to permit movements of vegetative planting material into Rwanda. It is worthy to note that Burundi and Rwanda had developed an arrangement whereby planting materials were permitted to move freely between the two countries as obviated from the materials to be multiplied in Burundi.

Total area for multiplication will vary within each country, however, 20ha is the target for each country. Presently in Uganda, a total of 25ha has been identified in the Ntungamo district. This land was provided by the Agricultural and Local Council offices of the district as their contribution to the initiative and with the hope that once the multiplication program gets underway, it could help in diversifying the district's dependence on highland bananas. Planting of the first 10ha is completed in Uganda and Tanzania, respectively.

From each in-country multiplication plots, crops will be ratooned after six months. About 4 million cuttings are expected to be generated after this initial phase. Part of these will be transported to Rwanda to establish other multiplication and demonstration plots (conditions permitting) and the rest distributed to Rwandese farmers who would have returned. Percentage of these materials distributed or used for further distribution would depend on the physical infrastructure and human resources available in 1995. It is our hope that by then rehabilitation would have commenced to permit an efficient in-country implementation and control of the multiplication and distribution activity in Rwanda. Ratooned plots would be maintained and possibly increased in size.

Due to cassava's low multiplication ratio and bulkiness, large areas are required to produce any meaningful quantity of stock material which in turn makes it expensive to transport. It is hoped that the world bank emergency grant for seeds and tools will provide further assistance in distribution through the participation of NGOs (Care international, World Vision). IITA/EARRNET provided an initial seed money in June 1994 to start the multiplication scheme in Uganda and Tanzania.

3.5. Uganda

3.5.1. Ecologically sustainable plant protection

Cassava mealybug

Surveys were undertaken in Masindi, Lira, Apac, Tororo, Mbale, Iganga and Jinja districts by staff of National Biological Control Program (NBCP) with the assistance of the District Plant Protection Officers. The main purpose was twofold:

- to assess level of CM in areas of release of CM natural enemies
- to determine the spread of *E. lopezi* from areas of release

Monitoring of CM level and *E lopezi* in release area involved the selection of 50 plants and randomly detopping 10 of the selected plants. The tips were kept in bags to assist in determining *E. lopezi* level. CM numbers were estimated based on development instars.

Results show that although CM has continued to spread, damage has not been severe. The main reason behind this in addition to the cool wet climate is that CM seems to be spreading together with *E. lopezi* as observed in Soroti and Kumi situated 100 km away from Tororo where the *E. lopezi* was released. At Namulonge, CM was discovered during routine field inspection. When some infested tips were bagged, hundreds of *E. lopezi* emerged from the samples even though no releases had been made. In most areas, level of CM was below 5 CM/tip showing a general reduction of the pest. *Hyperaspis notata* was recovered for the first time in release fields in Aboke, Apac District.

The infestation level by CM has greatly dropped especially in Tororo, Mbale, Jinja and Iganga in Eastern Uganda. Panic among farmers has subsided though there were fears in these areas especially Tororo that resurgence of CM may occur due to outbreaks of *Zonocerus variegatus* in West Nile, Tororo and Western Uganda. Farmers sprayed chemicals to control the pest on cassava which to an extent, jeopardized the biological control of CM. However, there have been no reports of heavy resurgence of CM. The initiation of local *E. lopezi* rearing at NAARI will boost the parasitoid populations during the dry season.

Cassava green mite

Releases of *Neoseiulus idaeus, Typhlodromalus limonicus* and *Typhlodromalus aripo* phytoseiidae) and subsequent recoveries in Uganda: The cassava green mite has remained a serious problem in cassava production in Uganda. Collaborative effort to control the pest using classical biological control in Uganda was initiated in 1987 with exotic phytoseiids of Colombian origin received from IITA-PHMD and released in several locations in Uganda. Similar releases made in other countries in Africa confirmed that the phytoseiids never became established in a wide range of agronomic and ecological conditions. Through foreign exploration in the Neotropics, *Neoseiulus idaeus* and *Typhlodromalus limonicus* imported from Brazil have been released experimentally in several countries and establishment is now reported in some countries in Africa.

Three species of exotic phytoseiids, *N. idaeus, T. limonicus* and *T. aripo* were imported and experimentally released in young cassava fields between February 1993 and June 1994 at different locations in Uganda. Mass releases were made at least one day after shipment in pre-selected fields with high CGM abundance during both dry and rainy seasons to ensure establishment.

The survival of phytoseiids at release sites was followed up in a post release monitoring schedule where CGM and phytoseiid abundance on cassava plants were determined. Phytoseiid population was estimated from 25 young and 25 old cassava leaves of 25 plants. The leaves were picked and put in separate paper bags and taken to the laboratory. The phytoseiids on the leaves were then counted under a binocular microscope, picked and put in 70% alcohol and sent to IITA-Benin for identification. *T. aripo* was monitored by breaking cassava tips of 3 release plants and counting the number of phytoseiids within the buds under the dissecting microscope and conserved in 70% alcohol for identification. Recovery surveys were less frequent in other areas compared to Namulonge due to logistic constraints.

The CGM population was generally high (over 70 actives/leaf) in all the months and this was adequate to sustain exotic phytoseiids. The CGM populations were higher in January, February and June and these supported generally the high phytoseiid population during the dry periods. The phytoseiids were generally more abundant on the lower mature cassava leaves than on the young upper ones. *T. limonicus* was recovered only at

Nangabo in March, one month after release. *T. aripo* was recovered consecutively for 2 months after release at Namulonge, while *N. idaeus* was recovered only at Namulonge in March, a month after release.

A biological control agent can be considered as permanently established if it can be recovered in 3 successive years after the release. The poor recovery of the exotic phytoseiids from the release sites in Uganda indicate that the species have not survived or have migrated from cassava. *N. idaeus* and *T. limonicus* have however been reported to be established in Benin with mean recovery periods of 6 and 4 months and a maximum recovery period of 18 and 11 months respectively. The poor recovery of *N. Idaeus* and *T. limonicus* in Uganda could therefore be attributed to extreme climatic conditions and inadequate alternative food sources. Releases in Uganda however need to continue in different agro-ecological zones. A prediction of non establishment of the exotic phytoseiids is yet premature.

Survey of distribution of indigenous phytoseiids and their alternative host plants in Uganda: Cassava is grown in most parts of Uganda in areas with average annual precipitation of over 750 mm. The north and eastern districts which have relatively lower annual rainfall and more dry periods have more acreage. The cassava green mite is widely distributed in the cassava regions and severe damage occurs in the drier areas. A diversity of indigenous phytoseiids are present in Uganda and they are assumed to play a role in controlling CGM populations in the field in certain locations.

Surveys of indigenous phytoseiids were carried out in three ecological zones, the dry savanna, moist savanna and moist forest zones in the districts of Luwero, Iganga, Apac and Mpigi districts between June 1993 and June 1994. The survey involved visiting cassava fields and estimating the abundance of CGM on cassava plants. The common weeds present in the fields were also examined and the indigenous phytoseiids and tetranychids found on them were collected and sent to IITA-Benin for identification.

The phytoseiid species found in the 4 districts are shown in Table 16. A diversity of indigenous phytoseiids was found at sites in Mpigi compared to Luwero, Apac and Iganga districts. A local species of phytoseiid, *Eusieus fustis* was found at all sites in the 4 districts. The host plants on which the local phytoseiids were found are shown in Table 17. *E. fustis* was found on all the common weeds that were sampled. Cassava green mite average densities per leaf ranged between 50 and 70 in the rainy season in Mpigi to 100 and 133 in the dry season in Luwero district.

Since the survey was carried out during the dry and rainy periods under diverse cropping practices, the various species of local phytoseiids observed in many sites in Mpigi district may possibly be attributed to differences in climatic conditions. The area is within the "Lake Crescent" where rainfall and humidity is relatively high and dry periods are less. The occurrence of *E. fustis* in all the locations also suggest that this is probably the dominant species and can tolerate extremes of climatic conditions. *E. fustis* is also known to be a generalist feeder and so is able to survive over a wide range of food sources some of which may not be present in certain locations. Some of the local phytoseiids found on cassava were also found on weeds. This suggests that some phytoseiid species can move from cassava to other vegetation in the field and vice versa and they feed on CGM as well. They may therefore be important natural enemies of CGM which need to be confirmed.

Culture maintenance of exotic phytoseiids: Small colonies of two promising phytoseiid species in Africa, *N. idaeus* and *T. limonicus* were set up in the laboratory in November 1993 using the two methods developed at IITA for different species, to initiate mass production of exotic phytoseiids for mass releases in Uganda.

The phytoseiids were fed daily by collecting cassava leaves containing CGM from the field and brushing the CGM eggs and actives on the cultures of *N. idaeus* while *T. limonicus* were fed on CGM on leaves kept alive with stalks sealed in 1 cm diameter vials containing water.

There was inadequate supply of CGM (prey) during the rainy period, so the population of phytoseiids in the cultures declined drastically. The brushing method could not ensure the cultures free of local contaminants. As a result, most of the cultures of *N. idaeus* became contaminated with *E. fustis*. Cultures of *T. limonicus* were also overrun by local contaminants. New colonies of *N. idaeus* and *T. aripo* were shipped to Uganda on 26 June 1994. *N. idaeus* were taken for maintenance cultures in the laboratory while *T. aripo* was released directly in the field to create a nursery for future releases. It is possible that *T. aripo* will be mass produced and released easily since they have survived in the field for at least two months. In order to generate adequate prey for CGM, tunnel production systems need to be established. However maintenance and small scale experimental releases of *N. idaeus* will still be carried out frequently.

