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MIDTERM EVALUATION OF REDSO/ESA'S GRANT TO THE INTERNATIONAL POTATO CENTER (CIP) FOR THE CIP/PRAPAC POTATO NETWORK RESEARCH PROJECT (698-0435.04)

Table of Contents

Page #

I. List of Acronyms.....

II. Executive Summary.....1

III. Evaluation Team Composition and Methodology.....7

IV. Introduction to the Project.....8

V. The Project Purpose.... 12

VI. Issues to be Addressed in the Evaluation.....12

A. Immediate Operational Needs.....12

B. Future Programming Requirements.....13

VII. Economic, Political, and Social Context of the Project.....13

A. Importance of potatoes in the cropping systems, rural diet, and household economy in the member countries.....13

B. Policy framework -- priority given to research on potatoes by the NARS.....14

C. Unequal strength and maturity of the national potato programs.....14

D. Other barriers to international collaboration.....15

E. Linkages between potato research, seed multiplication agencies, development programs, and extension.....15

VIII. Progress towards Achieving Project Outputs.....17

A. Development of potato varieties resistant to bacterial wilt and late blight.....17

B. Development of viable potato production technology.....20

C. Development and transfer to farmers of economically viable and locally tested post-harvest storage technologies.....22

D. Development of simple rapid multiplication techniques to facilitate transfer of clean seed.....24

E. Development and use of monitoring techniques.....25

F. Delivery of in-service training.....27

G. Effectiveness of the regional network.....31

Page #

IX. Adequacy of Input Delivery, Management, & Sustainability.....33

A. PRAPAC.....33
B. CIP.....34
C. Host Country Collaborating Institutions.....35
D. REDSO/ESA.....36
E. USAID Missions.....36
F. Other Donors.....37
G. Status of Financial Inputs.....37

X. Progress towards Achievement of the Project Purpose.....42

XI. Recommendations.....42

A. For PRAPAC through End of the Grant.....42
B. For REDSO/ESA.....47
1. Through End of the Grant.....47
2. For the Longer Term.....48
C. For CIP through End of the Grant.....49
D. For Host Country Collaborating Institutions through End of the Grant.....50
E. For USAID Missions through End of the Grant.....51

XII. Lessons Learned Applicable to the Design & Implementation of Similar Projects.....52

Appendixes:

A. Evaluation Scope of Work
B. List of Persons Contacted
C. Bibliography of Sources Consulted
D. Technical Tables
E. True Potato Seed
F. The Uganda National Potato Research Program

I. ACRONYMS

CIP	International Potato Center (Lima)
CVHA	Food Crop Culture for High Altitudes (Burundi)
IPM	Integrated Pest Management
ISABU	Burundi Agricultural Science Institute
ISAR	Rwanda Agricultural Science Institute
INERA	National Agricultural Research and Study Institute (Zaire)
NARS	National Agricultural Research Systems
ODA	Overseas Development Administration (United Kingdom)
PNAP	National Potato Improvement Program (Rwanda)
PRAPAC	Regional Potato Culture Improvement Program
REDSO/ESA	A.I.D. Regional Economic Development Services Office for East and Southern Africa
SPAAR	Special Programs for African Agricultural Research (an international multi-donor funding program under the aegis of the World Bank)
SSS	Selected Seed Service (Rwanda)
TPS	True Potato Seed
T/Ha	Tons per hectare
USAID	U.S. Agency for International Development

II. Executive Summary

A. Development Objectives of the Activity Evaluated

In February 1986, REDSO/ESA awarded a five year $1.557 million grant to the International Potato Center (CIP) to continue and expand a potato improvement research network (known as PRAPAC) which encompassed Rwanda, Burundi, and Zaire. An additional $251,100 was provided for activities in Rwanda by the USAID/Rwanda Farming Systems Research Project, and USAID/Burundi provided $377,000 from the Basic Food Crops Project and $313,000 equivalent in P.L. 480 local currency generations for Burundi national potato research. In 1987, Uganda joined the network.

B. Purpose of the Evaluation

The present March 14 - April 2, 1989 mid-term evaluation was conducted at the end of year three of the grant, by a five-person team led by a REDSO/ESA Project Development Officer, and an independent technical consultant, with two representatives from CIP (the retired director of research, and the current regional economist) and a REDSO/ESA agronomist. The team was tasked with the investigation of both immediate operational needs of the network, and its future programming requirements (see the evaluation scope of work in Appendix A). Immediate operational needs involved current project management arrangements, and the quality of regional potato research and collaboration. An assessment of PRAPAC's sustainability in terms of financial, institutional, socio-economic, and environmental concerns was also required. The capability of national research programs and their links with other institutions responsible for conveying inputs and technologies to farmers were also investigated. Future programming requirements included the adequacy of present funding, the duration of the grant, and concerns related to a decision on whether a follow-up Phase II grant should be considered by REDSO/ESA. In reviewing prospects for the future, the needs for future funding for the four national research programs were considered, and discussed with the three USAID Missions in the east Africa region.

C. Evaluation Methodology

To investigate these issues, the full team traveled to Burundi, Rwanda, and Zaire to interview CIP personnel, the PRAPAC coordinator, national research directors, potato researchers, and farmers participating in on-farm trials. The full team also conducted interviews at the Muguga quarantine station in Kenya and the Kenya Agricultural Research Institute, as these facilities support PRAPAC. Due to plane cancellations, plans for the full teams' field-work in Uganda had to be cancelled. The main body of the report was drafted by the full team, and its recommendations were reviewed with all four countries' national research directors, CIP, and REDSO, in a debriefing on April 1, 1989. The three team members resident in Nairobi traveled to Uganda on April 5-7, 1989 to interview national research staff and Makerere University researchers; their findings on the Uganda program are reported in Appendix F, and their recommendations are integrated with other recommendations in the main evaluation report.

D. Findings and Conclusions

High rural population densities are forcing farmers into the higher elevations where potatoes are well adapted and highly productive, and where there are few alternative crops. Potatoes are also an important cash crop in the internal urban markets of PRAPAC countries.

The four national potato research programs have unequal strength, sophistication, and financial support. Rwanda currently has the largest and strongest program in the region. Though active, Burundi's program has relied on expatriate CIP advisors' leadership since 1983. Zaire's program has been limited by lack of local funding, thus its facilities in the southern Kivu province are very under-utilized. Uganda has a the largest cadre of trained researchers available for national potato research, of the four countries, but the program is only now being re-established as part of post-war reconstruction; foreign exchange limitations have blocked the rehabilitation of necessary research facilities, and a stable stream of local currency has not been established for operational costs. The network can foster increased sharing of scientific results, particularly between Rwanda and Burundi.

Some progress has been made towards achievement of the project purpose, as the small number of potato scientists is being used more efficiently. Research progress is evident in such areas as: development and dissemination of improved varieties resistant to major diseases (Late Blight and Bacterial Wilt); rapid seed multiplication techniques; production of clean seed; diffused light stores for seed both on-station and on-farm; ware potato storage; integrated pest management; use of repellant plants in stores; and dormancy breaking. It was difficult, however, to separate the impact of PRAPAC from the impact of CIP and/or other support for national potato research programs. Detailed technical findings and conclusions applicable to future research are presented in Section VIII of the main evaluation report, and in Appendix F.

Interaction between research and extension is weak in all PRAPAC countries, and linkage with agencies responsible for seed multiplication and distribution must also be strengthened. It has proved difficult to institutionalize regular socio-economic data collection and monitoring in PRAPAC member countries; an on-going process of socio-economic research would better focus research on farmers' needs.

PRAPAC is doing a good job of organizing workshops and providing short-term training to member countries' scientists. Now that the grant-funded training center in Ruhengeri, Rwanda, has been completed, PRAPAC will need to work with the Rwanda Institute for Agricultural Research (ISAR) to program the use of this facility, its administrative support, and maintenance. In reviewing the effectiveness of the network, the team noted, however, that scope exists for improving the flow of ideas and technologies among PRAPAC members, including the mechanisms for the sharing of information.

Responsibility for the delivery of inputs is divided between PRAPAC, CIP, REDSO/ESA, USAID Missions, host country collaborating institutions, and other donors. Details specific to each source are presented in Section IX of the evaluation report, but a few findings are worth highlighting in this summary. During the first three years of project implementation, much of the PRAPAC Coordinator's time was spent on managing construction of the training center and his adjacent residence. As a result, he has been able to offer relatively little technical assistance to national potato research programs in the network. Assembling additional support from other donors to supplement A.I.D.'s resources for work in Zaire and Uganda will require initiative from CIP. In Burundi, Belgian cooperation and ODA already support technical assistance; future local cost support for Burundi's potato research will also be provided by Belgium. Establishment of

PRAPAC as an entity distinct from CIP requires additional attention; this would be enhanced by development of a formal mechanism for quantifying member states' annual in-kind or cash contributions to PRAPAC activities.

There is a critical need for additional funding for the national research programs in Zaire and Uganda. Though less critical, resources for the Burundi and Rwanda programs will need to be monitored over time, especially if research in Rwanda is to expand into the screening of lower elevation disease-resistant varieties. Increased emphasis on collaborative monitoring by REDSO/ESA and the USAID Missions' Agricultural Officers could set the stage for the integration of national potato research support into future Mission budgets, and consideration of future bilateral support for PRAPAC. The USAID Missions in Rwanda, Burundi, and Uganda are all undertaking bilateral agriculture research project design and/or redesign activities or long-term research planning in the coming months that would serve as appropriate fora for the consideration of national potato research funding needs. The overall status of grant finances was reviewed; a budget revision will be needed soon to cover expected short-falls in the line items for the Coordinator's salary, services, and supplies. Bridge funding will also be needed to maintain the momentum of PRAPAC activities for an additional 8 months through the September 1992 end of A.I.D.'s centrally funded SAARFA Project (the central funding source for Africa agricultural research and support to faculties of agriculture). The $188,000 reserved for contingencies in the grant budget can be reprogrammed for these purposes.

