CAMEROON
PROJECT ASSISTANCE COMPLETION REPORT

A. BASIC PROJECT IDENTIFICATION DATA:

1. PROJECT TITLE: Tropical Roots and Tubers Research Project (ROTREP)

2. PROJECT NUMBER: 631-0058

3. MODE OF IMPLEMENTATION: Cooperative Agreement with the University of Maryland Eastern Shore (UMES) as lead university; sub-grants issued by UMES to Alabama A & M University (AAMU) and Florida A & M University (FAMU). Government of the Republic of Cameroon (GRC) implementation agency: Ministry of Scientific and Technical Research (MINREST) through the Institute of Agronomic Research (IRA).

4. PROJECT DESIGNERS: UMES, AAMU, FAMU, GRC, USAID/Cameroon.

5. PROJECT COOPERATIVE AGREEMENT DATES/OBLIGATIONS:

	Date	Amount ($000)
a. Original Cooperative Agreement	08/29/86	3,700
b. Amendment No. 2	09/25/86	95
c. Amendment No. 5	08/14/87	249
d. Amendment No. 7	08/25/88	1,300
e. Amendment No. 8	03/02/89	368
f. Amendment No. 9	06/22/90	350
g. Amendment No. 11	01/01/92	1,000
h. Amendment No. 12	03/30/92	2,177
Total Obligation		9,239

6. PROJECT ASSISTANCE COMPLETION DATE: Original - August 29, 1991; 1st Revision - August 29, 1993; 2nd Revision - December 31, 1994; 3rd Revision - November 30, 1994 [Project Authorization Date: August 29, 1986; Protocole Agreement GRC-UMES Date: October 1, 1986; Technical Assistance Dates: October 1986 to November 1994].

7. TOTAL PROJECT FUNDING - ACTUAL: ($000)

	Planned	Actual
a) A.I.D. Funding	9,239	9,239
Technical Assistance	4,845	4,491

Short-term Training		519	346	
Language Training and Transportation	90	17		
Participant Training	509	633		
Commodities/Construction		1,591	1,598	
Recurrent Cost		1,316		1,688
Other Direct Cost		369	466	

	Planned	Actual
b. GRC Funding	$3,316	3,912
Personnel	1,858	2,106
Commodities	842	512
Research/Operating Cost	534	903
Inflation/Other	82	391

8. RESPONSIBLE MISSION OFFICIALS (Life of Project):

a. Mission Director(s): Jay P. Johnson
Peter Benedict

b. Project Officers: William Judy
Gary Cohen
John Dorman
Quincy Benbow
Elzadia Washington

c. REDSO/WCA Project Manager (close out) Yves Coffi Prudencio

9. EVALUATION DATE(S): September 1989

B. PROJECT PURPOSE/OBJECTIVES, OUTPUTS, STATUS OF ACCOMPLISHMENTS, LESSONS LEARNED, REFERENCES:

10. PROJECT GOAL: The goal of ROTREP was to contribute to the improvement of the Cameroonian farmers' socio-economic welfare through increased productivity of root and tuber food crops.

Project Purpose: The purpose of ROTREP was to improve the socio-economic welfare of farmers in Cameroon by increasing the productivity of cassava, yams, and cocoyams through

(a) the development of technically and economically feasible root and tuber crops, rapid seedstock multiplication technology for cassava, yam and cocoyam, and (b) the development of a root rot resistant cocoyam variety that has desirable agronomic characters through cytogenetic and breeding studies.

Project Objectives and Outputs:

(1) Develop locally acceptable varieties of cocoyam which are resistant to root rot disease in Cameroon.

(2) Develop a technically and economically feasible seedstock multiplication system(s) for yam, cassava and cocoyam.

(3) Study the nature and magnitude of post harvest losses of root and tuber food crops systems and recommend research problems and opportunities for improving the system(s).

(4) Assist in the institutional development (Human and Physical) of the Institute of Agronomic Research in root and tuber crops research.

Background: In 1977, the Institute of Agronomic Research (IRA) in the GRC Ministry of Scientific and Technical Research created the Cameroon National Root Crop Improvement Program (CNRCIP). The objectives of CNRCIP are:

- To promote varieties of root crops which are high-yielding, tolerant to the principal pests and diseases, with a high nutritive quality and accepted by the consumers;

- To develop improved cultural practices and techniques which small farmers can use;

- To develop rapid seed multiplication of improved material to be used by all grades of planters;

- To develop appropriate storage and processing techniques which will reduce losses and to study the commercialization of derived products; and

- To train national researchers and technicians to continue the research program.

Roots and tubers, in order of their production and importance in Cameroon are cassava, cocoyam, yams, sweet potatoes and white potatoes. Cassava is the most important root and tuber crop in Cameroon but research on this crop did not start until 1976. Research priorities

are on obtaining resistance to tuber root rot, improving post-harvest technology and nutritional levels and achieving a rapid seedstock multiplication system. There are three cultivars of cocoyams, the white, red and yellow with the white being the most acceptable to consumers and the most susceptible to cocoyam root rot caused by a soil fungus. The research priority is focused on developing a variety that is resistant to root rot. Yam in terms of production and importance ranks third, but in terms of income generation it ranks first. The white yam is grown mainly for cash sales while the trifoliate yam is the main food yam. Research, which started in 1968, has been focused on selection of local varieties and improved cultural practices. Sweet potato research also started in 1976.