3.5.2. Nematology

Following a survey for nematodes of root and tuber crops in Uganda, the root-knot nematode, *Meloidogyne incognita* was discovered to be causing serious damage and high yield losses to cassava in Masindi district. Experiments have shown that cassava yield poorly under heavy *M. incognita* attack and thus could pose a considerable threat to cassava production in Uganda. A preliminary investigation into the incidence of root-knot nematodes on cassava was thus conducted in two areas of Uganda.

The incidence of root-knot nematodes on cassava was investigated by observing the extent of *Meloidogyne* induced galling on the roots. A total of 88 sites were visited in 2 general areas; Masindi (36) and in Eastern Uganda (52). Galling was assessed and recorded according to a gall index scale of 1-5.

1 - no galls (1%)
2 - trace (1-25%)
3 - slight (26-50%)
4 - moderate (51-75%)
5 - severe (76 - 100%)

Preferentially, 10 plants per field were examined, although this was not always possible. Galled tissue was examined under a stereomicroscope to ascertain *Meloidogyne* as the cause of galling. Examination of the galled material confirmed *Meloidogyne* as the cause of galling. The extent of galling observed in this study was found to be high, with no galling recorded at only 5.7 per cent of the sites. A large percentage of sites had only trace galling, however, 15.9 per cent of sites were observed to have moderate to severe galling indicating that *Meloidogyne* is a prevalent pest of cassava in Uganda.

It has been shown that much variation in tolerance or susceptibility to *Meloidogyne* occur between cultivars of cassava. Differences in pathogenicity between species or races of *Meloidogyne* can also affect varietal reaction. It is possible that many of the cultivars that were examined in this study are particularly susceptible to *Meloidogyne*. All cultivars examined were the common and most widely grown cultivars. If they are particularly susceptible, then this could have a substantial impact on the yield. Many farmers when interviewed during the study commented on their cassava yielding low although this may not be directly attributed to root-knot. The increasing land pressure that was reported, especially in the East, acts only to increase populations of *Meloidogyne* as there is less rotation and more continual cropping.

In conclusion, it can be seen that *Meloidogyne* root-knot nematodes are a prevalent pest of cassava in Uganda in at least two areas. It would therefore be useful to establish the extent of this prevalence throughout Uganda and identify cultivars with greater tolerance levels to root-knot nematodes since this has the greatest potential for controlling the problem.

Varietal reaction to root-knot nematodes: Cassava is susceptible to a number of species of *Meloidogyne*, however, *M. incognita* is referred to as possibly the most important. Nematodes disrupt the normal translocation of water and nutrients in the roots, where they form galls, breaking and deforming the vascular elements. The main effect is to reduce the production of storage roots or tubers. There is a great variation in response of cassava cultivars to rot-knot nematodes. It has been indicated that the most promising method for control of nematodes is through the use of resistant or tolerant cultivars for most parts of the world.

A preliminary study was conducted to evaluate the root-knot incidence in 38 on-farm cassava variety trials spread over Uganda. The trials were established as part of an on-going program to identify African cassava mosaic virus resistant cultivars which would be accepted by the farmers. The opportunity was therefore taken to assess any differences in susceptibility of the cultivars to natural populations of *Meloidogyne*.

Thirty eight trial sites were visited together with the on-farm trial harvesting teams. As the whole cassava stems were uprooted at harvest, the root systems were examined for the presence of galls. All the cassava plots were between 10 and 13 months old. The number and range of cultivars varied between sites. At 16 sites, the average galling index was established from 6 plants. At the other 22 sites, 10 plants were used. The degree of galling, which is an indication of the relative damage and infestation by *Meloidogyne* was assessed according to the percentage of the galled portion of the root system on a scale of 1 - 5 as mentioned earlier. Samples of the cassava roots and soil from around the roots were also taken in order to verify *Meloidogyne* as the cause of galling. Identification of the species and other nematodes present was conducted together with the International Institute of Parasitology, UK. All galling was established to have been caused by Meloidogyne sp. In all cases the species responsible was identified as *M. incognita* although in a number of cases there was a mixture with *M. javanica* (Treub) Chitwood.

Three cultivars, TMS 60142, TMS 60140, and Ebwanateraka seemed to be less affected by root-knot nematodes while TMS 30786, Bukalasa 11 and TMS 4(2)1425 are most likely to become galled.

3.5.3. Germplasm Development

Identification and development of consumer acceptable cassava varieties which are high yielding resistant to key pests and diseases, and adapted to different agro-ecologies in the country continue to be the major objective of our breeding program.

Germplasm collection: The second cassava germplasm collection was conducted in the north and northwestern Uganda since they were previously not covered. A total of 86 different morphotypes were collected. These together with the 1984 collection (350) have been planted at Namulonge for the first systematic evaluation. The IPGRI descriptor and electrophoretic techniques will be used to characterize the cultivars. The evaluation will be conducted in two other target ecologies in subsequent years.

Seedling evaluation: A total of 50 families consisting of 55,000 seeds were evaluated at Namulonge and another batch of 30,000 at Serere Agricultural and Animal Research Institute (SAARI). These seeds were received from IITA and from local populations which combined resistance to ACMV, mealiness and stay-green characteristics. 448 and 221 seedlings were selected and planted at Namulonge and Serere respectively (Table 18).

A total of 31 entries consistsing of 76 plantlets were also received from IITA in form of tissue culture. Eleven entries are for the cassava regional trial while 20 are breeders material. Due to long overstay in darkness (in transit), the post-flask establishment has been poor. Arrangements have been made to replace the ones which did not survive.

Open pollination seeds from selected good looking parents were distributed to IITA, Kenya, Rwanda and Burundi (Table 19). More seeds are being generated from a crossing block with 8 elite locals and four exotic clones.

Clonal Evaluation: A total of 779 clones were evaluated at Namulonge (437) and at Serere (372) respectively. A set of 256 were advanced and planted at Namulonge as follows PYT(A) 97, PYT (B) 119 and PYT(C) 40. At Serere, 72 clones have been advanced to PYT. Selections from Namulonge have also been planted in two other locations Migyeera and Kihonda (Masindi district).

Preliminary yield trials: A set of 91 clones advanced from clonal evaluation were tested in three row plots with two replications in Namulonge, 72 at Serere, 80 at Migyeera and 80 at Masindi. Data are being analyzed. Twenty six clones from Namulonge, 35 from Serere, 17 from Migyeera and 16 from Masindi have been planted in AYT, to confirm observations made in 1993 clonal evaluation.

Advanced yield trials: A total of 40, 35, 20, and 19 clones were evaluated in advanced yield trials at Namulonge, Serere, Migyeera and Masindi respectively and data are being analyzed.

Studies on cyanogenic potential indicate that all genotypes grown at Migyeera had above the recommended safe levels of 100 mg CN equivalent/kg fresh weight. Clones grown at Namulonge had below recommended cyanogenic potential levels. Huge differences were apparent among clones and locations. Genotypic ranking was constant over locations. The high cyanogenic potential levels at Migyeera corresponded with low dry matter, and this could be attributed to the very dry conditions during harvesting. Studies are underway to understand the relationships between this high cyanogenic potential and the soil nutrient status.

Uniform yield trials: Genotype by environment interaction study for yield and its components in cassava was done using 1993 uniform yield trial results to understand the nature, magnitude, consequences of G x E and select clones for on-farm trials. Data were recorded on root weight (tons/ha), percent dry matter, root number, and cyanogenic potential. Results were partitioned into main effects due to clones, locations and clone x locations interaction. Joint regression was used to obtain stability parameters.

Results indicate that clones, and clone x location interaction were significant for all characters except root number for which only location and interaction were significant ($P \leq 0.05$). The magnitude of CV ranged from 7.63 for dry matter to 33.0 for root weight (Table 20). Broad sense heritability was low to moderate (1.0% in root numbers to 26.6% in dry matter). Environment accounted for over 40% of TSS, while those for clones and interactions were low and comparable. Cyanogenic potential showed high sensitivity to environment.

Regression analysis of each genotype for root weight upon environmental index was applied to estimate stability parameters (Table 21). Ranks were assigned to coefficient b values, such that genotypes with b value of plus and absolute value of 0.1 received a rank of 1. and every subsequent increment of absolute value of 0.1 received an increment rank, and ranks were summed.

Genotypes with low rank sum satisfied criteria of high yield and stability using 20-30% selection intensity. Clones 89/91934-94, 89/KKWE-82 and 89/CB-71673-3 satisfied the criteria of high yield and stable performance.

Since in most urban areas of Uganda, cassava is freshly boiled and eaten, or even snacked on raw, it is important that genotypes which are released should have high yield and low cyanogenic potential across locations. Clones were stratified based on their cyanogenic potential, root yield and coefficient of variations across locations. Clones 89/91934-94, 89/KKWE-82, and 89/KKWE-74 had low cyanogenic potential and low CV. Clones 89/KKWE-82 and the check had high root yield and low CV. Clone 89/KKWE-82 satisfies both conditions of high root yield and low cyanogenic potential and found resistant to major pests and diseases.

The breeding program continues to make steady genetic progress as summarized in Table 22. Nase 1, Nase 2 and Migyeera are continuously being multiplied. Information on SS4 and TMS 4(2)1425 have now been compiled for presentation to the National Variety Release Committee for official release. 89/91934-92, 89/30786-11 and 89/1988-2-UYT-PDB have been identified for 1995 on-farm trials.