E. Recommendations

A total of 37 recommendations are proposed; they are presented by action agent in Section XII of the main report, but they are not ranked by priority order. The recommendations are divided by those to be undertaken before the end of the grant in February 1991, versus those which apply to the longer term.

In summary, recommendations addressed to PRAPAC are designed to use research resources more efficiently and to strengthen research collaboration, monitoring, and reporting. Technical re-orientation is also suggested on some fronts, e.g. the re-initiation of true potato seed research, the screening of R-gene free germplasm for blight resistance, a study of the long-term viability of fungicide use for the control of Late Blight, use of an integrated pest and disease control framework, and evaluation of the viability of mid-elevation potato production. A number of recommendations are also designed to help PRAPAC use the Coordinator more effectively,

by freeing up his time from administrative tasks, and setting clearer priorities for the use of his time for country-specific technical assistance, especially for Uganda. Other recommendations are designed to help establish PRAPAC as an entity distinct from CIP, e.g. establishing a mechanism to detail member states' annual cash and in-kind contributions to network activities, establishing a plan and schedule for moving a national scientist into the Coordinator's position, having CIP staff submit reports to PRAPAC on each consultation, and pairing national scientists with consultants for joint work in the region whenever possible. It is also recommended that the collection and monitoring of socio-economic baseline data receive much more emphasis in the network, with a workshop on the standardization of methodologies as a first step. Another recommendation highlights the need for PRAPAC to improve linkages between potato research and the agencies responsible for seed bulking and distribution, and extension. Finally, consideration should be given to expanding the network, though this would require additional outside funding, as existing resources should not be diluted for this purpose.

Recommendations for action by REDSO/ESA through end of the grant are focussed on the need to improve mechanisms for consultation and joint planning with USAID Missions, including use of the bi-ennual A.I.D. Agricultural Development Officers' Conference to this end, and the need to find funding for the national programs in Zaire and Uganda through re-opening dialogue with USAID/Kinshasa and formalizing financial plans with USAID/Kampala. For the longer term, REDSO should assess the availability of funding for a Phase II of PRAPAC activities, and the feasibility and cost-effectiveness of alternative ways of funding central African potato research, studies, and training. These alternatives might include one or more of the following options: support for workshops through regional or bilateral grants to CIP; bilaterally funded external degree training; bilateral local currency support for national potato research; and/or all four bilateral missions contributing to a joint PRAPAC grant budget. If a Phase II regional grant to PRAPAC seems advisable and feasible, use of a buy-in mechanism for USAID Mission contributions would simplify and concentrate financial management at the regional level.

A number of recommendations are addressed to CIP, for action by end of the grant. First, CIP should prepare a proposed budget revision for submission to REDSO which programs the $188,000 contingency line item to meet expected short-falls and to provide bridge funding through September 1992. In this budget proposal, funds should be programmed to procure a micro-computer and software for each collaborating national program. CIP should solicit additional outside funds to

support a resident CIP scientist, with a vehicle and operating budget, to be seconded to INERA for potato research in Kivu, Zaire. Finally, CIP should explore the interest of A.I.D. and other donors in funding the continuation of PRAPAC activities after the termination of the current grant.

It is further recommended that all host country collaborating institutions assess their long-term external degree training needs, and propose candidates to appropriate donors including USAID Missions.

A number of recommendations are addressed to the Uganda Ministry of Agriculture for action, to incorporate potato research into the 5-year national research plan now being prepared with USAID Mission assistance, to streamline logistics by consolidating national coordination on the Kawanda research station, and to draw on Makerere University personnel to conduct a socio-economic baseline study of potato farmers and consumers.

Finally, recommendations specific to bilateral USAID Missions are presented. The Missions in Rwanda, Burundi, and Uganda should all consider funding external degrees for potato researchers under their separate bilateral training projects. USAID/Kampala should consider programming at least $25,000 for immediate foreign exchange needs plus local currencies for Ugandan potato research. USAID/Zaire should consider funding the local costs of potato research in the Kivu through PRAPAC. USAID/Burundi should consider incorporating studies on potato (e.g. marketing) and support for potato research into its redesign of the Farming Systems Research Project and/or the design of its new Agricultural Marketing Reform Program. USAID/Rwanda should consider using A.I.D. project development and support funds to commission a study on the current and potential importance of potato as input to the FY 90 design of its new Agricultural Research Project.

F. Lessons Learned

A number of lessons were learned which are applicable to the future design and implementation of similar activities. First, a network is only as strong as its weakest link, and networking cannot substitute for the development of national research programs. To build up national programs to a level where networking can be effective requires support for long term degree training and the local costs of national research programs. Secondly, links between research and extension need to be improved for research network investments to have impact. Further, for commodity research networks, special attention needs to be paid to the improvement of seed

multiplication and distribution services. Third, agricultural research is a long-term process, and dramatic results at the farm level cannot be expected within the first few years. During the early years of a network, its Coordinator should be able to devote full time to creating an atmosphere conducive to cooperation among the collaborating countries. Though ideal, it is difficult to recruit a Coordinator with both technical science and administrative (e.g. funds negotiation) skills. If major construction is necessary, a competent local engineer should be hired by the grantee to manage this construction to avoid inefficient use of scientists' time. Finally, many of the benefits of networking are much more difficult to measure than the discrete outputs provided by other kinds of development projects.

III. Evaluation Team Composition and Methodology

The evaluation team was made up of five members:

Deborah Prindle
Team Leader
REDSO/ESA Project Development Officer

Nigel Smith
Technical Team Leader
Professor of Geography
University of Florida

Peter T. Ewell
Coordinator of Social Science Research
International Potato Center (CIP),
Region III (Nairobi)

Orville Page
Former Director of Research of the
International Potato Center (retired)

K.B. Paul
REDSO/ESA Agricultural Development Officer

The team convened in Bujumbura, Burundi, on March 15, 1989, for team building sessions with Monica Sinding, Deputy Director of REDSO, and Dr. Sylvester Nganga, Regional Director of CIP.

From March 16 - March 31, 1989, the full team conducted interviews with the leaders of the national agricultural research programs, potato researchers, and farmers in three of the four countries in the network (Rwanda, Burundi and Zaire) and in Kenya. Staff from PRAPAC, CIP, REDSO, and the country missions of USAID, and some other donors were also interviewed.

On April 1, the team met in Nairobi with the directors of the four national agricultural research institutes of all four PRAPAC member countries to debrief them on findings and recommendations, and to hear their suggestions about how best to strengthen potato research in central Africa.

Two cancelled flights made it impossible for the full team to visit the fourth country, Uganda, as scheduled; information gathered on a separate (April 5-7, 1989) trip by the three team members resident in Nairobi is summarized in Appendix F. Relevant recommendations have been integrated into Section IX of the main report.

IV. Introduction to the Project

Potatoes (*Solanum tuberosum*) are an important crop in the highlands of Central Africa in areas above 1800 meters on both slopes of the Zaire/Nile Divide in Burundi, Rwanda, Eastern Zaire, and Western Uganda. Introduced by European missionaries and colonists starting in the late 19th century. Potatoes are now widely grown by small farmers, both for home consumption and as a high-value crop for sale in national markets. Yields in farmers' fields average from four to seven tons per hectare, well below those achieved in other developing countries such as Mexico (13t/ha) or Bangladesh (12t/ha) and far less than the 30-45t/ha routinely harvested by farmers in the United States or the Netherlands. Nevertheless, central African farmers can obtain more nutritious food and cash income from their small plots of potatoes than from any alternative crop, and in a shorter growing season. High yields have been limited by severe pressure of two major diseases -- "late blight" (*Phytophthora infestans*) and "bacterial wilt" (*Pseudomonas solanacearum*) -- and by a number of other constraints including a lack of appropriate varieties and clean, high-quality seed.

In the years before Rwanda, Burundi, and Zaire gained independence in the early 1960's, Belgian researchers introduced European varieties and carried out experiments on cultural practices. Subsequently, for nearly 20 years after independence, the disease resistance of the available varieties degenerated. In response to farmers' needs, national potato research programs were organized in the early 1980's, with the support of the regional office of the International Potato Center (CIP) in Nairobi. To help establish these research programs, CIP posted scientists from its own staff in Rwanda between 1979 and 1986, and in Burundi from 1983 to the present.

The national research systems of countries in central Africa do not have enough trained scientists or other resources to organize comprehensive programs in isolation. In addition, the agro-ecological conditions and problems of potato production are broadly similar throughout the zone. Following the example of agricultural research networks in other parts of the world, the leaders of the national potato programs of Rwanda, Burundi, and Zaire and representatives of CIP formed PRAPAC ("Programme Regional d'Amelioration de la Culture de la Pomme de Terre") in 1982. Uganda was added to the network in 1987.

The basic objectives of the network are as follows:

- Collaboration and communication between the potato programs of member countries, to avoid, wherever possible, the duplication of research effort;

- The exchange and transfer of technologies and ideas;

- Training of national scientists and technicians; and

- Stimulation of better research through interaction and communication, both between scientists in the member countries and with specialists from other parts of the world.