Research has focused on the main constraints to production: low yields, virus diseases and weevils. The main constraints to white potato production have been disease susceptibility (late blight, wilt, virus), lack of good planting material, and poor market systems. Research on white potato was intensified in 1987.

Since 1976, several international organizations have provided assistance to the IRA roots and tubers research program, including the International Institute of Tropical Agriculture (IITA), the International Potato Center (CIP), the International Development Research Center (IDRC), the Administration-General For Cooperation in Development (AGCD), the Gatsby Charitable Foundation, the International Foundation for Science (IFS), the Research Project for Maize and Cassava (RPMC), and the U.S. Agency for International Development (USAID). Since 1980, these organizations spent a total of $14.9 million on roots and tubers research in Cameroon, of which USAID provided $9.2 million through the ROTREP Project.

In 1986 USAID agreed to fund the Roots and Tubers Research Project in Cameroon by signing a Cooperative Agreement with the University of Maryland Eastern Shore (UMES). Working as a consortium, UMES subsequently issued sub-grants to the Alabama A&M University and Florida A&M University. On October 1, 1986 a Protocol Agreement was signed between the Government of the Republic of Cameroon (GRC) and the consortium.

11. STATUS OF COMPLETION OF PROJECT ELEMENTS (Inputs):

a) Procurement: The grantee had the responsibility of procuring and contracting during the entire life of the project. The lead university, UMES, was to provide long-term technical assistance and also execute memoranda of agreement with Alabama A&M University and Florida A&M University to provide technical assistance to implement the diagnostic survey on storage, processing and utilization of root and tuber food crops. Short-term consulting was to be provided by all three collaborating universities. The commodities that had to be procured included vehicles, laboratory and field equipment, research supplies, office furnishings and equipment, and household furniture and appliances for the long-term technicians.

Status: All required commodities were procured according to specifications as identified by the technical staff. Commodities were procured and received within the expected time frame. Project commodities which were transferred to IRA are shown in attachment 6.

b) Construction: The grantee was responsible for developing plans for construction and building renovation, as well as awarding and managing construction contracts.

Status: The project succeeded in establishing a functional tissue culture laboratory which was a critical pre-requisite for useful work in the development of rapid seed stock multiplication system for root and tuber crops. This ultra modern tissue culture laboratory was fully completed and furnished. The project has also completed the construction of a greenhouse complex facility nursery. Additional infrastructure included the construction and completion of two growth rooms and two screen houses for disease indexing and tissue culture activities. Construction has been completed and a provisional reception took place on October 7, 1994 by REDSO/WCA.

c) Technical Assistance: The technical assistance component of ROTREP initially included 132 person months of long-term advisors plus 22.7 person months of short-term consultancies. Fields of expertise included: agricultural economics, breeder/agronomist, plant geneticist, biotechnology/agronomist, plant breeder and plant pathologist. Subsequent amendments (amendments 10 and 11) added an additional 97 person months of long-term advisors and 25 person months of short-term consultancies. The responsibility of the technical assistance personnel was to assist IRA in accomplishing the above objectives through project implementation.

Status: The lead university, the University of Maryland Eastern Shore (UMES) was responsible for overall project implementation. UMES coordinated the placement of all long-term technical assistance personnel, procurement of all commodities, and design and supervision of construction of the biotechnology complex. UMES provided a chief of party/agricultural economist for four years, a chief of party/biotechnologist for two and one half years and home office support personel.

Alabama A & M University (AAMU) provided the leadership for the diagnostic studies of the storage, processing and utilization of root and tuber food crops in Cameroon. From 1987-89, AAMU was responsible for participant training activities. From 1990-94, AAMU coordinated all short-term technical assistance to the project. AAMU provided a crop breeder for two years and home office support personnel. Florida A & M University (FAMU) was responsible for all language training associated with the project. From 1987-89, FAMU coordinated all the

short-term technical assistance to the project. From 1990-94, FAMU was responsible for the participant training component. FAMU provided a crop breeder for two years, a pathologist for two years, and home office support personnel.

The review of the effectiveness of the technical assistance component is given in the section on accomplishment. In terms of numbers, accomplishment of technical assistance: 100% completed.

d) Training: The training component of the project included the training of six Cameroonians in various fields at the graduate degree level, short-term training of technicians in third countries, and in-country training.

Status: The project was responsible for the training of Cameroonian counterparts working with expatriate scientists in various fields.

Seven Cameroonian researchers were trained at the graduate level. One Cameroonian has received a Ph.D in Food Technology, and returned to Cameroon in December 1991. Three Cameroonians have received M.Sc. degrees in Food Technology, Horticulture/Tissue Culture and Crop Breeding. They returned to Cameroon respectively in May 1991, October 1992, and 1993. An additional three Cameroonians obtained by December 1994 M.Sc. degrees in Agricultural Economics, Crop Breeding/Pathology, and Tissue Culture/Pathology. The last three have been approved by GRC to continue on to Ph.D Degree up until December 1995. Their respective universities have awarded them graduate assistantships to pursue their studies.