3.5.4. Technology transfer

Since its introduction in Uganda in the 19th century, cassava witnessed a relatively rapid spread and adoption by farmers mainly due to the flexibility of the crop in the farming systems and ability to do well under declining soil fertility. Despite the rapid spread and adaptation of this crop, cassava production faces numerous constraints which have constantly caused food shortages, lack of planting material, change of food culture and eating habits, reduced family income and food security at household level in affected areas.

To alleviate these, the National Root Crops Program and the Farming Systems Support Program have collaboratively implemented a technology transfer program with the aim of improving the level of cassava production in Uganda and hence the welfare of the farming community. This report highlights the activities implemented in the following districts: Kasese, Mubended, Kibaale, Hoima, Masindi, Luwero, Mpigi, Masaka, Mukono, Iganga and Arua.

The specific objectives were to:

- carry out effective and self sustaining training programs for staff at district level, farmers and or opinion leaders.
- evaluate the performance of cassava under mosaic virus, mealybug and cassava spider mite infected zones
- rapidly multiply farmers' selected genotypes.

Training of extension personnel in charge of sub-counties in mandated districts

The traditional approach to training people has been to deliver formal lectures which convey information but do not build skills. However, the approach adopted in this program is participant-centered directed towards improving on the job performance which in turn increases the relevance and ability to achieve the project goals.

Trainees (Table 23) were trained at the District Farm Institute (DFI), Mukono. Trainees then organized subsequent training sessions for other extension personnel, thereby making use of their own human resources to improve the skills of their subordinates.

The three major components of the training were:

- action-oriented, designed to help participants learn through practical sessions,
- skill-focused, designed to develop or enhance needed skills through continuous data collection and time to time exposure/interaction with researchers,
- targeted toward change, designed to help participant change their own performance, and eventually the performance of others i.e farmers and/or policy makers. The overall objectives of the training were therefore:
    - To train the extension personnel in-charge of sub-county staff in basic aspects of cassava production, disease and pest identification
    - To train in methods of on-farm research with emphasis on the farmer as the key and sensitive participant;
    - To train in methods of rapid multiplication
    - To outline their responsibility and discuss possible strategies for implementation

Topics discussed at length included the following:

- The importance or role of cassava in our food systems
- Agronomic practices of cassava production
- Economic importance of cassava

- Identification and possible control of priority diseases and pests of cassava (African cassava mosaic virus (ACMV), cassava mealybug (CM), and cassava green mites (CGM).
- On-farm methodologies
- Rapid multiplication, storage, and transplanting of clean planting materials.

The success of the program was seen to lie heavily on total commitments, having an efficient transport system, effective feed back machinery and regular refresher courses for long term sustenance.

On-farm evaluation of cassava genotypes

On-farm validation of technologies is becoming increasingly important as an effective means of technology transfer. Several cases of genotype x location x year, and genotype x location x cropping system interactions have been reported. It is for these two broad reasons that the improved cassava genotypes are being tested out on-farm to assess their stability of performance and acceptability by the farmer in the coffee farming areas of Uganda. The broad objective is to validate the nine improved cassava varieties against one local check variety at on-farm in eleven selected coffee growing districts of Uganda. Specific objectives include:

- evaluating the performance of the cassava genotypes in differential ACMV infected zones (i.e low, medium, and high inoculum areas);
- to study the suitability of these genotypes under various cropping systems; and
- to capture farmers' salient criteria which constitute qualities of an acceptable cassava variety.

A three-level management was adopted (i.e researcher, extension staff and farmer). The researchers participated in planning, provision of planting materials and, from time to time, extending technical advice. On the other hand, routine supervision and data recording was the responsibility of the extension staff while the remaining aspects of management were farmers responsibility.

Data were recorded on genotype sprouting ability, ACMV incidence (%), ACMV severity (1-5 scale), ACMV systemicity, whiteflies on four top most leaves, cassava bacterial blight (CBB), and/or cassava green spider mite (CGM) at one and two months after planting (MAP). Data recorded during yield evaluation included root yield, root number per plant, root raw taste, root cooked taste, mealiness, farmers ACMV assessment and suitability in the cropping system.

Genotypic yields in Iganga district were relatively high (Table 24) ranging from 24.9 tons/ha in B11 to 52.2 tons/ha in TMS 30337. Mean number of roots per plant were also high. TMS 30337 outyielded the local check by 42%. All the TMS series yielded more than 40 tons/ha. Farmers ranked raw and cooked taste of all genotypes as sweet. Similarly, all genotypes were mealy, suggesting that these factors are probably influenced by environment, particularly soil. The age/stage at harvest also could play a role.

Farmers ACMV assessment indicated that all the TMS series were resistant to ACMV in all the sub-counties. The local check was ranked as very susceptible throughout the district. Farmers felt that all genotypes were suitable either as sole crop, for intercropping or weed smoothering. TMS 30337 and TMS 30786 were ranked first for weed smoothering (sole crop) while Bao, B11, Teraka and local were ranked first for intercropping.

Genotype mean root yield (tons/ha) in Hoima district (Table 25) were generally high. The lowest yielder was B11 with district mean of 19.3 tons/ha, while TMS 30786 ranked highest with a mean yield of 35.8 tons/ha, the local check yielded 25.0 tons/ha, and this was 30% lower than TMS 30786. The number of roots were fairly high but below 10 roots/plant. Bitterness was reported in raw as well as cooked cassava in TMS 30786, TMS 30337 in Buhimba and Kigorobya sub-counties respectively. The rest of the other genotypes were both sweet as well as mealy.

The farmers in Hoima district rated all the TMS series as resistant to ACMV, while Teraka and local check were ranked susceptible to the disease. Farmers rated all genotypes suitable in their farming systems. TMS 30337, TMS 30786, TMS 4(2)1425 and TMS 30001 were rated suitable as sole crop and suitable for weed smoothering. This was because of low branching and spreading habits, which form dense canopy under which no weeds could survive. TMS 60142, TMS 60140, B11, Bao, Teraka and local check were scored better for intercropping because they form higher branches and have light canopy which permits light for other crops to survive.

Generally root yield for the Kibaale district were moderate with a mean of 36.8 tons/ha. Yields (Table 26) ranged from 23.0 tons/ha in TMS 60142 to 47.4 tons/ha in Bao. The TMS series yielded lower (< 40 tons/ha) than the local check which yielded 42.6 tons/ha. The relatively better yield performance in the local check is probably due to better adaptation in its local environment. All genotypes grown in the district were scored either 1 or 2 for

raw and cooked taste indicating that they were sweet. Similar ratings were given to mealiness. This suggest that all genotypes were mealy to taste.

Farmers ACMV assessment in Bwamiramira, Mugarama, Bwanswa, Mabaale and Kankindo sub-counties indicated that all genotypes did not show signs of ACMV infection. However, in Kagadi sub-county, the local check and Teraka were rated as having shown some symptoms. Genotypes were all rated suitable in the cropping systems of the district. However, TMS 30337, TMS 30786 and TMS 4(2)1425 were scored as suitable as sole crop and for smoothering weeds. TMS 60142, Bao, B11, local and Teraka were rated as suitable for intercropping.

Genotype mean yield across the different districts varied from 25.4 tons/ha in TMS 60142 and B11 respectively to 36.9 tons/ha in Teraka. TMS 30786 and TMS 30337 showed wide adaptation, resistance to ACMV and high yield potential. Masaka had the lowest mean yield of 17.1 tons/ha, followed by Masindi (22.6 tons/ha) respectively (Table 27). Best yields were obtained from Kasese (43.2 tons/ha), Iganga (39.3), and Kibaale (36.5) respectively. Other districts had low to moderate tuber yield. Low yields were probably due to ACMV infections transmitted mostly through cuttings.

The following deductions can be made from the results obtained from the on-farm testing of the technology transfer system:

- Generally, the introduced genotypes (TMS series) are more resistant and/or tolerant to ACMV than the local varieties
- Because of this high levels of ACMV resistance, their root yield remained fairly stable across locations
- Genotype by environment interaction is implied with respect to ACMV
- Whitefly transmission appear to be less important since most of the observed infection appear transmitted through cuttings.
- Most genotypes appear to have sweet raw and cooked taste though TMS 30786 tended to be consistently bitter. Other isolated cases of bitter raw/cooked taste may be associated with soil types.
- All genotypes have mealy cooked taste.
- All genotypes are suitable in the farmers cropping systems. The new introductions tend to be more suitable as sole crops and useful for weed smoothering, while the locals are more suitable for intercropping.
- There is overwhelming demand for planting material as a result of farmer participation in the adaptive trials.
- More farmers are willing to participate in the adaptive trials
- Opinion leaders, district agricultural officers, and farmers demand for multiplication of resistant genotypes in their districts.
- Informal discussions with farmers reveal qualitative statements and hope that a remedy has come
- Many new genotypes are chosen by the farmer for multiplication and distribution to their neighbors.

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3.5.5. Information exchange

A number of workshops/symposia have been hosted by the Uganda cassava program. These include an international ACMV workshop in which 20 participants from different African programs and IITA participated. A CTA/NARO/NRI symposium on 'Integrating management of pests, diseases and weeds of cassava in Africa'

attracted over 100 scientists worldwide. All these meetings/workshops have encouraged interactions among root crops researchers within the region.

4. FUTURE PERSPECTIVES

4.1. IITA

Although IITA has had limited involvement in agricultural research in East Africa compared to West and Central Africa, it is gradually expanding its mandate to all humid and sub-humid regions of sub-Saharan Africa. The establishment of the East and Southern Africa Regional Centre for the Improvement of Cassava, Banana and Plantains (ESARC) will address specific needs of the mid-altitude ecologies of East and Southern Africa. The following are some technologies developed by IITA that are mature or have potential for dissemination by NARS in the region.