PRAPAC is an association of national programs; it is not an independent institution in its own right. It is governed by a committee of the directors of the national institutions involved, plus the Regional Director of CIP/Nairobi. Activities are implemented by the Executive Committee of the leaders of the national potato programs, who meet at least twice a year.

Each collaborating program has agreed to take a leadership role for two or three of a total of 9 priority research areas, called "sub-projects" in this report (Table 1). This separation of responsibilities makes sense in terms of the abilities of the national programs and their special interests. Burundi, for example, conducts research on bacterial wilt, a particularly serious problem in that country. Rwanda is responsible for late blight research, since it has the best capability in the region for innovative breeding to incorporate new sources of resistance to the disease.

CIP is responsible for the selection and distribution of promising germplasm through its regional office in Nairobi, and for backstopping research as needed. The Government of Kenya provides facilities for quarantine services at its station in Muguga. CIP also provides training through regional courses and workshops for individuals in Nairobi and at its headquarters in Peru.

The organizers of PRAPAC envisioned that external funding would be required for about ten years to develop and institutionalize an effective regional potato research network. As a first phase, they applied for and received a $1.5 million grant from USAID through REDSO/ESA for five years (1986 - 1991). Additional funds for local costs have been provided by the USAID missions in Rwanda, Burundi, and Uganda. The grant supports a full-time international scientist hired by CIP and posted in Rwanda as the PRAPAC network coordinator. It has also financed the construction of a training center in Ruhengeri, Rwanda, and the costs of coordination. The national potato program in Zaire has never been funded by the USAID mission in that country. The program in Uganda is just now being re-established, as part of post-war reconstruction.

TABLE 1: PRAPAC Potato Research and Training Sub-Projects by Countr

Sub-project	Country	Objectives
Storage of seed and ware Potatoes	Burundi	Find appropriate techniques to store seed and ware potatoes
Study of control of bacterial wilt (*Pseudomonas solanacearum*)	Burundi	Select genetic material resistant to wilt and study agronomic control measures.
Study of control of late blight (*Phytophthora infestans*)	Rwanda	Select genetic material resistant to late blight and study agronomic control measures.
Local training of staff and technicians	Rwanda	Provide short courses for scientists and technicians of PRAPAC countries.
Varietal adaptation of potato to different agro-ecological zones	Zaire	Identify clones suitable for different ecological areas.
Cultural practices in different agro-ecological zones	Zaire	Provide baseline data on potato production systems for design of improved technologies.
Integrated pest management (IPM)	Uganda	Devise IPM strategies suitable suitable for adaptation by PRAPAC countries.
Basic seed production technology	Uganda Rwanda	Produce "clean" (disease-free) material for seed production.
Breeding and germplasm conservation and evaluation	Uganda	Breeding and selection of disease-resistant material and establishment of a gene bank at Kabanyolo.

V. The Project Purpose

The purpose of this project is to provide support to the International Potato Center's (CIP) Program for continuing and expanding a potato improvement research network encompassing Zaire, Rwanda, Uganda, and Burundi. The general goal of the network is more efficient utilization of the relatively few agricultural scientists currently conducting research in Central Africa. The more immediate purpose is to develop and disseminate improved potato varieties and cultural practices specifically adapted to the region.

VI. Issues to be Addressed in the Evaluation

The evaluation team's scope of work (see Appendix A) was prepared by the REDSO/ESA Agricultural Division with CIP concurrence. It includes two types of issues: (a) those related to the project's immediate operational needs, and (b) concerns about future programming requirements. In addition, during the team planning meetings on March 15-16, 1989, the team reviewed a memo from the REDSO Agricultural Officer which listed more detailed and in some cases additional study questions to guide the evaluation.

A. Immediate Operational Needs

First, the project's immediate operational needs called for the team to investigate the adequacy of REDSO and CIP project management arrangements and the quality of regional potato research collaboration and coordination. The sustainability of the PRAPAC potato research network also had to be evaluated on four dimensions: financial, institutional, socio-economic, and environmental. Review of PRAPAC's financial sustainability required an assessment of future needs for host country, A.I.D., and other donor funding. Needs for A.I.D. funding had to be considered in terms of the appropriateness and availability of central, regional and bilateral resources. Questions about PRAPAC's institutional sustainability involved the status of host country scientists' readiness to assume the network coordination function, the extent to which PRAPAC had established an identity distinct from that of CIP, and the ability of PRAPAC to assemble and manage financial resources on its own initiative. The socio-economic factors affecting PRAPAC's sustainability were also a concern, e.g. whether and where potato was an important crop, the extent to which farmers' perceived needs and available resources were setting PRAPAC's research agenda, and other political and economic influences affecting member countries' willingness to collaborate with each other and the impact of PRAPAC activities. Data on these socio-economic factors is essential

for routine project monitoring and project evaluations, but is was not clear whether its collection and analysis was receiving adequate attention from PRAPAC. The environmental sustainability of PRAPAC interventions was also in question, towit, the extent to which its technologies rely upon chemical inputs, and their long term environmental impacts.

The capability of collaborating national potato research programs was another immediate concern, and their linkages with other host country institutions responsible for making available to farmers the improved genetic materials developed by research.

B. Future Programming Requirements:

Major issues that required investigation during the evaluation focussed on funding -- the adequacy of present funding through the end of the grant in February 1991, future funding needs of the four national programs, and the desirability of extending the duration of the grant and/or of planning for a Phase II A.I.D. grant. The question of whether regional potato research should be assigned a priority for future REDSO/ESA resources was a major evaluation issue.

VII. Economic, Political, and Social Context of the Network

A. Importance of potatoes in the cropping systems, rural diet, and household economy in the member countries

The rural population density in the PRAPAC region is the highest in Africa, and is increasing rapidly. As pressure on the land increases, people are moving up into higher elevations where potatoes are well adapted and highly productive, and where there are few alternative crops. In Rwanda, for example, potatoes are the fifth most important food crop in terms of total production, after bananas, sweet potatoes, cassava, and beans (ISAR, 1988). Average per capita consumption is over 50 kilos per year. In the highlands of the north, however, potatoes are the most important food, and per capita consumption is nearly 175 kilos per year (Rwanda, 1988). Similar consumption patterns are found in the homologous areas of the other countries.

Potatoes are also an important cash crop in the internal markets of the PRAPAC countries. In Zaire, potatoes are a high-value luxury vegetable flown into Kinshasa, where the retail price is over ten times what farmers in producing areas receive. In the other countries, the market has spread beyond its historical base in the European population and potatoes are consumed by an expanding share of the population. It has been

estimated that potato producers in Rwanda sell between 35 and 50 percent of their output through local markets. About one percent of total output is exported to Burundi. Burundian farmers sell less -- only about 10 percent of their harvest -- but the market is becoming increasingly important (Scott, 1988).

B. Policy framework -- priority given to research on potatoes by the NARS

In Rwanda, ISAR has given first priority to potatoes in designated high-altitude agro-ecological zones because they are a high-yielding, income-producing crop. In Burundi, ISABU is just developing a system for setting priorities, but the director underscored the growing importance of potatoes as a crop for the internal market. In Zaire, potatoes are one of three food crops given priority for research in Kivu province.

C. Unequal strength and maturity of the national potato programs

A challenge facing the PRAPAC network is the linkage of national research programs of very unequal strength and sophistication. Rwanda has the largest and strongest potato program (PNAP) in the region. Potato research started in 1970 with Belgian assistance. Between 1979 and 1986 research capacity was built up under the leadership of expatriate scientists posted by CIP. Preliminary results raised high expectations. There was a difficult transition as roles changed in PNAP with the departure of expatriate scientists in 1986. The program lost staff, released varieties for which there was not a strong demand, and encountered problems maintaining seed quality. PNAP is now back up to strength with six scientists and ten technicians and carries out research on a full range of topics, but is somewhat short of working space and facilities. The Director has a Ph.D. and wishes to perform a more active role in PRAPAC.

The potato program in Burundi has been led by expatriates posted by CIP since 1983. Currently, one agronomist funded by Belgian cooperation assists with on-station screening and rapid seed multiplication. Another agronomist funded by British ODA works with on-farm research. The program has developed an infrastructure appropriate to the needs of the country including a seed farm, a tissue culture lab, and an integrated system for the production of seed free of bacterial wilt. On-station and on-farm research has been successfully integrated in a number of areas. ISABU's management is gaining more authority over research programs operated by Belgian and other donors, but it has not been able to provide enough national scientists to the potato program. Professionals are

frequently shifted from one job to another, and lack of continuity is a chronic problem. Currently one national scientist, on the job for less than a year, and five technicians are working with the two expatriates. In 1989, an additional Burundian scientist (with an M.S. degree) was appointed as counterpart for the expatriate CIP researcher. ISABU has not provided a national counterpart for the on-farm research program, which may well not be continued when the British agronomist leaves in August, 1989.

The potato program of INERA in Zaire is based at the Mulungu station in southern Kivu province, where basically good facilities are significantly underutilized. The current program was established in 1980 with the cooperation of CIP staff based in Rwanda. A proposal was drawn up in 1982 when PRAPAC was formed for $281,000 for equipment, supplies, and travel over a five year period, but it was never funded by USAID/Zaire. The potato program receives virtually no operating funds from INERA. Currently two scientists, an extension specialist, and seven technicians run a skeleton research program with very modest assistance from PRAPAC's coordination budget. There is potential for significant expansion of the program if adequate funding can be provided.