Twelve Cameroonians received short-term third country training in subject areas ranging from administrative and staff management to maintenance of electronic research equipment. In-country training was also conducted by ROTREP technical assistants and senior Cameroonian researchers for junior staff in genetics, tissue culture, plant pathology and agricultural economics. Fifty one IRA Ekona researchers, administrators and support personnel received training in the use of microcomputers in research and administration. Twenty people received training in tissue culture techniques for extension. The project conducted local training for administrative personnel taking into consideration the specific needs of a sophisticated research program. The effectiveness of the training on overall human resource development will be discussed in the following section. Fourteen Cameroonians received on-the-job training. Twenty eight ROTREP scientists presented papers at international conferences, workshops and symposia. Twelve University of Dschang students and six other agricultural university students conducted research toward their theses under ROTREP staff supervision at Ekona.

12. STATUS OF PROJECT ACCOMPLISHMENTS:

Objective 1: Develop domestically acceptable varieties of cocoyam which are resistant to root rot and blight complex.

Status: At the end of ROTREP on November 31, 1994, the project had not developed agronomically and socio-economically acceptable cultivars of 'white' cocoyam which are tolerant/resistant to root rot disease.

During the first year of ROTREP in 1987, the situations of cocoyam and the root disease were assessed. In terms of importance, cocoyam ranked second among the roots and tuber crops. Calorie intake per person per day was estimated at 128. But the severity of the root rot disease had caused production to decrease by more than 20 percent in less than two years. The disease was caused by the fungus "pythium myriotylum". Of the three cultivars of cocoyams in Cameroon, the white (which was the most popular) was the most susceptible, followed by the pink cultivar. The yellow cultivar was resistant to root rot. The fungicide, Ridomil (dimethylphenyllala- minate de methyl) was effective in controlling the fungus but was beyond the reach of the average grower. The first priority of the project was to collect germplasm from the various provinces in Cameroon and other countries as well, including Jamaica and Puerto Rico (later on, germplasm was also collected from Equatorial Guinea).

One year later, the project had successfully isolated the root rot disease and mass production of the fungus for screening the cocoyam germplasm was started. A protein content range was determined and the Diploid chromosome number of the white and red cocoyam was confirmed to be 2n=26 and the yellow cocoyam was confirmed as tetraploid with 4n=52. By early 1989, it was determined that the breeding program would involve hybridization and stringent selection criteria. The production of tetraploids from the white and red, essential to hybridization in the breeding program, started. Stress was put on phytopathology evaluation, electrophoresis and cytogenetic studies, field evaluation of germplasm, and crossing block for hybri-dization. Pathological work focussed on the production and characterization of isolates of the fungus in pure culture, mass production of inoculum for artificial infestation and field evaluation of germplasm material for resistance to "pythium myriotylum".

Following the September 1989 mid-term evaluation, the project pursued the objective using three approaches, all based on the germplasm collection assembled during Phase I of the project. In the first approach, clones from the germplasm were evaluated in trials, with the expected result of selecting clones with acceptable yields and high levels of resistance (tolerance) to Pythium root rot, which could be combined with disease-reducing cultural practices to give farmers a useful package. In the second approach, clones from the germplasm collection were used as parents in a conventional breeding program based on red x white (diploid x diploid) hybrids, with the expected result of selecting clones with high yields and

intermediate levels of resistance to Pythium root rot. The third approach used clones from the germplasm collection as parents in a non-conventional breeding program based on yellow x white and/or red (tetraploid x diploid) hybrids, with the expected result of selecting clones with high yields and high levels of resistance to Pythium root rot.

To obtain a cocoyam clone resistant to root rot using the conventional approach takes at least seven years, with luck. If one is successful, the non-conventional breeding methods could take half the time. The various non-conventional methods include: (1) Embryo rescue of interspecific hybrids between yellow polyploidies and white and red diploidies. An attempt to rescue embryos at 10, 20, and 30 days after pollination started with signs of swelling of the 20 and 30 days embryos indicating imbibition, cell division and growth. (2) Polyploidization of white and red diploid clones followed by hybridization with yellow polyploid (resistant) clones. Seedlings explants and corn buds of diploid red and white are treated with various

concentrations of colchicine for different durations in order to induce polyploidies that may be crossed with the yellow material. Results show that 0.05 to .25 percent concentration affected plant morphology. Cytological examinations to look for mutations are underway to confirm ploidy levels. (3) Anther and/or pollen culture of yellow polyploidies to produce diploidies to hybridize with white and red diploidies. This method attempts to reduce the yellow tetraploids to diploidies before hybridization. Anthers and pollen of yellow clones are cultured to produce haploid plantlets. Pollen germination and growth occurred in most cultures, but there was no plant regeneration after six weeks of culture. (4) Protoplast fusion of yellow polyploidies with white and red diploidies or induced tetraploids. Somatic hybrids may be produced by fusion of protoplasts followed by regeneration of plantlets. By this the resistance trait of the yellow tetraploid is transferred into the red and white. Experiments could not be conducted because of time constraints.

Nevertheless, a manual on cocoyam breeding and a review of pathology of the root and tubers were produced.

Objective 2: Develop a technically and economically feasible yam, cassava and cocoyam rapid seedstock multiplication system.