4.1.1. Germplasm development

Significant progress has been made at IITA in the development of improved cassava clones that combine a good levels of resistance to diseases with high yields and good quality characteristics. Some of these materials have undergone on-farm trials in East Africa and some have been released. In recognizing the scope available for increasing production through genetic improvement, IITA/ESARC/EARRNET will assist NARS to develop improved genotypes with high yield potential and good food quality characteristics for the diverse ecologies of the region.

The cassava workshop held 4-22 July 1994 which breeders from the region attended was highly relevant to the future efficiency and integration of the cassava breeding process in that strategies and approaches to streamline future genetic improvement activities within the region was institutionalized. Backstopping in terms of regular visits to the individual program will be facilitated. EARRNET will provide an enabling environment to NARS to make effective use of IITA's broad based genetic stocks with multiple pest and disease resistance, important quality traits and appropriate adaptation. The germplasm would be utilized as part of regional breeding and selection activities to suit local conditions in the various national programs and agroecologies.

Comprehensive germplasm collection, evaluation and characterization would be encouraged with assistance provided by the Genetic Resources Unit and Tissue Culture Laboratory in field maintenance and in-vitro conservation. Collections would be maintained in-vitro by ESARC for future utilization in enhancing improvement at IITA, ESARC and national programs once the capacity and capability has been developed within the region for virus indexing to enable their distribution.

Multinational, multi-site trials are planned as an integral activity of the networks considering the limited adaptation of varieties. Results will enable rationalization of testing sites at national and regional levels. The 10 clones to be utilized in the study have already been distributed to different national programs for initial establishment and multiplication. Findings would be incorporated into the GIS database to ensure that optimal benefit is derived from the G x E Studies.

4.1.2. Rapid multiplication and distribution of healthy planting materials of recommended cassava varieties

The multiplication and distribution of healthy planting materials of recommended varieties is fundamental to the achievement of impact from cassava improvement efforts. In the absence of a suitable system for doing this, very productive varieties remain largely at research stations.

The techniques of rapid multiplication using two-node cuttings from every portion of the cassava stem has been developed and used by CIAT, IITA and some NARS for some years. The efficacy of a concerted effort at using these methods in conjunction with a system for distribution has been proven in projects in Cameroon, Rwanda, Malawi and Uganda with the involvement of IITA. Continuous execution of projects on rapid multiplication and distribution of planting materials will result in increased availability of improved/recommended varieties to farmers, a cost effective system of distribution of healthy planting materials, increased productivity of cassava farmers and increase in cassava production.

4.1.3. Virus elimination and indexing for international exchange of cassava

The national root crop programs in East Africa could benefit immensely from a system of in vitro micropropagation, virus elimination and indexing of cassava propagules. Currently, it is not possible for varieties or advanced genotypes developed in one country to benefit other countries in the region. This impedes the spill-over effects of cassava improvement activities in the region.

Kenya and Uganda have good tissue culture facilities that could be supported through the provision of laboratory supplies to engage in in vitro micropropagation. The technology for virus diagnosis developed at IITA, CIAT,

SCRI (Scottish Crops Research Institute) and other institutions could be used to index the resulting plantlets. Such materials could then be available for international exchange in collaboration with the plant quarantine authorities.

4.1.4. Post Harvest Processing Equipment

Timely harvests and efficient postharvest operations play a crucial role in the lives of farmers. Appropriate equipment to carry out these operations reduces crop waste and enables more complete utilization of the food crops grown. This is especially true for farmers who are stepping beyond the subsistence stage to farming that can generate income. IITA has devoted attention to designing and fabricating improved equipment. Efforts have been focused on cassava graters, dewatering devices, sifters, stoves, chipping machines, grain threshers, winnowers and grinders. While the primary goals have been to minimize crop losses and improve labor productivity and product quality (which, in turn enhance the welfare of rural women and children), activities that have evolved recently include on-farm testing and demonstration of the equipment, training of manufacturers, and networking to promote the use of improved equipment.

These objectives and activities stem from the fact that in improving the quality of farm products, they also help raise incomes and standards of living for farm families who use the improved equipment.

In 1990, IITA conducted a survey in Moniya village near Ibadan, Nigeria and revealed significant gains from using improved equipment for processing cassava: a doubling of incomes, resulting from a 72% reduction in processing time and a 55% reduction in handling losses. IITA has extended on-farm testing and evaluation to 13 sites in 5 African countries: Nigeria (8), Benin Republic (2), Ghana (1), Malawi (1) and Togo (1). These sites also serve to demonstrate the equipment being tested and to train people in its use. As a result, demand for the equipment is growing, from individual farmers, as well as from private entrepreneurs (fabricators of equipment and food processing industries).

Conclusion drawn from the COSCA study is that improvement in cassava processing technology is urgently needed in East and Southern Africa. A processing technology that reduces processing labor requirement and improves product quality and thereby expands market demand for cassava products will motivate farmers to adopt available improved production technologies including improved varieties to expand cassava production. As farm production rises and more farmers go commercial (on however small scale), demand for such simple but efficient farm equipment is likely to grow among the East African nations. Private enterpreneurship will likely develop to meet this need. Given their expertise, IITA scientists will continue to provide technical support and training to manufacturers, so that their capability to serve the needs of the local market in East Africa can be assured.

4.1.5. Processing and product development

Postharvest handling of cassava is the single largest constraint to increasing cassava production in Africa. This situation has prompted NARS leaders in the East African region to target cassava postharvest technology as a priority area for research. Research at IITA has demonstrated that cassava can be used not only for making traditional products, but also in the production of a large number of products, such as bread, cakes, biscuits, pastries, etc. which have become part of the African diet but are usually made from imported wheat. Soybean flour is used to fortify cassava flour in order to obtain foods of high nutritional quality. An on-going project is developing an appropriate technology for the production of high quality cassava flour for inclusion in bakery products. A second project to start in 1995 will promote the adoption of cassava-based technologies by women's group, farmer organizations and small and medium-scale rural and urban entrepreneurs in West Africa. A similar initiative in Central, Eastern and Southern Africa will be highly desirable. Training and backstopping are critical in accomplishing the aim of the postharvest activity due to the limited institutional capacities coupled with the lower range of available cassava-based products.

4.1.6. Biological control of cassava pests

Classical biological control has been successfully implemented in Kenya, Tanzania and Uganda through collaboration between IITA and national biological control programs in the suppression of the recently introduced pest of neotropical origin, the cassava mealybug. The IITA Biological Control Program has been very successful in training national scientists in aspects of initial survey, distribution of parasitoiids and subsequent follow-up monitoring in the affected countries. National Biological Control Programs are in place in all countries that were affected by the mealybug and have in most cases been assisted with laboratory equipment, transportation and operational expenses. IITA-BCP will continue to assist countries to establish their own rearing facilities for beneficial insects to quickly respond to cases of pest recurrence.

4.1.7. Baseline and impact assessment studies

COSCA provides information on cassava production systems, processing methods, consumption patterns and market prospects. Considering the status of regional information on cassava, collaboration between COSCA,

ESARC, EARRNET and NARS to establish a regional database on cassava based production and food systems is desirous. This will serve as a reference point for future monitoring change and assessment of impact of regional and national research and development activities.

COSCA surveys, in varying levels of detail, have been conducted in certain countries in East and Southern Africa (ESA) (Table 28). Findings for these countries and selected countries in West and Central Africa have made major contributions to identifying constraints to cassava production, defining development opportunities and setting of research priorities. Together with these benefits, the survey methods of COSCA (which combine standardized technical design and analytical procedures with near autonomy for national level implementation) have proved to be highly appropriate for funds for the same purpose. ESARC, drawing on the experience and support of IITA and in liaison with the networks, would assist national programs with survey activities and would ensure that a regional synthesis of findings is achieved. Activities will take account of the current status of COSCA studies on a country basis. As such, there will be three forms of survey activity based upon the current knowledge-based for cassava in the region (Table 29).

Through this a national and related regional database on cassava will be developed which would help to refine research plans in response to survey fundings, particularly the capability to respond to local circumstances and address the diversity of the ESA Region.

4.1.8. Training

The following IITA-based and regional courses of relevance to cassava are planned for 1995 (Table 30). Other in-country courses will be determined during the next SC meeting.

4.2. Coordination office

The effectiveness and efficiency in developing, adapting and disseminating improved agricultural technologies depends on the existence of a strong research base comprising personnel, infrastructure and financial resources. NARS in East African region vary considerably in structure, manpower strength, ability to secure and sustain adequate funding for research activities and to establish functional linkages with extension agencies in disseminating improved technologies. Thus for constructive regional collaboration, national systems requirements need to be distinguished at their different stages of institutional development and strategies developed which will evolve and change as NARS grow in strength. The Coordination office hopes to help deepen understanding and broaden knowledge of root crops programs in the region: their ecologies, organizational structures and linkages, resources (scientists, finances, infrastructure), research and training programs/activities, etc.; improving identification of research and training needs; establishing partnerships which are relevant to specific NARS needs and consistent with their stage of development or absorptive capacity; serving a monitoring function for the demand of technology and ensuring that development of improved technologies on cassava is "demand pulled". The Coordination office similarly intends to disseminate as much information as possible on the general root crop activities at IITA specifying achievements such as improved breeding lines, production and post-harvest technologies, training, specialized techniques that are adaptable for use within the research programs of NARS. The following activities will thus be emphasized:

4.2.1. Systematic studies of national program needs at their various stages of institutional development

The basic principle underlying the network scheme is the ability to serve all NARS of the region, no matter the size and stage of development. This calls for a thorough understanding of the NARS, through gathering of basic data on different aspects of their operations and formatting them into country profiles.