D. Other barriers to international collaboration

The operation of a successful research network requires that scientists put aside political rivalries and dedicate themselves as professional colleagues to the solution of common problems. Historical tensions between the three francophone countries, particularly between Rwanda and Burundi, will require continued diplomacy designed to strengthen linkages. The addition of Uganda has brought an anglophone country into the network. Although many of the French-speaking scientists speak English, the reverse is less true. Meetings will inevitably go more slowly, and resources will need to be allocated for translations and/or summaries of key papers.

E. Linkages between potato research, seed multiplication agencies, development programs, and extension

All of the national potato research programs are engaged in production of clean seed, and in research directed to the development of improved technologies of various kinds. If these activities are to benefit small farmers, the linkage with the agencies charged with bulking seed must be strengthened. Research institutions should strictly limit their production to a small quantity of high quality seed.

The linkages are the best in Rwanda. PNAP now produces between 500 and 800 tons of seed on two farms. This is then passed to state seed company Selected Seed Service (SSS) and to rural development projects for bulking and distribution. Methods for quality control, particularly positive selection, have been introduced. Nevertheless, PNAP has had trouble maintaining quality, possibly because it is trying to produce too much seed.

In Burundi, between 80 and 100 tons of basic seed is produced at the farm in Mwokora. Multiplication is partly the responsibility of CVHA, a regional development agency which is in charge of extension in the highlands. CVHA's progress toward the production of an adequate volume of high-quality seed for farmers has been slow, and the extension system is regarded as a bottleneck. Regional Development Societies and other development projects also multiply seed potatoes.

In Zaire, INERA is part of the Ministry of Science and Technology, whereas seed multiplication is the responsibility of the Ministry of Agriculture. The program in Mulungu has developed no linkages with other agencies, and multiplies the 8 - 14 tons of seed it produces through a handful of farmer-cooperators. CAPSA, a Canadian-funded project in Northern Kivu, multiplies and distributes seed potatoes and other seeds directly to farmers. It has received basic seed from Rwanda through PRAPAC, but it has not as yet established an effective working relationship with the Zairian potato research program at Mulungu.

Private sector smallholders can only be organized as an effective mechanism for quality seed multiplication if they are given adequate incentives to remove diseased plants ("rogue") when they are detected. In Rwanda, farmers are unwilling to follow this practice, as diseased plants will still produce ware tubers. Thus, only large private sector farmers who would agree to follow roguing recommendations or state agencies could be used in future to multiply good quality clean seed tubers. Promotion of roguing by smallholder seed producers should continue to be promoted through training.

Linkages between research and extension are weak in all of the countries. They are in separate ministries in Zaire and Burundi, where extension is integrated with rural development agencies. Researchers have taken on responsibility for technology transfer, but their impact is limited by a lack of funds and an appropriate infrastructure throughout the potato-growing regions.

VIII. Progress Towards Achieving Project Outputs

A. Development and identification of potato varieties resistant to bacterial wilt and late blight

(1) Bacterial Wilt

Bacterial wilt, also known as "brown rot", is caused by the bacterium *Pseudomonas solanacearum*. Four host-adapted races are known, of which races 1 and 3 attack solanaceous crops such as potatoes, tomato, eggplant, and pepper. At present, only race 3 has been identified in the potato growing regions of PRAPAC countries. Control is more effective against race 3 than race 1, as the latter has a wider range of host plants.

Tubers can be infected with wilt bacteria despite the absence of foliage damage. Latent tuber infection can occur if infected seed tubers are planted in cool locations. Wilt tolerant varieties may be symptomless carriers of *P. solanacearum*. Losses due to wilt are estimated at between 20 to 25 percent of yields in the PRAPAC region. From time to time the cause of wilt should be verified, as it may be attributable to other widespread pathogens.

The ISABU potato program in Burundi is responsible within PRAPAC for regional bacterial wilt research. Initiated in 1984, the program continues bacterial wilt research initiated in the colonial era by the Belgian government. CIP technical support funded outside the A.I.D. REDSO/ESA grant, brings to PRAPAC extensive background research in this complex disease including outstanding expertise contracted from the University of Wisconsin. Genetic material is made available to the program from many sources. Antisera kits have been made available recently to permit identification of specific races of wilt bacteria.

Despite these resources, total resistance to bacterial wilt has not been found. In field trials conducted at Gisozi, Burundi, during the past three years, several advanced clones have been identified with acceptable tolerance to the wilt disease. These tolerant lines include the variety Ndinamagara and CIP clones 382043.12 and 382017.27.

An integrated approach to control bacterial wilt, includes use of tolerant varieties and adoption of sanitation practices and crop rotation. At the ISABU-CIP Seed Farm at Munanira, Burundi, plants with wilt symptoms are removed together with adjacent plants in the same row. At the ISAR-PNAP Seed Farm near Kinigi, Rwanda, diseased plants are marked to avoid their use as seed, while positively selected vigorous plants are saved for seed.

Wilt bacteria may survive up to four years even in the absence of volunteer potatoes and weed hosts. An effective rotation system involves graminaceous crops such as the wheat and the Setaria grass which has been planted at the Munanira Seed Farm. Setaria requires little attention during a three-year cycle. It is cut to feed cattle which provide manure for eight hectare rotation sequences on the 40 hectare farm. This integrated approach may also have application at the PNAP Gishwati Seed Farm in Rwanda, which is located close to extensive cattle farms.

At the Gisozi Research Station in Burundi a quality seed production scheme involves tissue culture and in vitro multiplication followed by rapid multiplication by stem cuttings in screenhouses where tubers are grown in plastic bags containing a pasteurized soil mix. This continuous process of flushing clean material from tissue culture through the seed production system guarantees that the early multiplication steps are free of contamination by wilt bacteria. The ISAR-PNAP station at Ruhengeri has similar equipment to that found at the Gisozi Station. Seed supplies are inadequate in both Rwanda and Burundi.

The team concluded that:

- There are no outstanding faults in the production of healthy basic seed in Burundi and Rwanda.

- "Roguing" (the removal of infected plants and their immediate neighbors) and other sanitation practices must continue to be rigorously enforced during field multiplication of seed to ensure quality. Removal of volunteer potato plants on seed farms is essential.

- The size of seed tubers produced by the Rwandan program is excessive and wasteful.

- There is sufficient preliminary information on the integrated control of bacterial wilt to transfer the technology to Zaire and Uganda.

(2) Late Blight

Theoretically, potato plants have two mechanisms of resistance to late blight which is caused by the fungus *Phytophthora infestans*. One type, the so-called major gene or "vertical" resistance is dependent on R-genes, while "field" or "horizontal" (generalized) resistance is attributed to multiple minor genes. R-genes are derived from *Solanum demissum* crosses which have infiltrated potato breeding programs worldwide.

From forty years' past experience, major gene resistance fails sooner or later through the spontaneous appearance of compatible races of the blight fungus. Failure of resistance to late blight has been of only passing concern to commercial potato growers and potato breeders in developed countries where costly fungicide control of blight is common practice.

It is also theorized that potato cultivars may have minor genes which are assumed to provide field resistance if major gene resistance fails. In PRAPAC countries introduced potato varieties like Sangema, Montsama, Murca and Cruza 148 are believed to process good levels of field resistance despite the presence of R-genes. But the recent severe blighting of several previously tolerant varieties suggests a low level of horizontal resistance following the failure of R-gene resistance through the appearance of a compatible race(s) of P. infestans.

At a Workshop in May, 1988, it was proposed that a spectrum of blight fungus races be collected from the field and stored in liquid nitrogen for future screening. In screening for field resistance, the effect of R-genes would be neutralized by inoculating plants in the field with a homogeneous mixture of compatible races from cryogenic storage. It is hoped that this technique would discriminate between R-genes and background minor gene resistance. This approach relies on the assumption that a wide enough spectrum of races would nullify all major genes, the residual resistance being of the field type. This conceptual framework for resistance screening has won the support of the PNAP-PRAPAC late blight project at Ruhengeri, Rwanda. It requires the collection and identification of races on differential hosts and the availability of liquid nitrogen to maintain the pathogenic integrity of races. The scheme perpetuates the slow demise of the major-minor gene hypothesis.

There are other alternatives. PNAP, Rwanda, has already introduced the use of fungicide sprays such as Dithane M-45 applied by manual back-pack sprayer. This permits the growing of potatoes during the rainy season ensuring a year round supply of cultivated (and volunteer potatoes) but also a continuous source of blight inoculum. To be successful, spray programs depend on accurate measurement of active ingredients, the application of spray with sufficient pressure to penetrate to lower leaves and the timing of sprays to ensure coverage of new foliage and the renewal of fungicide washed off by rain. It is critical that research on resistance continue to receive a high priority, as some member countries do not have sufficient resources to subsidize fungicide use by all farmers.

Another alternative depends upon the availability of blight resistance clones free of genes from S. demissum. A special breeding, program to provide material was initiated by CIP in the mid-'80s but is still in the early development stage.

The team concluded that:

- The failure of the major gene approach to late blight resistance discouraged continued breeding in developed countries for blight resistance. In the meantime high yields, desirable horticultural qualities and consumer preferences perpetuated breeding using parental material with R-genes. Developing countries in PRAPAC continue to rely on a failed heritage for sustainable blight control while developed countries now rely on sophisticated spray programs for control. Temperate zone countries have devoted little research to warm climate potato diseases such as bacterial wilt.

- Dithane M-45 is a modern and preferred fungicide for late blight control. Combined with late blight resistance varieties such as Sangema, a subsistence level spray program which uses subsidized chemicals may be technically feasible but not sustainable in a PRAPAC context.