Status: Three stages are necessary in propagation by tissue culture: (1) establishment of the aseptic culture, (2) multiplication and rooting, and (3) acclimatization or transfer to soil. Yam-1 media has been successfully used for establishing culture of different species of yam, for example 'Dioscorea rotundata' and 'Dioscorea esculenta'. Medium Y-3 with auxin IAA gave the best results with rooting. Contamination of yam culture was reduced by the procedure of double sterilization (on surface sterilization) of yam nodal segments from 90% to 12% using Calcium hypochlorite. Based on ROTREP findings, the best growth media for acclimatization

of tissue culture derived cocoyam plantlets is the Non-sterile Pure Soil (NSPS). This result has led to tremendous savings (in energy, time and material) as plantlets are now transferred directly into unsterilized soil. The initial problem with cocoyam buds was severe fungal and bacterial contamination. However, by 1988, ROTREP had developed a procedure to store cocoyam media up to 6 months. Cocoyam C-6 was proved very effective as a media and has been used to obtain aseptically cultured plantlets but regeneration is low (50-60%). By 1993, 7,000 acclimatized tissue culture plants had been produced using a substrate of top soil and coffee parchment.

Mass culturing of improved cassava has started with clones 8061, 8034, and 8117 producing hormones. Yields of cassava tissue culture derived plantlets from cultivars 8034 were more than twice those of non-tissue culture derived material for the same clone. Tissue culture material yielded 58.6 kgs after 13 months compared to 23.0 kgs from non-tissue culture material after 17 months. Data currently available on cocoyam yields of tissue culture material showed average yield at 2.56 tons/ha compared to 9-10 tons/ha for non-tissue culture material. These low yields may be attributed to abundant suckering which is good when producing planting material and poor when emphasis is on yield. Research continues on solving this problem.

A study on the economics of research and development of rapid seedstock multiplication of cocoyam through tissue culture revealed that technical labor and glassware/ materials were the most expensive factors. Other production factors examined were culture media, fixed lab facilities, and greenhouse facilities. Even though the study did not estimate cost of production per plantlet, the results did lead to the development of a new strategy for training lower level laborers to replace technical labor. Various studies completed on rapid seedstock multiplication are shown in Attachment 8.

The procedures for developing rapid seedstock multiplication for cassava, cocoyam, and yam have been established. An MR5000 has been installed and has made virus indexing a reality. All that is left for a breakthrough is the development of a cocoyam variety resistant to the root rot disease.

As previously planned, if this breakthrough was enhanced, an analysis and recommendation of policy issues to facilitate private sector adoption of the rapid seedstock multipli-cation system would have been carried out. This initiative would have required the exploration of linkages with private firms in the USA (i.e., Pioneer Seed Company), Nigeria and other countries for joint ventures in the adoption of rapid seed multiplication systems. Experts from the private sector were going to be utilized in achieving this output.

Objective 3: Study the nature and magnitude of post harvest losses of root and tuber food crops, the processing and utilization constraints of root and tuber food crop systems, and

recommended research problems and opportunities for improving the systems.

Status: In 1987, a diagnostic survey conducted by the project concluded that:

- That there was a lack of reliable efficient storage systems for roots and tubers in the communities surveyed.

- The non-existence of well developed processing and preservation technologies impeded the expansion of production.

- The lack of appropriate production implements and facilities for on-farm post-harvest handling promotes post-harvest losses.

- There was a limited number of food products from root crops.

A 1990 survey of 69 yam producers in the Fako Division (the major yam producing division) concluded that:

- Yam production in Fako is largely a male activity (84%)
- Sixty-six percent of the farmers sold their yam to wholesalers or consumers in the market while 31 percent sold from their homes and only three percent at the farm gate.

- Yam farm size averaged 0.42 hectares.
- The bulk of labor was from the family.
- The distribution was 45%, 39%, and 15% for food, sale, and seeds respectively.

A variability analysis showed that yam production was profitable:

- Profit for the general system $400
- Profit for the tapping system (double harvesting) $725
- Profit for the non-tapping system $125

Analysis of market structure indicated a degree of competition which prevented monopolistic practices. It found very little barriers of entry and a relative specialization in yam marketing. Analysis of market conduct showed rural markets as the main supply places for traders.

Also in 1990, the Project conducted a survey of 420 root crop farmers in the South West Province. Two years later a

similar survey (259 interviews) was carried out in the North West Province. General findings were the following:

- The average age of farmers was 42 years in both provinces.
- In the South West area women's participation in farming was 57% compared to 74% in the North West.
- The average number of years in school was 6.7 in the South West and only 3.4 in the North West.
- The percentage of farmers who never attended school in the South West Province was 34 compared to 46 in the North West.
- Mixed farming systems was noted in 86% of the farms in the South West and 77% in the North West; Mono cropping accounted for 12.4% in the South West and 2.1% in the North West; 21% of farmers in the North West used both practices whereas only 1.7% of farmers in the South West used both practices.
- Sources of information (new technology) generally were from family members for those in the South West Province. In the North West almost 90% of information came from friends.
- Losses due to root rot in the South West were estimated at 36% and 22% in the North West.