EARRNET aims at (a) creating and maintaining a data base on countries, containing information on cassava research needs and capacities of national agricultural research systems; (b) devising means for measuring and classifying key cassava research related factors which include agroecological zones, scale of research systems (e.g., human and financial resources, sizes and types of institutes, types and quantity of local research programs), internal demand for technology, external sources of information on new technologies, and linkages to those sources; (c) identifying mechanisms and strategies for setting priorities and allocating resources to cassava research; (d) evaluating national and regional research environments so as to help countries exploit opportunities for acquiring new technologies from outside; (e) identifying and assessing mechanisms that enable NARS to manage their links with policy makers, local producers, and external sources of knowledge and technology.

4.2.2. Link NARS to the most appropriate source of technology and assistance at IITA, or elsewhere with major focus on adaptive research requirements and underlying objective of strengthening national capabilities.

Access to relevant scientific information towards development of objectives appropriate to the conditions in participating countries is crucial. Most countries cannot finance their respective national research on a scale

needed to meet their total requirements. The scope of research on cassava in a country can be increased through effective information management used to supplement or replace some kinds of research thereby releasing scarce resources to be used for programs that must be conducted locally. National programs have limited ability to identify and receive information needed to conduct adaptive and resource management research. An analysis of structure and levels of technology generation and transfer in the region is crucial for guiding the flow of information among research systems. Programs should have in place the capacity to assess technology and information they need. Improving linkages to policy makers, farmer knowledge systems, external sources of knowledge, technology, and resources will be explored.

This is intended to promote consolidation of research efforts around national priorities that are set in a regional context, on the asumption that a common basis or structure for determining regional research policies and organization and management exist. As discussed during the ASARECA meeting in Addis Ababa, it is difficult to have regional research programs or regional research institutions/organizations without the prior formulation of a regional policy on agricultural development and research. Priority setting will have to include research activities and demand outside the country as integral elements of national priority setting process.

4.2.3. Coordinate and/or facilitate IITA's cassava activities in EARRNET member countries

The coordination office will assist IITA colleagues to concentrate their efforts on the most pressing problems on cassava in a coherent/holistic approach to avoid fragmentation, inconsistencies and confusion so that the total impact will be greater than the sum of the individual parts.

4.2.4. Strengthen NARS' cassava improvement research through collaborative testing of germplasm generated at IITA

Because of cost and personnel constraints, it is crucial that the genetic materials furnished be consistent not only with the specific needs of NARS but their absorptive capacities as well. The small and less experienced national programs would be encouraged to undertake wide multilocation testing of almost-finished varieties and technologies from which materials will be selected for extension services while the stronger and relatively more endowed national systems could use early generation materials from IITA for their own adaptive breeding work.

National programs would be encouraged and assisted to adapt and use a farming systems orientation in their crop and resource management research. The many useful attributes of the farming systems approach (built-in mechanisms for on-farm technology assessment-adaptation/refinement, validation and feed-back to on-station workers, inter-disciplinary collaboration integrating improved variety research with management practices) assure that developed technologies are practical, realistic and will be productive in the African farmers environment, thus enhancing transfer to and adoption by users.

4.2.5. Assist NARS to strengthen linkages between their agricultural research and extension services in order to promote more effective use of research information

The agricultural research-technology transfer links are generally recognized as a major bottleneck in agricultural technology transfer systems. Research and extension need to be linked whereby basic, strategic, applied and adaptive research, subject-matter specialists, village-level extension workers and farmers should be seen as participants in a single agricultural knowledge and information system.

On-farm research allows direct contact among farmers, extension agents and researchers and has been shown to have important influence on applied and adaptive research programs. Implementation of on farm trials in collaboration with extension personnel will involve testing and adaptation of improved agricultural technologies, multiplication/ distribution under farmers condition and training of extension agents and farmers. Monitoring tours which bring together scientists from selected national programs will be organized to evaluate the relative performance of varieties and management practices included in the multilocational trials. A positive relationship will be fostered between research, extension and farmers. Farmer interest and preference for new or components of improved technologies will be noted.

The coordination office, in collaboration with national programs will seek to improve, on sustainable basis, the research-extension-farmer linkages into national "networks" to effectively and efficiently transfer improved technologies to farmers and feedback to on station research either at national, regional or international levels. This could generate confidence in the development community for national programs and lead to closer collaboration in the transfer and adoption of relevant technologies. The resulting recognition by national planners and policy makers of the important contributions of agricultural research to overall national development (increased agricultural productivity, better living conditions for rural communities, food security for entire population, etc) could be very useful in assuring improved and sustained funding for agriculture and development research.

4.2.6. Identify training needs of NARS at all levels (short- and long-term attachment and degree training, visiting scientists)

To expose the different opportunities at IITA and elsewhere, consolidate and satisfy training needs, the coordination office will work closely with; (a) programs to identify and select appropriate scientists/technicians for training courses at IITA; (b) collaborate with IITA's Monitoring and Evaluation Unit in following up careers of past trainees; (c) help IITA's Training Program to constantly improve effectiveness of its courses in responding to genuine concerns of the NARS; (d) assist Training Program in decentralizing group courses to regional and national level; and (e) encourage scientific visits and research attachments with IITA programs to build up skills and expertise of national program personnel.

4.2.7. Facilitate communication between NARS and IITA (and possibly other IARCs)

This will increase IITA's understanding of NARS' requirements for technical assistance including training. Because of the many small-sized NARS in the region as well as the general scarcity of financial resources, EARRNET serves a crucial function in technology development and validation in the area. The office will work to improve the effectiveness of collaborative activities by; (a) reinforcing NARS linkages to technology (IARCs, NARS); and other research development organization; and (b) assuring that the IARCs role is catalytic while encouraging the NARS to take increasingly more responsibility for network management.

4.2.8. Country Visits

The purpose is to increase familiarity with the NARS' research and development environment, validate profiles, facilitate communication and feedback to IITA programs and services about NARS strategic needs, and establish a work program for strengthening IITA/NARS partnership.

Visits will be made to different countries to participate in annual research work program conferences to; (a) discuss workplans for each NARS (b) follow-up preparations for executions of regional projects including plans to expedite seed and other supplies; (c) coordinate and participate in monitoring visits; and (d) facilitate scientific visits and placements of candidates for research and training attachments at IITA or other relevant institutions.

4.2.9. Preparation of research proposals:

Assist NARS to prepare research proposals, identify potential sources of funding support and monitor research progress with collaborating scientists.

Table 1. Cassava production in East Africa (1991)

Country	Area (1000 ha)	Yield (t/ha)	Production (1000 t)
Burundi	52	11.2	580
Kenya	67	9.7	650
Madagascar	343	6.7	2290
Rwanda	50	11.2	560
Uganda	380	7.6	3350
Africa (Total)	8922	7.7	68931

Source: Cassava: the latest facts about an ancient crop. CIAT, Cali, Columbia

Table 2. Staff strength (qualification) of different national programs

NATIONAL PROGRAM	SCIENTISTS			TECHNICIANS
	PhD	MSc	BSc	DIP/CERT
UGANDA	3+2*+1**	3+1*+2**	1	12
RWANDA		1	2	5
BURUNDI		2	1	3
KENYA	1+1*	2+2*+4**	3	3
MADAGASCAR	1	2**		6

* Undergoing training

** Through collaboration with other local institutions

Table 3. USAID and IDRC financial (US$) assistance to national programs

NATIONAL PROGRAM	IDRC	USAID				
		*ESPP	RM&D	PH	GERM	TT&IA
BURUNDI	7,500		6,300	4,290		
KENYA	-	4,865	4,865	4,000		
MADAGASCAR	7,500			4,000	2,365	
RWANDA	12,000			6,365	3,200	
UGANDA	12,000	6,300	6,300	4,300	3,000	
TOTAL	39,000	11,165	27,830	12,590	8,565	15,000

*ESPP = Ecologically sustainable plant protection
RM&D = Rapid multiplication and distribution of planting materials
PH = Post harvest technology
GERM = Germplasm development and distribution
TT&IA = Technology transfer and impact assessment

Table 4. Collaborative regional research activities for EARRNET member countries

Collaborative regional research	Lead countries
Ecologically sustainable plant protection (ESPP) with respect to cassava green mite (CGM) and cassava mealybug (CM)	Kenya, Uganda
Development of improved post-harvest technology for cassava	Burundi, Uganda, Kenya
Germplasm development and distribution	Rwanda, Uganda
Technology transfer and impact assessment	All collaborating countries
Rapid multiplication and distribution of improved planting material	All collaborating countries

Table 5. Cassava related training courses offered within East and Southern Africa

Course title	Location	Date	Number of participants	Type of course	Sponsor
Agronomy and rapid multi-multiplication of cassava	Antananarivo Madagascar	24 May-3 June, 1994	18	In-country	EARRNET
Breeding of root and tuber crops	IITA (Ibadan)	4-22 July 1994	15(3)[1]	Intn'l	EARRNET
Impact assessment (socio-economists)	Njoro, Kenya	11-22 July 1994	15 (5)	Regional	EARRNET
Root crops research development (cassava and sweet potato)	Lilongwe Malawi	1-26 Aug. 1994	19 (2)	Regional	EARRNET SARRNET
Impact assessment (biological scientists)	Njoro Kenya	20-30 Sep. 1994	19 (3)	Regional	USAID
Post harvest technology for	IITA(Ibadan)	31 Oct-25 Nov. 1994	20 (2)	Intn'l	EARRNET

[1] Number in brackets are EARRNET supported participants to the regional/international courses.