- Pathogenic races are unlikely to nullify major genes when sprayed on a field so as to identify field resistant plants.

- Selected blight tolerant potato varieties have been distributed to Burundi, Rwanda, and Zaire, some prior to the initiation of PRAPAC.

B. Development of viable potato production technology

PRAPAC is a relatively young network, started in 1982, but only effectively funded since 1986. Normally some ten years elapse before a scientific discovery finds its way through testing and verification and into consumers' hands. Also, PRAPAC operates in a region of modest financial inputs for national programs, and the region contains potato programs with inadequate staffing levels for many areas of research. In this respect, expectations on delivery of potato production technologies that can be used immediately by peasant farmers should not be too high.

The PRAPAC countries lack adequate and established infrastructure for the transfer of technologies to farmers. In Burundi, for example, there is only one extension agent posted in each of the country's fifteen provinces. Grassroots level extension workers are employed by the various development projects, thus they are not part of the country's extension system. ISABU does have a "pre-extension department", and through its efforts, some technologies are reaching a limited number of farmers. Burundi's proposed Structural Adjustment Program has a mandate to restructure and strengthen the national extension system; ultimately this will facilitate the transfer of technologies to farmers.

Rwanda's extension system is more extensive; however, the number of grassroots extension agents is limited. Without any means of transportation, they can reach only a handful of farmers; moreover, agricultural extension is only part of their job responsibilities. Zaire faces a more or less similar situation. Through PNAP's efforts, the Cruza and Sangema varieties have become popular with Rwandan farmers. Several of these farmers are also spraying their potato fields with fungicides (Dithane M-45) on a regular basis. Although this is a good beginning, farmers' skills and understanding of the spraying procedures should be improved through field demonstrations by extension agents, and on farm trials.

In all of the countries visited, researchers are conducting a limited number of on-farm trials. Farmers participating in these on-farm trials are the first to benefit from any successful technologies generated. Although a slow process, some farmer-to-farmer technology diffusion takes place. The country's extension service, however, has the major responsibility for the transfer of technologies from researchers to farmers.

The previous rationale is not meant as an excuse for inaction or inappropriate research directions. Rather, PRAPAC should be measured at this stage in terms of how much it is promoting the <u>efficiency</u> of research in the region. Networks are no panacea for agricultural problems afflicting a region. The main hope is that a network will find a solution to a problem more quickly than isolated efforts. In some instances, a network research thrust may reach a dead-end, but time and money will still have been saved if the network is functioning properly. PRAPAC appears to be a cost-effective way of stimulating research on potatoes in the region, although certain aspects of its work need improvement.

In spite of PRAPAC's youth and relatively modest size compared to some other international agricultural research networks, it has assisted national programs to make some impressive strides in delivering environmentally-sound potato technologies appropriate for small farmers. The adoption of diffuse-light storage sheds by small farmers in Burundi, Rwanda, and Zaire is impressive. In those countries, diffuse storage sheds, primarily for seed potatoes, are made cheaply with local materials and are often attached to the side of houses. The Burundi program has targeted progressive farmers in conspicuous places, such as in yards or village shops, to help promote the technology. This approach has evidently paid off, although hard data on adoption rates are lacking. Studies are clearly needed on the extent and rate of adoption of potato technologies generated by PRAPAC activities.

Another aspect of diffuse light storage is the widespread use of Lantana leaves to help control tuber moth damage. This simple biocontrol method, based on a common weed, is exactly the kind of environmentally-benign technology that is needed in farming areas. Lantana leaves are also particularly appropriate for farmers who cannot afford to purchase pesticides.

C. Development and transfer to farmers of economically viable and locally tested post-harvest storage technologies for seed table potatoes

The Burundi program has been assigned the principal responsibility for developing post-harvest storage and utilization technologies. A brief description of research conducted, both on-station and on-farm, and the progress made are described below.

(1) Post-harvest storage of table potatoes: The principal problems encountered during storage are: greening, sprouting, rotting, shrivelling, and damage caused by insects and rodents. The farmers usually store potatoes in baskets inside the house and consume these as soon as possible. Any device that reduces exposure to light, keeps the potatoes cool, and allows air circulation should increase storage life. Studies on low-cost methods to increase the storability of potatoes for home consumption are underway.

(2) Post-harvest storage of seed potatoes: The idea here is to store seed potatoes without damage and deterioration until the next planting season. Exposure to light retards sprout growth; though it causes greening, this is not a problem. Seed potatoes should be protected against rodents and tuber moths. The Burundi program has developed and tested low cost diffused light storage technologies using locally available materials which seem to work well. Use of dried leaves of Lantana, a common weed, against tuber moth attach is effective. A similar study conducted in Zaire also showed that dried and chopped Lantana leaves was more effective in controlling tuber moth damage (only 4% damage) than fresh Lantana (14% damage) or fresh Tagetus, a wild marigold (26% damage).

(3) Breaking dormancy of seed potatoes: The length of dormancy in seed potatoes is a varietal characteristic. Some varieties grown in the PRAPAC region remain dormant for only two months (e.g. Cruza) while others up to eight months under some conditions (e.g. Uganda 11). Seed potatoes of varieties with a long dormancy period obtained from plantings in the first season (September-December) cannot be planted in the second season (March-June), unless the dormancy can be broken artificially. The Burundi program has tested, with partial success, several simple technologies such as exposure of seed potatoes to mild heat, or covering seed potatoes with wet straw for several days. Simple sprouting of potatoes is not good enough; apical dominance must be overcome to stimulate multiple sprouts in as many of the seed potatoes as possible. The Burundi researchers are conducting studies to determine the effects of various dormancy-breaking treatments on final tuber yields.

(4) Post-harvest processing: The potato program in Zaire is trying to address a critical problem of consumption. While some potatoes are rotting in the farmers' fields in the Kivu province where over 50% of the country's potatoes are produced, the western part of the country around Kinshasa has to import potatoes from other countries to meet its demand. Transportation of bulky potatoes (80% water, by weight) by air is

difficult and expensive, so the Zaire potato program is searching for viable alternatives. Researchers are testing simple technologies to peel, chip and sun-dry potatoes while maintaining their natural color. Small farmers could use this technology for long-term home storage for consumption, while entrepreneurs could use this method to supply processed potatoes to the potato-deficit areas of the country.

(5) Country to country exchange of technologies: Burundi, Rwanda and Zaire are using similar technologies for the storage of seed potatoes. Burundi is using Actellic (a low toxicity insecticide) against tuber moths for on-station seed storage, while promoting pungent *Lantana* leaves for on-farm seed storage. Zaire is beginning to follow Burundi's lead in this regard. Burundi is still perfecting its dormancy breaking technologies; hopefully, these will be transferred to the other cooperating countries at a later date.

D. Development of simple rapid multiplication techniques to facilitate transfer of clean seed to PRAPAC countries for their seed production schemes

Although potatoes were first grown in culture 35 years ago, it is only recently that *in vitro* techniques have been widely used for rapid multiplication in seed programs. In the international exchange of germplasm between countries, quarantine services prefer to handle sterile plants in test tubes. Tissue culture is also a method of choice for the maintenance of collections of genetic material free of diseases and pests, and a tissue culture rapid multiplication unit requires a very modest investment. A source of artificial or indirect natural light, some test tubes, agar medium, a household "pressure cooker" for sterilizing, and an alcohol lamp are the essential minimum items required.

At both Gisozi, Burundi, and at Ruhengeri, Rwanda, tissue culture facilities have been established to provide for rapid multiplication of potato plantlets. Recently, the Belgian government supplied both institutions with laminar flow transfer chambers. After approximately 3 weeks of growth on medium in a test tube, a potato plantlet can be removed and cut into 3 or 4 nodal sections and transferred to fresh agar growth medium. By repeating this process, each new batch replaces a season's multiplication in the field. Finally, plantlets are transplanted to pasteurized soil to establish roots and develop

tubers. Screens are used to exclude aphids. Sometimes stem cuttings from these disease-free plants are rooted in a coarse sand-peat mix and grown in raised beds in a screenhouse. Test tube cultures and healthy small tubers are ideal for export.

It is difficult to maintain quality in the field multiplication of large quantities of seed. If possible, seed farms should be isolated from commercial potato growing areas. Growing potatoes year-round maintains a source of disease inoculum as well as aphid virus vectors. It is important to eliminate volunteer potatoes as was observed at the Mwokora Seed Farm in Burundi. A 3- to 4-year rotation cycle of wheat or Setaria grass reduces the incidence of bacterial wilt inoculum and root-knot nematodes in the soil. While such a rotation has been established on the terraced Mwokora and Munanira seed farms, better management of steep slopes and the development of a rotation and sanitation program is needed at PNAP's Gishwati Seed Farm in Rwanda. The numerous stakes marking both positive and negatively selected plants at the Kinigi Seed Farm, Rwanda, contrasts sharply with the need for few stakes marking the removal of wilted-infected and adjacent plants at the ISABU Seed Farm at Munanira, Burundi. Clearly, there are seed farm management techniques in Burundi which could be usefully transferred to Rwanda.

The team concluded that:

- Tissue culture facilities have been established at the Gisozi Research Station in Burundi and at the PNAP Station in Ruhengeri, Rwanda.

- At the time of visit the more efficient rapid multiplication operation was at the Gisozi Station.

- Seed Farm management at facilities in Munanira and Mwokora, Burundi, appeared to be considerably more efficient than at Kinigi and Gishwati Seed Farms in Rwanda. Although the scale of production of seed was greater in Rwanda, this reflected a 3- to 4- fold greater total area in potatoes in Rwanda than that grown in Burundi.