Both Provinces expressed the same obstacles to production (in priority order): disease and pests, insufficient labor, scarcity of planting material, and lack of capital. Various studies completed on post-harvest issues are shown in Attachment II.

One other priority the project wanted to accomplish was in the area of post harvest losses, storage, processing and utilization of food crops. The project intended to utilize the expertise of its two returned long-term participants with M.Sc. and Ph.D. degrees in Food Technology. These participants were expected to utilize their expertise and experience in the improve-ment and processing, handling and storage of roots and tubers. However, the project did not succeed in addressing the various constraints and capitalizing on opportunities in these areas as additional funding for this component was not made available.

Objective 4: Assist in the institutional development of IRA in root and tuber crops research.

Status: The Institute of Agronomic Research (IRA) was created in 1974 and is one of the five specialized research institutes in the Ministry of Scientific and Technical Research. It has six research centers, 16 stations and 29 sub-stations or Antennas spread throughout the diverse ecological zones of Cameroon. The headquarters is at Nkolbisson on the outskirts of

Yaounde. IRA conducts research on both cash and food crops, with particular emphasis on the cereal, roots and tuber crops.

Human resource development was essential for the successful development of IRA. As noted above, ROTREP actively pursued human resource development by providing three main types of training for researchers: in-country or on-the-job training, out-of-country non-degree training, and degree-related training. In 1979, IRA had three researchers in its roots and tuber research Program, one Cameroonian agronomist and two expatriates. By the end of 1994, IRA had 24 Cameroonian researchers. Of these, 10 work with ROTREP. In terms of sponsorship of degree training, the GRC sponsored 11 individuals, IDRC three, the Gatsby Charitable Foundation one, USAID/ROTREP seven, and CIP two.

A major responsibility of the UMES/FAMU/AAMU technical assistance staff assigned to ROTREP was to provide on-the-job training to counterpart national scientists and research technicians. The skills of national staff were constantly upgraded as they planned, executed, and analyzed the results of field experiments with the expatriate researchers. ROTREP management adopted a policy of requiring expatriate staff to prepare joint scientific publications with their counterpart staff.

The knowledge and capability of technicians was also upgraded by such informal training.

In addition to informal training activities, the short-term courses were designed to develop special research skills of national scientists and technicians. This training involved structured, intense training within a defined curriculum.

Due to the active human resources development component of the project, the objective/output to develop Cameroonian staffed institutional capacity to conduct applied national roots and tuber research programs has been accomplished. By the end of 1995, there will be a qualified, competent core staff of researchers in Cameroon to conduct roots and tuber research without the assistance of long-term expatriates.

IRA had limited infrastructure before ROTREP was established. Due to the project, Cameroon now has a fully equipped, operational biotechnology/tissue culture laboratory (J.P. Johnson Biotechnology Laboratory), two green houses, two screenhouses, two growth rooms and 25 hectares of land at the Ekona Research Center has been prepared for plant collection and field trails. A computer resource room with 11 computers has been established, as well as a radio communication instrument, fascimile and telephone communications. Overall, the Project has created a more conducive research environment for efficient and productive research programs.

Overall Status/Accomplishments of ROTREP

As noted by various assessments including the legacy and impact assessment of USAID/Cameroon's agricultural and natural resources program, ROTREP is succeeding in fulfilling its objectives. As of the project assistance completion date on November 31, 1994, the development of a cocoyam variety resistant to the root rot disease has not been developed. Nevertheless, the production of cassava and cocoyams, the main root and tuber crops, has increased. It is reasonable to suggest that the release of improved cultivars and recommended cultural techniques have played a part in this increase. At least 15 improved clones of root and tuber crops have been released to growers. Standard cultural practices for growing root and tuber crops have been produced and transferred to farmers in the form of technical bulletins, minikit packages, and field-level demonstrations.

The total value of root and tuber crops has also increased. Estimates indicate an annual increase of 856% for potatoes and 360% increase for cocoyams. Adoption of new material generally increased farmers' sales by 31% for cassava and 43% for sweet potatoes. Total consumption has increased by almost 6% for cassava and 37% for sweet potatoes. The development of feasible seedstock multiplication systems for cassava, cocoyams, and yams is practically achieved and is only awaiting application.

In terms of institutional development, the training of Cameroonian researchers will lead to Cameroon's root and tuber research program being managed predominantly by Cameroonians. ROTREP, apart from contributing substantially to human development, has provided the J.P Johnson Biotechnology Laboratory which can be cited as a particular achievement. It is a center of excellence which can be used by Cameroonians and researchers from neighboring countries to develop new techno-logies for not only roots and tubers but other crops as well. Long-term linkages have been established with many research institutions, e.g. IITA, CIP, CORAF, CIRAD and of course the three universities associated with ROTREP. In order to assist