Table 6. Backstopping visits made by IITA staff to EARRNET headquarters from January to October, 1994

Name	Profession
J.P. Eckebil	DDG, ICD, IITA-Ibadan, Nigeria
F.M. Quin	Director, CID, IITA-Ibadan, Nigeria
H.R. Herren*	Director, PHMD, IITA-Cotonou, Benin
S.M. Lawani	Director, Information Services, IITA-Ibadan, Nigeria
J.L. Gulley	Leader, Training, IITA-Ibadan, Nigeria
P. Neuenschwander	Director, PHMD, IITA-Cotonou, Benin
R. Asiedu	Leader, TRIP, IITA-Ibadan, Nigeria
A.P. Uriyo	Project Coordinator, IITA-Ibadan, Nigeria
F.I. Nweke	Economist, RCMD, IITA-Ibadan, Nigeria
J.M. Teri	Coordinator, IITA-SARRNET, Malawi
M. Porto	Physiologist, IITA-SARRNET, Mozambique
M. Zweigert	IITA/GTZ/Biological control, IITA-Cotonou, Benin
J. Braimah	Entomologist, ESCaPP, IITA-Cotonou, Benin
W. N.O. Hammond	Entomologist, TT&T, IITA-Cotonou, Benin
S. Yaninek	Entomologist, ESCaPP, IITA-Cotonou, Benin
A.G.O. Dixon	Breeder, IITA-Ibadan, Nigeria
R. Ortiz	Breeder, IITA-Onne, Nigeria
N.M. Mahungu	Breeder, IITA-SARRNET, Tanzania
K. Muimba	Pathologist, IITA-SARRNET, Zambia

* Left IITA during the year.

Table 7. Seed population and in-vitro plantlets distributed to EARRNET member countries

Year	Country	No. of families	No. of seeds	*in vitro* plantlets	
				No. of clones	No. of plantlets
1993	Burundi	38	5,000	-	
	Rwanda	38	5,000	16	80
	Uganda	88	27,340	20	100
	Kenya	-	-	19	95
	Madagascar	-	-	66	330
1994	Uganda	287	94,824	31	81
	Burundi	192	38,316	-	-
	Rwanda	119	23,193	-	-
	Kenya	147	38,633	29	120
	Madagascar	164	38,973	29	76

Table 8. CM survey in Western Kenya (June 1994)

Site	% Infestation	CM Damage	CM density	E. lopezi (No)
Siaya B. Onyango	0	1.00	0	0
Karapul P School	4	1.08	0.08	0
Boro P School	2	0.02	0	0
Kaugagi Alepo	0	1.00	0	0
Uranga shops	6	1.12	0.07	0
Budalangi Bunyala	6	1.12	0.07	0
Mundere P School	0	1.00	0	0
Osogo School, Nabwire	26	1.40	0.35	0
Osogo School, Mudange	34	1.62	0.53	0
Matayo's shops	0	1.00	0	0
Mundika water plant	0	1.00	0	0
Chakol P School	0	1.00	0	0
Akoret Chief camp	0	1.04	0	0
Osuret P School	0	1.00	0	0
Myanga Lunakho	0	1.00	0	0

Table 9. Emergence of natural enemies from CM infested cassava tips from western Kenya (June 1994)

Site	% Infestation	CM Damage	CM density	E. lopezi (No)
SIAYA				
Uranga shops	0	0	3	1 (bug)
Kaugagi Alego	4	3	1	1 (bug)
BUSIA				
Budalangi Bunyala	1	1	2	1 (moth)
John Osogo	0	3	0	0
Mundika water plant	0	0	6	0
Osuret P School	4	5	3	0
Matayos shops	4	3	3	0
Mundere P School	0	1	0	0
Port Victoria Nambwire	5	1	4	0
BUNGOMA				
Myanga	1	0	3	0
SOUTH NYANZA				
Suna south	0	0	0	0
Kendu bay	2	0	0	0

Table 10. CGM survey in western Kenya (June 1994)

Site	% Infestation	CGM Damage	CGM Score	CM abundance
Siaya B. Onyango	50.0	1.53	0.68	5.00
Karapul P School	73.3	1.97	0.72	10.70
Boro P School	46.7	1.67	0.67	14.70
Kaugagi Alepo	53.3	1.43	0.57	8.33
Uranga shops	30.0	1.33	0.55	3.00
Budalangi Bunyala	26.7	1.13	0.35	2.67
Mundere P School	53.3	1.60	0.62	5.33
Osogo School, Nabwire	80.0	2.43	0.97	41.30
Osogo School, Mudange	83.3	2.20	0.76	15.00
Matayo's shops	23.3	1.23	0.43	2.33
Mundika water plant	53.3	1.70	0.70	224.70
Chakol P School	100.0	2.97	0.61	43.30
Akoret Chief camp	96.7	2.83	0.59	339.00
Osuret P School	26.7	1.50	0.68	2.67
Myanga Lunakho	26.7	1.53	0.57	2.67

Table 11. Mean number of *N. idaeus* at Katumani field Q (January-June 1994)

Date	Release plants		Adjacent plants		CGM per leaf
	Upper leaves	Lower leaves	Upper leaves	Lower leaves	
24.01.94	0.00	0.00	0.321	0.00	69.8
03.02.94	0.00	0.00	0.00	0.00	63.3
25.03.94	0.00	0.00	0.00	0.00	75.0
20.04.94	0.00	0.12	0.00	0.00	38.0
18.05.94	0.04	0.04	0.00	0.00	114.0
20.06.94	0.28	0.12	1.28	0.28	56.7

Table 12. Evaluation (scores) of diseases in farmers fields

Leaf infections		Root infection	
Scale	Evaluation	Scale	Evaluation
0	no infection	0	no infection
1	1-10% of the leaf surface is infected	1	1-10% of the stem is infected
2	10-30% "	2	10-30% "
3	30-50% "	3	30-50% "
4	50-80% "	4	50-80% "
5	80-100% "	5	80-100% "

Table 13. Clonal classification based on sprouting ability

Germplasm number	Name of clone	Mean sprouting	Class
243	Madamomialankanjo	12.83	A
378	H46	11.89	AB
452	H43	11.70	AB
477	H54	11.55	AB
222	Java A	11.36	AB
221	Singapore Ameliore	10.76	AB
476	Graines No 2	10.13	AB
514	H71	9.74	AB
478	H55	9.64	AB
254	Mamoakely	9.34	AB
327	V35	9.06	AB
275	Borbona	8.84	AB
107	Mangahazo fotsy	8.75	AB
392	V28	8.49	AB
488	Guacupi 454	8.00	AB
459	Quinzoma GB87	7.99	AB
399	L92	7.29	AB
457	Begala	6.99	AB
437	Boledaka	6.19	AB
508	H65	5.84	AB
475	Sab Paolo	5.53	AB
442	Hongotrakohoravina	3.52	B

Table 14. Clonal differentiation based on ACMV infection

Accession No.	Name	Infection (%)	Class
390	Montomaso	53.17	A
483	Vira Barco	49.39	AB
248	Variaty	47.57	AB
396	L46	45.75	AB
395	P66	44.95	AB
308	A28	44.39	AB
227	Madagascar No 27	41.95	AB
159	Tongobitsy No 2	38.20	BC
178	Camanioc	38.17	BC
154	Fotsy	36.51	BC
487	!tu 192	36.00	BC
116	Mangahazo Fotsy	35.78	BC
110	Dorodpro	27.59	C

Class A - susceptible
Class AB - slightly susceptible
Class BC - slightly resistant
Class C - resistant

Table 15. Damage, density, percentage of parasitism, percentage of hyperparasitism and infestation percentage of 15 sites sampled in 6 communes

Commune	Site(cell)	Damage	Density	%parasitism	% hyperp	%infested
Musambira	Nkoto	1.7	0.32	5.4	45.5	20
	Kigarama	1.3	0.38	26.2	66.8	20
	Kigusa	1.4	0.12	51.7	13.3	26
Runda	Bwirabo	1.2	0.15	42.1	87.5	14
	Sheli	1.4	0.26	59.0	0.0	22
Mugina	Nyarugenge	1.3	0.41	39.8	2.9	26
Tombwe	Nyinya	1.4	0.26	16.7	0.0	30
	Mwendo	1.0	0.05	2.0	12.5	14
	Muremera	1.3	0.20	8.8	0.0	80
Ntongwe	Buhanika	1.3	0.48	10.7	29.4	18
	Nyaluteja	1.6	1.63	2.2	37.5	44
	Gako	1.2	0.17	5.4	45.5	22
Nyamabuya	Nyakabanda	1.1	0.05	8.4	2.6	4
	Nyakaleka1	1.1	0.12	11.6	12.5	16
	Rubona	1.4	0.10	26.8	0.0	26