E. Development of Use of Monitoring Techniques

One of the basic concepts underlying the development of PRAPAC has been the importance of an inter-disciplinary approach to develop technology to meet the needs of the small farmers of the region. Research priorities should be set on the basis of diagnostic studies, and dynamic factors including the adoption of new technology and marketing and consumption patterns should be monitored regularly.

Over the past ten years, CIP's Social Science Department has sent five scientists on assignments ranging from a few months up to two years to investigate the following key elements of the potato food systems in the member countries:

-- A compendium of baseline information about potato production and utilization in Rwanda (Durr, 1983)

-- A study of consumption patterns in Rwanda (Poats, 1981).

-- A study of potato marketing, which also draws together baseline data from secondary sources about production and utilization patterns in Rwanda, Burundi, and Zaire (Scott, 1988).

-- A diagnosis of seed production and distribution in Rwanda (Monares, 1984)

-- Studies of farmers' perception and use of varieties in Rwanda and Burundi, and work on the feasibility of TPS in Rwanda (Haugerud, 1988 and unpublished manuscripts). The results are yet to be analyzed and published.

The agronomists which CIP has posted in Rwanda and Burundi have integrated on-farm and on-station research following the "farmer-back-to-farm" philosophy.

In spite of chronic delays getting the data analyzed and published, the range and quality of baseline information is relatively good. It has proved more difficult to institutionalize a regular role for socio-economic monitoring in PRAPAC and in the member national programs. As in most NARS in developing countries, there are very few professionals with training in the social sciences in the national agricultural research institutes. An on-going process of socio-economic research in the national programs would better focus research on farmers' needs. Reliable data about the role and market and nutritional importance of potatoes would strengthen the position of potato researchers as they argue for more personnel and funds. Better collaboration with universities and other host country agencies could assist with this data collection.

In Rwanda, a survey of farmers' demand for improved seed was undertaken by an affiliated agency, but the person responsible has been transferred to other duties, so the questionnaires have not yet been coded or analyzed. The data is needed for research planning and the development of seed distribution systems. An agronomist with experience in Farming Systems research has recently been added to the team, a very positive development.

In Burundi, a CIP expatriate agronomist is running up to 100 on-farm trials a year on the adaptability of new varieties, the benefits of seed potatoes that have been produced under a system of positive selection, and methods for storing potatoes for consumption. This important work has not been tied to any systematic surveys of farmers' current practices and needs, which will make the interpretation of the results more difficult. An opportunity to train social scientists to cooperate closely with agronomic research has been lost.

In Zaire, the extension specialist from the potato program participated in three general surveys sponsored by another agency of vegetable producers. The results were too general to be useful in setting research priorities for potatoes. With support form PRAPAC, he has recently carried out a study of potato consumption patterns in Kinshasa to be used as a baseline study of the feasibility of the small-scale processing of dried potato flakes in Kivu to reduce transport costs (Murhandikire, 1987). This is just the kind of research by nationals which PRAPAC should encourage.

F. Delivery of in-service training:

(1) Development of a regional training center:

Through a PRAPAC initiative and funding, a very attractive and functional training center has been constructed within the PNAP compound in Ruhengeri, Rwanda. This facility includes two classrooms, office and storage space, dormitory rooms to accommodate up to 22 trainees, kitchen and dining room facilities. When not used for PRAPAC activities, this facility will be rented out to other organizations.

(2) Regional courses:

a) PRAPAC regional seed/bacterial wilt workshop. This was conducted in Bujumbura, Burundi, May 4-7, 1987. Thirty-five researchers from Burundi, Rwanda and Zaire attended, and 17 scientific presentations were made. In addition to the national programs, participants also came from the national universities, Ministries of Agriculture, seed services of the cooperating countries, and from the CIP headquarters.

The proceedings of this seminar have been published (Seminaire sur la Production des Semences de Pommes de Terre en lien avec la Bacteriose, Ruhengeri, Rwanda, May 4-7, 1987).

(b) PRAPAC regional late blight workshop. This took place in Gisenyi, Rwanda, May 9-13, 1988. Fifteen scientific papers were presented by potato researchers from all four participating countries. Thirty-four persons including representatives from REDSO/ESA, USAID/Rwanda, Universities in Rwanda and Uganda, CIP and IPO/Netherlands attended. The proceedings of this workshop have been published (Workshop on Late Blight of Potato, Ruhengeri, Rwanda, May 9-13, 1988).

(3) In-country training:

(a) PRAPAC in-country production course; April 6-10, 1987, held in Butembo, Zaire. Thirteen trainees participated.

(b) PRAPAC in-country production course; July 4-8, 1988, held in Mulungu, Zaire. Thirty-one persons attended.

(c) Since 1983, two production courses per year have been conducted (one in French and one in Kirundi) with on average 25 participants coming from different seed multiplication projects in Burundi. For example, a PRAPAC in-country potato storage course was held in Gisozi, Burundi, February 6-10, 1989. The ten participants came from the Selected Seed Services of Burundi, and from several development projects. Also, since 1987, a two-day workshop for farmers is carried out in Kirundi annually.

(d) PRAPAC/PNAP in-country practical seed production training; June 6-18, 1988, held in Ruhengeri, Rwanda. Three researchers from Uganda and one from Zaire participated.

(4) Several technicians and extension service personnel from the four PRAPAC countries received in-service training by working with various researchers of the national potato programs.

One researcher each from Rwanda and Zaire attended the CIP regional post-harvest workshop in Nairobi, February 29-March 4, 1988. Three researchers also participated in NIVAA potato production course in Netherlands, June 6-24, 1988. One person from the Zaire program attended the CIP regional processing course in India, May 11-22, 1988, while the director of Rwanda's potato program attended the CIP regional seed workshop in Zimbabwe, February 22-26, 1988.

From Burundi in 1986, two researchers attended a CIP production course in Tunis, and another researcher participated in a germplasm management course at CIP/Nairobi and individual training at CIP/Lima. In 1987, three Burundian researchers attended the germplasm workshop and the African Potato Association meeting in Nairobi, and one researcher attended the IPM course at CIP/Nairobi. In 1988, one Burundian researcher attended the Storage course given by CIP/Nairobi.

The activities described above are not intended to be exhaustive, but are meant only to document PRAPAC's commitment to train the nationals in all aspects of potato production. The Burundi program has trained A-2 and A-3 level technicians in rapid multiplication technics through tissue culture, seed multiplication and storage, and on-farm trials. These research technicians are now carrying out a range of tasks with minimum supervision.

The evaluation team is of the opinion that PRAPAC has done a good job of organizing workshops and providing short-term training to the cooperating country nationals.

(5) The team believes that the national potato research programs require more B.S. and M.S. degree level researchers. Trainees should be selected from existing national program staff whenever possible.

TABLE 2: Number of National Scientists (Researchers and Technicians) in Cooperating Countries' Potato Programs

Training Levels or equivalent	Zaire	Burundi	Rwanda	Uganda
Ph.D.	0	0	1 (1)	0
M.S. (Ag. Eng.)	1	1	3 (1)	4
B.S. (A-1)	1	0	0	4
Diploma (A-2)	3	3	7	0
Certificate (A-3)	4	5	4	0
TOTAL	9	9	15	8

NOTES: Numbers in parentheses are those currently in training.

A1 training level = equivalent to B.S. degree in agriculture
A2 training level = secondary school diploma in agriculture
A3 training level = post-primary three-year certificate in agriculture

As has been shown in the above table, the situation is particularly critical for the Burundi and the Zaire programs. Each of these two programs should have a minimum of two Ph.D.s and two M.S. level researchers. PRAPAC should initiate dialogue with the respective country research Directors to identify: a) potential trainees, and b) possible funding sources. Through the Rwanda Farming Systems Research Program, one PNAP researcher is completing his Ph.D. at Cornell University.

G. Effectiveness of the Regional Network:

This section analyses the effectiveness of the network in improving the efficiency of research. One of the key advantages of networking is that it can help avoid unnecessary and costly redundancy through joint planning. Also, results are more easily transferable between countries if participating institutions adopt the same, or at least very similar, methodologies. Typically, in a collaborative research network such as PRAPAC, tasks are divided up among participating countries according to their comparative advantages in research. This approach is especially helpful in regions where national programs are too small to tackle adequately the full range of problems facing a commodity or factor of production by themselves.

The major mechanisms for exchanging information on research results among member countries are the Executive Committee and periodic workshops. The Executive Committee, which meets twice a year, is composed of heads of potato research in member countries and the PRAPAC coordinator. The Executive Committee is charged with drawing up workplans, proposing new projects and changes to existing projects for consideration by the Directors' Committee (composed of Directors of national programs of PRAPAC countries), and proposing budgets. The Executive Committee is also responsible for implementing decisions reached by the Directors' Committee and preparing annual reports.

Several workshops have been organized to provide opportunities for potato scientists in the network to present findings, discuss problems, and identify technologies and research methodologies suitable for adoption in the region covered by the network. These workshops include presentations by outside experts, who provide valuable new perspectives. PRAPAC workshops organized since 1985 include: Potato Production, Butembo, Zaire, October 1985; Seed Production in Relation to Bacterial Wilt, Bujumbura, Burundi, May 1987; and Late Blight, Gisenyi, Rwanda, May 1988. Workshops are currently scheduled on an annual basis. The next one will be on Rapid

Multiplication in Ruhengeri, Rwanda, in June 1989, followed by a workshop on Integrated Pest Management in 1990. These workshops are important mechanisms for strengthening the cohesiveness of the network.