the GRC in prioritizing its research efforts on root and tuber crops, ROTREP has defined the principal themes and crops that should be focused on. The themes include breeding for disease and pest resistance, rapid seedstock multiplication system, post-harvest technology studies, and marketing research. The project has left behind an important research impact and a capacity to carry on research. However, the down side of this success will be that this ROTREP-created capacity is 'housed' in an inappropriate institutional model which is cumbersome and costly. During the past two years, the United Nations/FAO and World Bank have been collaborating with other donors (including USAID) on the restructuring of agricultural research in Cameroon. They are now at very advanced stages of negotiating with the GRC. If this effort succeeds, IRA and the Institut de recherche zootechnique et veterinaire (IRZV) will be merged and reduced. The new research institute will function as an autonomous structure with its own Board of Governors. It will have as one of its goals, partial self-financing including possibly an independent research foundation. If restructuring efforts succeed, the capacity that USAID has built up will be put to good use for Cameroon and West and Central Africa. If it does not come to pass, the capacity may be greatly reduced and some of it totally lost. The younger (essentially the USAID trained personnel) and better trained researchers may leave or seek out regional and international research activities and continue their professional growth. However, these research activities may or may not be priority areas for Cameroon. The national research capacity of the country could dissipate.

Due in part to the accomplishments of the USAID funded research activities, Cameroon has been placed by AID in the first tier of countries designated as technology-producing. These countries meet the criteria of surface area cultivated in foodcrops; a minimum of 100 scientists on the research staff; developed
station facilities; a prioritized research agenda; network participation; a history of national support of the research budget; and a faculty of agriculture with the ability to teach, do research, and produce B.S. degree candidates qualified to do advanced degree training in the United States.

These factors continue to hold true today in Cameroon, with the major exceptions of a reduced level of national support for research and research priorities that are still unclear.

Because of the relative advantages Cameroon possesses that gives strong hope for the development of agricultural technologies, perhaps donor commitment to research programs should be long term, 15-20 years or more. However, this position needs to be balanced with the country's commitment of

budgetary support. With the termination of the ROTREP Project, the main constraint to continuing the research effort started by ROTREP will be lack of research funds. One area the project has focussed on is teaching researchers to develop good, solid research proposals to attract research grants. Sustainability of the J.P Johnson Laboratory will require producing and marketing in vitro plants of cassava, yams, banana, plantains for all scales of growers. Another possibility is for the laboratory to be a repository of germplasm material and charge fees to various institutions for its use and the training of students.

13. LESSONS LEARNED:

a. Sustainable development in Cameroon and other African countries will require the increased use of profitable and sustainable agricultural technologies that help farmers, processors, marketing agents, and policy makers to address on-and off-farm constraints and to accelerate transformation.

b. The flow of technology to and within Africa to meet future needs will require an enabling environment which would involve: (1) reforming research and policy institutions; (2) creating financially sustainable funding mechanisms; and (3) developing and sustaining human resources capacity.

c. Successful institutional development is a long-term endeavor which requires a comprehensive approach, a high-level commitment by all parties, flexibility, patience, plus a willingness and ability to adjust appropriately to changing conditions.

The approach followed in project design and implementation, as well as the significant accomplishments of the project, reflected many of these attributes of successful institutional development. USAID invested heavily in developing the human and infra-structure capacity for the Cameroon national research system. However, other key aspects of institutional development were not sufficiently pursued. USAID's investment has created a large cadre of trained researchers who have returned to an institution that is unable to fully utilize their skills and realize their potentials because of the lack of a sustainable financial and institutional base.

The project may not have been integrated within the IRA structure to the extent desirable. As a result, many of the management improvements (budgeting, inventory

and commodity control, prioritization and evaluation of research) have not been fully institutionalized. In addition, when the budgetary contribution of the GRC for operating costs other than personnel was greatly reduced, the project adjusted inappropriately by covering nearly all operational costs without consideration for the impact of this on long-range sustainability. Conditionality should have been negotiated with the GRC to implement institutional reform and develop a viable long-range program to ensure financial viability.

d. USAID leadership in all aspects of IRA's institutional development would undoubtedly have led to greater program impact plus improved the prospects for both program and institutional sustainability.

Despite the impressive project contributions in human resource, infrastructure and technical program development, as well as some management systems improvement, the project did not adequately seek to address the broader institutional issues (priority setting, down sizing of the institute, diversification of funding, and resource accountability).

Although other donors are beginning to address some of these issues through a major World Bank led restruc-turing of agricultural research, USAID missed a unique opportunity to use its influence through both the NCRE and Roots and Tubers Research projects as both leverage and vehicles for IRA institutional change.

e. The large benefits of networking and linkages have been well demonstrated in USAID's agricultural research program.

Through "intelligent borrowing", plant breeding periods were reduced, with corresponding reductions in cost. This process includes screening, selecting, and adapting existing technologies to local conditions as opposed to generating it anew or simply borrowing technology wholesale. It also involves the development of linkages with other institutions in and outside the country. USAID supported research worked with several external organizations to borrow and adapt technology, then worked with several more to test and disseminate it.

f. Effective donor coordination at both the sector and sub-sector levels is crucial for achieving maximum program impact and program/institutional sustainability.