Table 16. Phytoseiids associated with CGM at different locations

Sites	Species
Mpigi District	
Bugema	*E. fustis*
Kiwenda	*Typhlodromalus saltus*
	E. fustis
Namulonge	*E. fustis*
	Typhlodromalus rykei Cheyletidae
	E. fustis
	T. saltus
	Ablyseius sp.
Luwero District	
Bombo	*E. fustis*
Nakasongola	*E. fustis*
	Amblyseius tomatonensis
Iganga District	
Naggalama	*E. fustis*
Busei	*E. fustis*
Bugiri	*E. fustis*
Bukona	*E. fustis*
Bukoli	*E. fustis*
Bukobuli	*E. fustis*
Butendi	*E. fustis*
	Typhlodromips shi
	E. fustis
Apac District	
Badr Odong	-
Aboke	*E. fustis*
Amintenng	-

Table 17. Host plants associated with indigenous phytoseiids

Host plant	Phytoseiid species
Bidens pilosa	*E. fustis*
	Typhlodromips shi
Siratro	*E. fustis*
Cassia sp.	*E. lokele*
	Amblyseius sp.
Centrosema sp.	*Phytoseius amba*
Euphorbia leterophylla	*E. fustis*
Asystasia sp.	*Typhlodromips shi*
Sweet potato	*Typhlodromips shi*
Brachiaria sp.	*Typhlodromips shi*

Table 18 Number of seedlings/breeding lines evaluated in 1993 and 1994

	Locations							
	Namulonge		Serere		Migyeera		Masindi	
Trials	1993	1994	1993	1994	1993	1994	1993	1994
Germplasm	-	350	-	-	-	-	-	-
Seedlings	55,000	80,000	30,000	25,000	-	-	-	-
Clonal evaluation	437	448	372	221	-	-	-	-
PYT	91	256(AB&C)	149	72	80	155	80	153
AYT	40 (A&B)	26	35 (A&B)	221	20	17	19	16
UYT	10 26	10	10	10	16	10	18	

Table 19: Seed distribution to various countries 1993/94

Country	Families	No. of Seeds
IITA (Nigeria)	27	10,000
Kenya	27	15,000
Burundi	17	11,600
Rwanda	17	20,000
Total		56,600

Table 20. Combined ANOVA, broad sense heritability (H^2), and % contribution to TSS for root numbers,root weight, dry matter and cyanogenic potential.

Source	df	Root yield	Tuber weight	Dry matter	Cyanogenic potential
Clone	9	1634.58 (6.19)	615.31* (10.8)	114.47**(19.7)	7874984.80**(37.14)
Location	3	10647.33**(44.91)	2775.05**(48.89)	993.00**(51.7)	9558814.17**(45.06)
Clone x Location	24	3523.96*(13.35)	771.18**(13.59)	12.45**(5.72)	3020834.32**(14.24)
CV		26.27	33.04	7.63	14.90
H^2		1.00	4.75	26.60	26.14

* ** Significant at the 0.05 and 0.01 probability levels respectively
Figures in brackets are % contribution to TSS

Table 21. Root yield (t/ha) and stability parameters of 10 cassava clones grown in UYT

Clones	x	b_1	S^2_d	Shukla	Rank
89/30786-11	9.25	0.58	1.23	27.76	20
Check	11.39	0.95	42.70	32.73	20
89/91934-92	13.88	1.44	0.29	21.59	12
89/KKWE-61	7.79	0.31	8.14	63.66	31
89/KKWE-74	9.37	0.68	44.16	46.63	29
89/KKWE-82	13.43	1.07	44.13	34.39	21
89/MGR-4	7.78	0.93	25.59	19.31	21
89/CB-71673-3	13.16	1.36	28.18	30.37	18
89/CB-71673-35	12.10	1.55	36.95	66.34	29
89/01438-13	10.77	1.06	2.85	0.96	12

Table 22. Genetic progress made during 1993 through cassava breeding

Clones	Current status	ACMV resistance
Nase 1 } Nase 2 } 1993 Migyeera }	Officially released and being multiplied and distributed	Medium resistance in Nase 1 and 2 to resistant in Migyeera
SS4 TMS 4(2)1425	Successfully gone through on-farm evaluation. Data have been compiled for release this year	Resistant
89/91934-92 89/30786-11 89/1988-2-UYT-PDB	Very promising, will enter on-farm evaluation in 1995	Resistant

Table 23. Training of extension personnel in charge of sub counties within the different Districts

Location	Number of Participants	Qualification	No.	Remarks
Arua	7	A.O A.A.O A.A.	1 3 3	Trial implementation and data collection were emphasized.
Masaka	5	A.O. A.A.O.	1 4	Farmer selection and trial management were emphasized
Kasese	20	A.O. A.A.O. R.C.s Farmer	1 4 3 12	ACMV awareness and production technologies were emphasized.
Mpigi	12	A.O. A.A.O.	1 11	Other than production methods, rapid multiplication technologies were taught.
Iganga	5	A.O A.A.O.	1 4	Methods of disease identification emphasized.
Mubende	5	A.O A.A.O F.A.	1 3	Cassava production & trial management were emphasized.
Masindi	13	A.O.	13	Cassava production aspects emphasized.
Mukono	6	A.O.	2	Disease & Pest identification methods emphasized.
Hoima	-	-	-	No training yet due to change of staff.
Kibaale	?	?	?	Training carried out but details missing

A.O. = Agricultural Officer; A.A.O = Assistant Agricultural Officer
F.A. = Field Assistant; R.C. = Regional Councillors

Table 24: Cassava genotype root yield (tons/ha) from on-farm trials in Iganga district 1992/93

Sub-Counties	Genotypes							
	TMS 60142	TMS 30337	TMS 30786	Bao	B11	Teraka	Local	Sub-county mean
Mubende	30.4	50.3	34.3	26.8	16.8	29.0	26.0	30.5
Waibuga	38.8	46.8	44.3	37.0	30.8	36.5	25.0	36.3
Baitambogwe	61.3	59.5	56.8	55.0	27.0	54.0	40.0	50.5
	43.5	52.2	45.1	39.6	24.9	39.8	30.3	

Table 25: Cassava genotype root yield (tons/ha) in on-farm trial in Hoima district 1992/93

Varieties	Sub counties				
	Buhimba	Kabwoya	Kyabigambire	Kigorbya	Mean
TMS 60142	23.5	23.0	29.3	33.5	27.3
TMS 30337	29.5	28.1	32.4	28.6	29.7
TMS 30786	34.9	29.4	46.8	32.1	35.8
TMS 4(2)1425	28.9	32.5	42.6	26.1	32.5
TMS 30001	33.4	26.3	-	29.7	29.8
TMS 60140	26.7	28.9	-	32.2	29.3
B11	22.5	15.8	26.2	12.8	19.3
Bao	34.2	27.8	42.6	26.3	32.7
Teraka	39.8	32.3	34.8	34.9	35.5

Table 26: Cassava genotype root yield (tons/ha) from on-farm trials in Kibaale district 1992/93

Varieties	Sub counties						
	Bwamiramira	Mugarama	Bwanswa	Mabaale	Kankindo	Kagadi	Mean
TMS 60142	20.3	24.7	17.7	28.7	29.3	22.5	23.0
TMS 30337	41.7	43.3	25.8	42.3	40.1	29.0	37.0
TMS 30786	40.0	26.7	32.3	33.5	43.6	24.0	33.4
TMS 492)1425	40.3	37.0	32.3	27.3	55.0	32.5	47.4
Bao	41.8	51.3	49.0	32.7	80.1	29.5	37.7
B11	55.5	36.7	39.0	34.0	40.1	20.8	33.8
Local	28.3	19.0	37.5	32.3	57.8	27.8	33.8
Terala	45.0	44.0	42.5	30.3	39.1	39.1	42.6

Table 27: Cassava genotype root yield (tons/ha) from on-farm trial in the multiplication districts in Uganda 1992/93

Subcounties	Genotypes							
	TMS 60142 Teraka	TMS 30337	TMS 30786	TMS 4(2)1425	Bao	B11	Local	
Masindi	29.5	27.3	31.0	33.9	-	26.6	32.8	-
Masaka	12.4	19.4	16.6	18.3	21.1	13.0	17.9	18.4
Iganga	43.5	52.2	45.1	-	39.6	24.9	30.3	39.8
Mukondo	27.3	34.6	35.1	37.1	38.2	29.7	40.1	44.3
Mubende	25.9	21.6	26.7	26.3	31.5	19.9	23.4	29.1
Hoima	27.3	29.7	35.5	32.7	19.3	25.0	35.5	29.7
Arua	28.3	24.0	36.4	25.3	31.9	23.1	28.4	-
Mpigi	20.0	35.4	31.0	28.3	33.8	24.7	31.2	37.1
Kasese	46.7	35.9	59.4	31.8	44.0	35.4	43.8	48.5
Kibaale	23.0	37.0	33.4	37.4	47.4	37.7	33.8	30.7
Mean	25.4	31.7	35.0	26.6	32.0	25.4	30.7	36.9

Table 28. Status of COSCA surveys in ESA as of 1994

Country	Phases of COSCA Surveys			
	1	2	3	4
Uganda	C	C	C	P
Kenya	C	-	-	-
Burundi	-	-	-	-
Rwanda	-	-	-	-
Madagascar	P	P	P	-
Tanzania	C	C	C	P
Malawi	C	P	P	-
Mozambique	P	P	P	-
Zambia	C	-	-	-
Botswana	P	-	-	-
Lesotho	P	-	-	-
Swaziland	P	-	-	-
Angola	-	-	-	-
Namibia	-	-	-	-
S. Africa	Involvement expected when SADC membership is approved			

*C = Completed
P = Proposed for 1994
- = No firm plans

Table 29 COSCA Surveys with augments that are required to obtain the 1994/95 reference database for the cassava R & D Plan