Progress in sharing information and technologies among PRAPAC members has been made in three main areas: dissemination of clones with some resistance, at least initially, to late blight, and diffuse light storage for seed potatoes, and training workshops. Since the establishment of PRAPAC in 1982, 4 varieties have been disseminated among PRAPAC countries (Table 2). Several varieties released prior to PRAPAC's establishment in 1982, particularly Sangema, have become more widely disseminated as a result of information sharing among network participants. Burundi, Rwanda, and Zaire are all studying diffuse light storage designs. In addition, published workshop proceedings and Annual Reports are distributed to PRAPAC members. The network coordinator plays a facilitating role in the dissemination of research findings, but the initiative for requesting technologies or information should come from national program scientists.

Scope exists, however, for improving the flow of ideas and technologies among PRAPAC members. Inadequate communication between network participants can lead to redundancy and difficulties in disseminating research findings. At the moment, some of the network activities operate more as disarticulated, separate thrusts rather than a coordinated effort to achieve shared goals.

Mechanisms for sharing information about progress of the nine PRAPAC sub-projects could be improved, particularly to systematically report and discuss findings of the nine sub-projects of the network. The annual report presents progress on some of the network's activities, but it is important to have an opportunity for participants to discuss progress and difficulties on all projects on a regular basis.

TABLE 3: Potato varieties disseminated among PRAPAC countries since 1982

Variety	Origin	Year Selected/ Introduced	Countries Where Released & Year	Observations
Cruza 148*	Mexico	1982	Burundi (1985)	Bacterial wilt late and early blight tolerant
Gasore	Belgium	1982	Rwanda (1984)	Susceptible to most diseases; recommended for planting at the end of rainy season
Muruta	CIP	1983	Burundi (1987)	No longer resistant to late blight, but is tolerant to most other diseases except viruses; recommended for valley-bottom culvation in dry season
Muziranzara	CIP	1982	Burundi (1985)	Resistant to late blight; susceptible to bacterial wilt; recommended for hills and poor soils.

* Known as Ndinamagara in Burundi

IX. Adequacy of Input Delivery, Management, and Sustainability

Responsibility for the delivery of project inputs is divided between PRAPAC, CIP, REDSO/ESA, USAID Missions, host country collaborating institutions, and another donors. Findings specific to each institution are presented below.

A. PRAPAC

The PRAPAC network is still only in its formative stage. The Coordinator's position is filled by a CIP potato scientist recruited by CIP and funded by the REDSO grant. The Coordinator has no secretary or administrative assistant, but does have the use of a driver. No time frame has yet been set for the eventual handover of the Coordinator role to a national scientist.

During the first three years of project implementation, much of the Coordinator's time was spent on managing the construction of the project-funded training center in Ruhengeri, Rwanda, and his adjacent residence. As a result, the Coordinator has been able to offer insufficient technical assistance to national potato research programs in the network. Table 7 in the Appendix shows the geographic breakdown of the Coordinator's travel time for 1988. Only one week was available to the Uganda program which entered PRAPAC in 1987, though this program and that of Zaire are most in need of technical assistance, as neither has a resident CIP adviser. A written job description for the Coordinator's position which would define the percentage of time to be spent in travel status, the allocation of travel time between country to programs, and the order of priority assigned to each of the Coordinator's functions, would resolve conflicting demands on use of the Coordinator's time.

PRAPAC has produced an annual report for 1986 and 1987 of project activities, and some workshops on the technical issues of potato research have been covered to bring together scientists from member countries. The annual reports have not come out on a systematic basis, however, and workshops have only been held on an annual basis. More attention in future to the collaborative setting of research proposals, and a workshop on methods for the standardization of socio-economic baseline data collection would help set priorities for future network research planning.

To date, project-funded technical assistance in potato research and training has been provided by expatriates, mainly staff and consultants from CIP/Lima and CIP/Nairobi. In order to involve PRAPAC members' scientists as advisors and trainers for other member countries, a PRAPAC scientist could be paired with each short-term expatriate advisor to allow joint consultative visits.

B. CIP

The national potato research programs in Zaire and Uganda require additional funding for technical assistance, vehicles, and local costs (fuel, agricultural inputs, and labor). Outside the REDSO/ESA grant, CIP has placed two resident expatriate researchers in Burundi, with funding from ODA for one of these positions. With initiative from CIP, it is possible that additional support from other donors could be obtained to supplement A.I.D.'s resources for work in Zaire and Uganda.

Staff and consultants from CIP/Lima and CIP/Nairobi are providing much of PRAPAC's technical assistance, and CIP has established strong relationships with the national programs in Rwanda and Burundi. CIP provided seed tubers to all of the countries before and since the creation of PRAPAC.

The establishment of PRAPAC as an entity separate from CIP would be enhanced by: (1) the submission of consultation reports to PRAPAC by CIP staff and advisers after each trip; (2) the establishment of a timeframe and mechanism for member countries to select future coordinators from seconded PRAPAC members' scientists; (3) instituting a collaborated format for CIP consultations, by pairing a national scientist with each external adviser during regional visits; and (4) development of a formal mechanism for annual in-kind or cash contributions to PRAPAC costs from member countries.

C. Host Country Collaborating Institutions

In Burundi, national potato research is the responsibility of ISABU but the host country operating budget does not even cover the salaries of personnel. ISABU depends upon donors for the funding of most research costs, such as vehicles, fuel, laborers, and agricultural inputs. USAID/Burundi is currently funding these expenses from residual P.L. 480 food program currency generations. At current rates of expenditure, these funds may last through December 1989. As part of its 1988-1992 agricultural aid package, the Belgian government has reserved funds for continued local cost support for four additional years. The adequacy of these budgetary resources will need to be monitored closely by CIP and ISABU during the coming year. In the event of a budget shortfall, ISABU may wish to develop a proposal with CIP assistance for submission to USAID/Burundi, as local currencies will be generated from 1990 on under the Mission's new Agricultural Marketing Reform Program.

In Rwanda, ISAR houses the National Potato Improvement Program (PNAP). Despite some support for national potato research costs provided by USAID/Rwanda's Farming Systems Research Project, PNAP is only exploiting a small percentage of its fields at the Gishwati Research station. Although more in-depth market and nutritional studies on the relative importance of potato in Rwanda are needed, the ISAR Director of Research has placed potato as the second most important commodity in his national agricultural research program. Rwanda's high altitude areas are suitable only for pasture and potato production, and ISAR wishes to expand its potato research program to the south to better exploit the relatively infertile and acidic soils of the Zaire-Nile Divide. Additional funding from USAID/Rwanda or other donors would facilitate this expansion.

46

Zaire's national potato research falls under the auspices of INERA. Research activities are concentrated in Kivu Province, though potatoes are grown in three other provinces.

Zaire's operating budget only provides salaries for research personnel. The $15,000 made available to date by the PRAPAC Coordinator from REDSO's grant to PRAPAC is providing the only support for other research costs. No funds are available to transport INERA staff from the other potato-growing regions for training at the potato research station in the Kivu. Further, the cost of seed distribution is severely hampering the distribution of improved varieties nationwide; this limits the impact of research. The evaluation team was impressed with the research results obtained thus far in the face of these resource constraints, but there is an especially critical need for additional local cost financing to increase the impact of the Zaire program.

D. REDSO/ESA

REDSO obligated $1,557,000 in the regional grant, including a $188,000 contingency line item. In programming the use of these contingency funds, priority should be assigned to ensuring that adequate funds have been provided for the Coordinator's salary, services, and supplies through end of the grant. Consideration should also be given to providing local cost support and a vehicle for the Zaire research program.

Increased emphasis on collaborative monitoring by REDSO/ESA and the USAID Agricultural Development Officers over the next two years would set the stage for the integration of national potato research support into future mission budgets, and consideration of future bilateral support for PRAPAC.

E. USAID Missions

At present, USAID Mission involvement is limited to the monitoring of bilateral contribution financial reports and USAID/Burundi and USAID/Rwanda contributions. USAID direct hire agricultural officers were not well informed about project progress, the status of PRAPAC activities, nor the relative importance of potato cultivation and marketing in their countries. In order to assess whether potato research should be assigned a higher claim on future bilateral A.I.D. resources, missions will require market, nutritional, and socio-economic studies on potato production and consumption in their countries. If PRAPAC produced such studies, they could help leverage additional bilateral funding in future for PRAPAC and the national potato programs. USAID/Burundi will be redesigning its bilateral agricultural research project in 1989, and USAID/Rwanda will begin designing a new start in agricultural research in 1990.

F. Other Donors

By the end of 1989, Belgium will begin funding $95,000 per year towards local costs of the Rwanda national potato research program. ODA and Belgian cooperation are each funding a technical adviser resident in Burundi. About 25% of CIP's core headquarters budget is provided by a centrally funded grant from S&T/AGR. There is scope for broader initiatives by CIP and PRAPAC to solicit additional resources from the Belgian Government, ODA, and other donors for the expansion of Zaire research, and the continuation of PRAPAC support after the end of the REDSO/ESA grant.