A large number of multilateral and bilateral donor organizations provide support to Cameroon's agricultural sector development. Donors share many developmental objectives (i.e., food security, economic growth, sustainable resource management) despite their differences in developmental approaches and available resource levels. Despite the obvious advantages of maintaining open dialogue and close coordination of donor-funded programs, donor coordination in Cameroon at times appears both ad hoc and only marginally effective. For the most part, donor coordination has been focussed on sub-sector issues (agricultural research, environment) and has failed to address the broader sector issues within the economic and political context of Cameroon (note: the World Bank has been meeting with a limited number of donors to design an agricultural sector structural adjustment program). Despite the crucial interlinkages between sub-sector issues, programs and institutions (research, higher education, policy, private sector development, environment), no donor forum has focused on how to effectively program and adjust development activities within the crisis environment faced by Cameroon.

g. USAID recognized the important "regional role" that both IRA and the University of Dschang could play in regional development and collaborated closely with the GRC and other donors in creating "research and educational centers of excellence". The levels of resources which were provided and the research and educational capacities which were created clearly reflected this regional role. Unfortunately, the comprehensive approach required for long-range "institutional development" and for achieving "institutional and program sustainability" did not take this adequately into consideration. The current agricultural sector institutional crisis in Cameroon, including both IRA and the University of Dschang, unless addressed soon could have serious implications for not only Cameroon but for other neighboring countries' developmental efforts as well. For both

national institutions and for those with a regional role, USAID needs to identify more realistic strategies to ensure institutional and program sustainability despite national-level political and/or economic crisis, if USAID investments are to be protected and usefully employed.

14. Recommendations

In order to insure continuity and sustainability of the research effort initiated by ROTREP, GRC should explore the following alternatives:

1. Commercialization of the rapid seed stock multiplication unit. The unit has the capacity of producing considerable amounts of yamseeds for which there apparently exists a good market. The unit can also produce seeds for cassava, plantain bananas and rubber trees for which there also exist potential markets. The production capacity of the unit has largely been increased by the two growth rooms and the two screen houses provided by ROTREP. However, there is a need to carry out a feasibility study to establish the economic feasibility and profitability of the unit, and compare the results with those of other alternative techniques, such as the miniset technique for yam. Production costs are presently high due to the small scale of operation and to the high cost of scientists' labor. An increased scale of operation and replacement of scientists labor by technicians labor are likely to bring production costs down and make the unit more profitable.

Other commercialization possibilities should also be explored, such as the previously mentioned possibility of using the unit as a repository for germplasm material and for training.

2. IITA involvement. IITA, the International Institute of Tropical Agriculture, detains the mandate for cocoyam research in Africa. However, it has stopped doing research on the crop for several years. With the Cameroon research institute taking the leadership in cocoyam research in the region, it should be able to receive some financial and technical backstop support from IITA which is mandated by the CGIAR system to conduct research on the crop. Also, as part of the upcoming CG system reform that calls for a strengthening of the NARS by the IARCs and for more IARC governance responsibility to the NARS, the Cameroon NARS should be able to request and obtain more support from IITA to sustain the cocoyam research initiated by ROTREP. The biotechnology laboratory of IITA could also provide technical assistance to the seedstock multiplication unit. IITA is reinforcing its presence in Cameroon with its new acid soils station and this should reinforce the IITA-IRA collaboration.

3. Regional collaborative research and SAATS. The research efforts initiated by ROTREP could also be sustained to some extent through regional collaborative research efforts in the region, if these are extended to cocoyam. Given the ecoregional and pole initiatives, Cameroon may become the

research pole for cocoyam in West and Central Africa. With sufficient evidence of the importance of cocoyam for food security in the region, cocoyam may be considered as a commodity to include in the SAATS (Sustainable African Agricultural Technology Systems) project being designed by USAID. For this alternative to be realized, IRA will have to propose and defend the idea in upcoming regional collaborative research meetings.

4. A cocoyam CRSP. Another way the ROTREP research effort could be sustained is through the Collaborative Research Support Project (CRSP) funded by USAID through cooperative agreements with US universities. If USAID continues to support the CRSPs, initiating a cocoyam CRSP may be one way of sustaining the research effort and maintain a linkage with UMES.

5. Support from other donors and institutions. Other donors and institutions would probably be willing to provide financial and technical assistance to IRA to pursue the ROTREP research effort if IRA could come up with adequate research proposals. It has been mentioned that some of IRA staff have received a training for writing research proposals; a training that was organized by the International Sciences Foundation. Observers in Cameroon feel that the French CIRAD, which is very active in Cameroon, is very much likely to take over the ROTREP research effort following the termination of USAID assistance.

6. Budgetary support. Research results in the case of ROTREP are mostly public goods. Thus, even if funds become available from any of the above mentioned sources, there will still be a need for GRC to provide IRA with a budgetary support, to at least guarantee a minimum and sustained flow of inputs/supplies, including labor, to maintain the equipments and insure a minimum level of sovereignty research.

7. Institutional reform of agricultural research. Most of the proposed alternatives may not be effective within the current institutional model of agricultural research in Cameroon. Therefore, GRC must be encouraged to restructure agricultural research in Cameroon so as to make it more efficient, relatively less dependent on government funds and more self-sustainable through alternative funding mechanisms, such as Foundations, check-off systems, etc. The on-going negotiations between GRC, FAO and the World bank for a structural adjustment of agricultural research in Cameroon need to be encouraged.