Scope of survey Analysis		Countries	Field Survey	Data
A.	COSCA Phase 4 with augments covering	Uganda Tanzania	Oct-Nov 1994 ?	Jan-Feb 95 ?
i)	Pest and disease incidence			
ii)	Spread & performance of improved varieties			
iii)	Efficiency of delivery system			
iv)	Further aspects of postharvest			
B.	COSCA Phases 2 & 3 with augments A(a) and A (d) above	Malawi Zambia Kenya Burundi	Sept-Nov 94 in 1995 " "	Jan-Mar 95 in 1995 " "
C.	COSCA Phases 1 - 3 with augments A (a) and A(d) above	Mozambique Botswana Swaziland Lesotho Zimbabwe	in 1995 " " " "	in 1995 " " " "
		Rwanda Angola Namibia S. Africa	? ? ? ?	? ? ? ?
		Madagascar	Aug-Nov 94	Jan-Feb 95

Table 30: 1995 proposed training courses

Course	Location	Proposed dates
Training workshop for research trainers and training coordinators: Crops management research courses and network collaborators	IITA, Nigeria	Jan 16 - 20
Use of geographical information systems (GIS)	IITA, Nigeria	Jan 16 - 27
Use of pathogens for control of insects	Benin	Mar 6 - 31
Choice and on-farm testing of improved technologies	IITA, Nigeria	Mar 6 - 17
FAO Workshop : cassava production and utilization	IITA, Ibadan	Not fixed
Sustainable food production systems: integration of crops and livestock	IITA, Ibadan	May 15 - Jun 2
Crop management research on banana/plantain	Uganda	Jun 12 - Jul 7
Breeding of root and tuber crops	IITA, Ibadan	Jul 3 - 21
Crop management research on root crop-based systems (EARRNET-SARRNET Eastern/Southern Africa)	Malawi	Aug 7 - Sept 1
Rapid multiplication of root crops (EARRNET/ Rwanda + local & international NGOs)	Rwanda	October 16 - 20
Rapid multiplication of root crops (EARRNET/ Burundi + local & international NGOs)	Burundi	Mar 6 - 10
Postharvest technology training course (Regional EARRNET/SARRNET)	Uganda	Nov 6 - Dec 1

TERMS OF REFERENCE FOR EARRNET GOVERNING BODIES

The Terms of Reference (TOR) of the various bodies involved in the execution of EARRNET activities were reviewed by the EARRNET Committee of Research Directors on May 3, 1995 and approved the following:

1. Committee of Research Directors (CRD)

The EARRNET Committee of Research Directors (CRD) is made up of directors of Agricultural Research of the network countries and a representative of International Institute of Tropical Agriculture (IITA), has the following responsibilities:

1.1 Takes overall responsibility for the proper functioning of the network and its coordinating office including the recruitment of the coordinator and the scientists within the network, ensuring the progress and success of the networking objectives.

1.2 Establishes the general policies and priorities of cassava research in the network countries.

1.3 Defines the relationship between IITA and CIP and between EARRNET and other networks such as SARRNET.

1.4 Considers and approves the annual work plan, budget and any suggestions submitted by the Steering Committee.

1.5 Ensures the timely preparation of progress and annual reports and approves their release for the public as well as to donors.

1.6 Organizes and implements a schedule for monitoring and evaluation of the programs.

1.7 Encourages the publication in referred journals, research results by collaborating national scientists.

1.8 Takes any other measures deemed necessary to attain the network objectives.

1.9 Appoints a Chairman and Deputy Chairman for the committee among the member directors to serve for a one-year term. The chairman is appointed on a rotational basis and on alphabetical order of the name of member countries. The Deputy-Chairman is the director of the next country in order for the chairmanship

1.10 The Chairman directs the network activities and reports to the Committee of Research Directors. The Deputy-Chairman replaces the chairman in case of absence.

1.11 The EARRNET CRD meets once a year. It was agreed that this meeting be an extension of other meetings such as that of the steering committee in order to minimize additional travel and time expenditures of CRD members.

1.12 Extraordinary meetings of the CRD are called by the Chairman or at the request to the Chairman by two-thirds of the members of the CRD.

1.13 The venue of the CRD meetings rotates among the EARRNET countries in the same order as for the appointment of the Chairman.

1.14 Quorum is established as half plus one the total number of CRD members.

1.15 The representative(s) of donors, the Chairman of the Steering Committee and the Chairman of SARRNET or his appointee, may participate as observers in the CRD meetings.

1.16 The EARRNET coordinator is the secretary of the CRD meetings.

2. The Steering Committee (SC)

2.1 The Steering Committee of EARRNET is formed by the heads of the national cassava programs of each collaborating country, the EARRNET coordinator and his assistant.

2.2 The SC serves as the technical arm of EARRNET towards the attainment of the objectives.

2.3 The SC prepares and submits medium and long-term plans for cassava-research for the consideration and approval of the CRD.

2.4 On the basis of long-term plans, it prepares and submits on timely basis, annual programs and budgets for the CRD consideration and approval.

2.5 It executes approved annual plans and submits quarterly and annual reports through the office of the coordinator. Quarterly reports will be submitted in November, February, May and August of each year.

2.6 It prepares new projects to further strengthen the EARRNET.

2.7 It carries out other activities as requested by the CD from time to time.

2.8 It appoints a chairman of the meeting to serve for a period of one year. The chairman is appointed in a rotational basis and on alphabetical order of the name of the member countries. The chairman conducts the meeting of the SC.

2.9 The SC meets twice a year during the months of February and August. The major objective of the meetings is to examine the results of research and other activities carried out during the previous agricultural year and, on the basis of those results, to develop a work plan for the next agricultural year. The second (August) meeting is mainly to examine progress of the network activities during the previous agricultural season.

2.10 For the analysis of results to be made during the first meeting, each country presents a written report on the previous year.

2.11 Extraordinary meetings of the SC may be called, in case important issues to be studied develop. The meetings may be called by the coordinator at the request of the coordinator by two-thirds of the number of SC members.

2.12 The venue of the meetings rotates among the EARRNET member countries in the form of one country per meeting following the alphabetical order of the name of the member countries.

2.13 Quorum is established as half plus one, the number of the SC members.

2.14 The Secretary of the SC meeting is the Assistant Coordinator.

3. *The EARRNET Coordinator*

3.1 The network coordinator is appointed by the CRD for a period of 3 years, renewable if found satisfactory.

3.2 Is directly accountable to the Committee of Research Directors of EARRNET.

3.3 Is responsible for the proper organization and functioning of EARRNET coordination office, provides dynamic and professional service for effective and efficient implementation of its assigned responsibilities.

3.4 Serves as the facilitator in the preparation and execution of annual programs at national and regional levels.

3.5 Prepares and submits for approval by CRD an annual work plan including visits to member countries.

3.6 Organizes or helps organize training courses, workshops, seminars, etc in relation to the mandate crop of the network.

3.7 Helps national programs in identifying and procuring materials and services relevant for the execution of EARRNET activities.

3.8 Organizes the meeting and field visits of the CRD and SC.

3.9 On the basis of reports received from the national program leaders and IITA, prepares harmonized technical and financial reports for submission to the CRD on a yearly basis.

3.10 Prepares and submits on a timely basis, a quarterly and annual report of EARRNET activities to the CRD.

3.11 Maintains close contact with the Chairman of EARRNET CRD, National Directors of Research of member countries and members of the SC.

3.12 Assembles and maintains an up-dated database of network activities.

3.13 Carries out other activities as required by the CRD and/or the CRD chairman.

3.14 Attends the CRD meetings and acts as the secretary and resource person.

3.15 Attends the SC meetings as an inherent member and as a resource person and provides active support to their deliberation.

3.16 Is the liaison between the CRD and the SC.

4. *The Assistant Coordinator*

The assistant coordinator who will be an agronomist will be appointed by the CRD for a period of three years, renewable if found satisfactory, and directly accountable to the EARRNET Coordinator.

4.1 Follows-up the implementation and development of the research training and technology transfer activities of the national programs planned by the SC and approved by the CRD.

4.2 Serves as a technical adviser to the national program scientists.

4.3 Prepares research projects on cassava which, after being included in the work plan and approved by the CRD, could be carried out in collaboration with the national program scientists or directly by himself or herself.

4.4 Prepares reports on courses, seminars, workshops and visits to EARRNET programs.

4.5 Carries out other activities as requested by the coordinator.

4.6 Attends the meetings of the SC, acting as the secretary and resource person.

5. *The International Institute of Tropical Agriculture (IITA)*

5.1 Provides technical backstopping in the planning, implementation, monitoring and/or evaluation of research programs in cassava within the multi-disciplinary teams in the region.

5.2 Participates actively in collaborative research with NARS scientists in the two commodities.

5.3 Facilitates the implementation of training programs of network scientists and technicians.

5.4 Makes available its facilities and expertise in procuring materials and services to the network.

5.5 Assists in identifying and recruiting a network coordinator as and when requested by the CRD.

5.6 Assists in any other matters that strengthens the effectiveness of the EARRNET.

Annex 2

Backstopping visits and meetings attended by Coordinator (January - October 1994)

Rwanda national program	January
Kenya national program	February
EARRNET SC meeting	February
RDC meeting	February
ESARC SC meeting	Feb/March
RDC meeting	April
SARRNET SC meeting	May
Kenya national program	May
Madagascar in-country training course	May
Madagascar national program	June
'Seed of hope' meeting, Nairobi	June
CTA/NARO/NRI workshop	June
'Seed of hope' meeting, Nairobi	September
PRAPACE SC meeting	September