15. SELECTED REFERENCE DOCUMENTS:

a. University of Maryland Eastern Shore - School of Agricultural Sciences, "Tropical Root and Tuber Research Project (ROTREP) - Activity Report on ROTREP Extention, January 1992 through November 1994".

b. Acquah, Emmanuel T. and Simon N. Lyonga. "Tropical Roots & Tubers Research Project (ROTREP), Internal Review of ROTREP", June 1994.

c. Hartmann, Peter A. and Peter W. Wyeth. "The Legacy and Impact of USAID/Cameroon's Agricultural and Natural Resources Programs". April 1994.

d. Mid-Term External Evaluation of the Cameroon Tropical Roots and Tubers Research Project (631-0058). September 1989.

e. Tropical Roots and Tubers Research Project Cooperative Agreement. Approved August 29, 1986.

Cameroon Mission Clearance of Preliminary Draft

CONT: RJacobs (signed) Date (none)
PMPD: NMinka (signed) Date 7/12/94
ADIR: RHarvey (signed) Date 7/21/94

ARD: PMbianyor/EWashington:cea:5/28/94 Doc. PCRROOT2
JMcMahon (signed) Date 7/11/94

REDSO/WCA Clearance of Final Draft

DIR: WPearson _____ Date _____
CONT: TFallon _____ Date _____
ADIR: SKReddy _____ Date _____
PO: YCPrudencio _____ Date _____

. Attachments
(see list below)

ATTACHMENTS (ROTREP PACR)

1. USAID Cameroon Action Memorandum to propose REDSO/WCA management of ROTREP.

2. USAID Cameroon Contractor/Grantee Evaluations

3. REDSO/WCA Trip Report to Cameroon, by Y. C. Prudencio to assess status of ROTREP, Oct 6-12, 1994.

4. UMES Memorandum of Jan 11, 1995, with list of various reports

5. Transfer of titles/commodities signed by IRA officials

6. Complete list of commodities transferred to IRA.

7. Waybill for last shipment of commodities to ROTREP from USA.

8. List of ROTREP reports and Publications.

9. Letter from BICIC attesting to closure of ROTREP accounts

10. Copies of severance letters for various ROTREP workers.

11. Reception report on construction of run-off, evacuation gutters and landscaping of the screenhouses.

12. E-mai Response of IRA (Dr Ayuk-Takem) to REDSO/WCA (Y.C. Prudencio) on status of ROTREP close-out activities.

13. Shipment Reference of ROTREP Core files from USAID - Cameroon to REDSO/WCA.

14. Terminal Report Memorandum from UMES, Feb 27, 1995.

15. ROTREP vouchers (2) submitted to REDSO/WCA for approval

16. Final Financial Report of ROTREP, March 1, 1995.

17. Final Grantee Report, including:

(a) Mid-Term External Evaluation Report

(b) Proposal for Extension of Research Activities based on the mid-term evaluation.

(c) Activity Report of Field Work between February 1992 and November 1994.

(d) Internal Review Report which summarizes the Scope of Work and Accomplishments for the period August 1986 through November 1994.

Attachment 8.A

Project Assistance Completion Report
Tropical Roots And Tubers Research Project

List of Major Studies and Analyses

1. A Diagnostic Survey on Post Harvest (storage, processing and utilization) Problems and Opportunities of Yam, Cocoyam and Cassava. 1988.

2. Market Demand Study for Root and Tuber Crops in Cameroon. 1991.

3. A Paper on Economics of Research and Development of Rapid Seed Multiplication of Cocoyam Through Tissue Culture. 1989.

4. Technical Reports on the Economics of Rapid Seed Multiplication of Cocoyam Through Tissue Culture. 1989.

5. A Report on Economics of Rapid Seed Multiplication of Cassava Through Tissue Culture.

6. Technical Report on Cost Function Analysis of Mass Production of Tissue Culture, Seedyam, Cocoyam and Cassava Plantlets. 1992.

7. A Report on Productivity Analysis of Small-Holder Yam Production in Fako Division: A Case Study of Bonakanda and Malende Zones. 1990.

8. A Data Base for Production of Root Crop Based Farming Systems in Fako Division of Cameroon. A total of 14 localities with a sample size of 420 root crop farmers were involved in the study. The final report was produced in 1992.

9. A Data Base for Production of Root Crop Based Farming Systems in North-West Province of

Cameroon. A total of 300 root crop farmers from 10 localities were involved in the study. The final report was completed in 1992.

10. A Data Base for Production of Root Crop Based Farming Systems in West Province of Cameroon. A total of 259 root crop farmers from 9 localities were involved in the study. The final report was completed in 1993.

11. Littoral Province: A Survey on Productivity Analysis of Root Crop Farming System in Littoral was completed in May 1993. A total of 7 localities with 150 farmers participated in the study. The final report will be completed by September, 1994.

12. A Technical Report on the Estimation of Yam Production Function of Small Holder Farmers in Cameroon. 1989.

13. A Report on Root and Tuber Crop Market Survey: Observation from Fako Division. 1989.

14. A Technical Report on Economics of Ware Yam Production in Bonakanda Farming Systems. 1989.

15. A Report on An Analysis of the Structure, Conduct and Performance of Yam Marketing Systems in Fako Division of Cameroon. 1990.

16. A Report on "Macabo Root Rot Disease: Knowledge, Occurrence and Incidence in Cameroon. 1990.