G. Status of Financial Inputs

The PRAPAC project (1986-1991) is approximately 60 percent through its planned life in terms of time elapsed. The network and associated activities have been funded through the following mechanisms:

$1,557,000	from REDSO/ESA for coordination and training
$ 251,100	from the USAID mission in Rwanda from the Farming Systems Research Project for support to PNAP
$ 690,000	including $377,000 from the Basic Food Crops Project and $313,000 equivalent in local currency from the USAID mission in Burundi for support to ISABU; these funds may be exhausted by December 1989. Two professionals resident in Burundi were recruited by CIP, and funded by Belgian cooperation and ODA (British cooperation).
$ 380,000	from Belgian cooperation for 1990-1993 support for national potato research in Burundi.

The national potato program in Zaire has not received any bilateral funds, and USAID/Kampala local currency support for Uganda potato research has been sporadic.

A proposal for a supplementary $2.5 million in foreign exchange for capital infrastructure was submitted to the international multi-donor group for Special Programs for African Agricultural Research (SPAAR) in 1987 for the support of member countries' national potato research programs. It was accepted by SPAAR on technical grounds, but the financial commitments necessary to implement the proposal have not been solicited.

The principal grant from REDSO/ESA is administered by CIP. About half of the total ($760,000) is earmarked for coordination functions. These include the salary and benefits of the coordinator, a vehicle, and a training budget for workshops and individual training. Small amounts of this portion of the budget have been pulled out to keep a skeleton research program operating in Zaire. The Coordination budget as a whole is 65 percent spent, very closely on track. Individual line items for salaries and supplies may require supplementation through a budget revision, using contingency funds or cost savings from elsewhere in the grant budget.

The next major area of project activity has been the construction and operation of the training center in Ruhengeri, Rwanda, with a total budget of $337,000. Construction was completed at a very reasonable cost of under $250,000, leaving over $125,000 for training activities for the remaining two years of the first phase of the project.

Only seven percent of a $200,000 budget for consultants has been spent. A $32,000 cold store is under construction in Muguga, Kenya, the quarantine station from which germplasm is distributed to the countries in the region, including the members of PRAPAC.

The bilateral budget from the USAID country mission in Rwanda was funded under the Farming Systems Research Project budget, and 72 percent of a total allocation of $251,100 has been disbursed. Most of it has been invested in capital items to be used by both PRAPAC and PNAP, including a truck, a greenhouse, a seed store, and a house in Ruhengeri for the PRAPAC Coordinator. The remaining funds are earmarked for supplies and maintenance.

In Burundi, $377,000 of Basic Food Crops Project funds plus $313,000 in local currency has been made available by the local USAID mission for the routine operating costs of national potato research.

49

TABLE 4: REDSO/ESA Budget for PRAPAC, 1986-1991

LINE ITEM	APPROVED	DISBURSED 12/31/88	% DISBURSED (60% OF PROJECT TIME ELAPSED)	BALANCE
1) Coordination				
- Personnel	252,500	189,150	75	63,350
- Training	145,000	63,507	44	81,493
- Travel	70,000	36,562	52	33,438
- Supplies	70,000	59,712	85	10,287
- Vehicles	50,000	27,112	54	22,889
- Services	72,500	50,371	70	22,128
CIP Overhead	100,000	63,962	64	36,038
2. Training Materials (includes construction)	376,500	244,720	65	131,780
3. Consultants	200,000	13,637	7	186,363
4. Cold Storage	32,000	0	0	32,000
5. Contingency	188,000	0	0	188,000
TOTAL	1,556,500*	748,733	48	807,767

*(NOTE: The budget line items in the grant agreement add up to $1,556,500 though the total was reported as $1,557,000. The budget needs to be corrected through a grant agreement amendment which will add the missing $500 to one of the line items.)

TABLE 5: Rwanda Bilateral Budget in Support of PRAPAC Activities
1986 - 1991
(US$)

LINE ITEM	APPROVED	DISBURSED 12/31/88	% DISBURSED (60% OF PROJECT TIME ELAPSED)	BALANCE
I. SEED DEVELOPMENT				
A) Capital				
Truck	32,000	21,959	69	10,041
- Greenhouse	22,500	32,349	144	(9,849)
- Seed Store	30,000	31,478	105	(1,478)
- Equipment	1,500	1,522	102	(22)
B) Materials				
- Maintenance	67,000	21,657	32	45,343
C) Local Travel	13,100	4,267	33	8,833
II. LATE BLIGHT RESEARCH				
- Supplies and travel	26,000	7,102	27	18,898
III. CONSTRUCTION OF COORDINATOR'S HOUSE	59,000	58,085	98	915
TOTAL	251,100	178,419	71	72,681

TABLE 6: Bilateral Local Currency Assistance to ISABU's Burundian National Potato Program from USAID/Burundi Budget for October 1, 1988 - September 30, 1989*

Item	Amount (000 Burundian Francs)
Labor	25,454
Equipment and supplies	15,194
Construction	2,507
Travel	2,120
Vehicle	1,543
Training	700
Communications	500
Services	482
TOTAL	48,500

* NOTE: The foreign exchange rate on 1 March, 1989, was 1US$=150 Burundian Francs. This assistance may not be totally expended by September 30, 1989; the budget may be sufficient for research expenses through at least December 31, 1989.

X. Progress towards Achieving the Project Purpose

Some progress has been made towards achieving the project purpose, in terms of using the small number of scientists more efficiently. More attention towards dissemination of improved varieties and cultural practices is needed; this will require closer links with extension. It was difficult to separate the impact of PRAPAC from the impact of CIP and/or other support for national potato research programs.

Progress has been made in such areas as: development and dissemination of improved varieties; rapid multiplication techniques; production of clean seed; diffused light stores for seed both on-station and on-farm; ware potato storage; integrated pest management, use of repellant plants in stores; and dormancy breaking.

XII. Recommendations (Not Ranked by Priority Order)

A. For PRAPAC through End of the Grant:

(a) If new sub-projects are undertaken, consideration should be given to terminating others in order to not spread research resources too thinly. At present, PRAPAC has 9 projects divided among 4 countries. Expansion of this research agenda would be too ambitious given the limited facilities, financial support, and scientific capabilities of PRAPAC member countries. If current resources are harnessed to undertake fewer sub-projects, more progress is likely to be made towards the overall objectives of the network. Some projects could remain as the sole responsibility of certain countries, while research on other sub-projects could be conducted by two or more member countries. Late blight and bacterial wilt would be prime candidates for joint research.

(b) The scientist responsible for a sub-project should personally report on progress at each annual meeting. To facilitate discussion of network business, a general PRAPAC meeting should take place every year which would include (1) a meeting of the Directors' Committee, (2) a meeting of the Executive Committee. Representative(s) from external donor organization(s) should also be invited to attend the annual meeting to assess progress, and to provide advice on donor policies and procedures.

Research methods should be discussed and adjusted, to ensure that results from each of the countries will be comparable, and that efforts will not be duplicated. Joint workplans should be discussed and adjusted in the light of the progress made and a continuing evaluation of changing needs.

(c) Consider the appropriateness of re-initiating true potato seed (TPS) research. TPS was part of the original research agenda of responsibility of Rwanda, but was dropped. Though inadequate information exists to assess whether TPS could make a contribution to improved potato production in the region, TPS might raise and help sustain potato yields under certain circumstances, by reducing the number of diseases in seed stock. (See Appendix E on TPS). This should either await the termination of another sub-project or be started in lieu of a sub-project approved but not yet initiated.

(d) Continue to schedule regular monitoring tours so that network participants can observe first-hand each other's experiments, trials, and research procedures, and invite donor representatives (REDSO, USAID's and others). Prior to leaving the country, each group should debrief the heads of the national research programs; this may require travel to the capital city, or transport of the national director to the research site.

(e) National potato programs in PRAPAC should explore ways to better involve universities in their work. Universities can provide help particularly in two areas: (a) backstopping with specialized scientific facilities and expertise, and (b) providing expertise and manpower for socio-economic research.

(f) A study should be made of the long-term viability of fungicide use as a component for the control of late blight. Factors include the prices which farmers can afford to pay for both sprayers and chemical products, the foreign exchange costs, and the long-term sustainability of subsidies. If a factory for formulating and packaging fungicides is considered for Rwanda, the benefits should be extended to other members of the network.

(g) At the earliest opportunity R-gene free germplasm should be screened for blight resistance by all PRAPAC countries. Screening for blight resistance should continue to select replacement cultivars when localized failure of a variety occurs.

(h) Research on the control of late blight, bacterial wilt, and insect and nematode pests should continue within an integrated control framework. The selection of resistant or tolerant varieties should be combined with improved cultural practices and other control components. The minimum use of chemical pesticides can be a valuable component. Care must be taken that the increasing use of fungicides in Rwanda not distort PRAPAC's overall priorities for research on late blight.

(i) All consultants, both from CIP and from outside, should send summary reports of their findings to all of the member programs, with summaries in French and English. A host country scientist should be paired with each consultant for joint consultations whenever possible.

(j) Consideration should be given to hiring an administrative assistant to free up more of the Coordinator's time for his or her principal role as scientific advisor to the national programs. ISAR Rwanda plans to make an administrative assistant available to the PRAPAC Coordinator to assist with training center programming and management. This individual's skills and availability should be assessed and an additional person should be hired full or part time if needed to assist the Coordinator with other administrative tasks. This could free up the Coordinator's time for editing research publications and the preparation of training materials. The long term sustainability of funding for this position, however, is a concern. Project-funded external short term consultants should assist with training materials development as needed.

(k) The Director's Committee should develop a more explicit written job description for the Coordinator's position including percentage of time to be spent on travel status, the minimum amount of country-specific technical assistance to be provided to each country, and the priority ranking of each function the Coordinator is to perform. A plan and schedule for moving a national scientist into this position should be prepared.

(l) Develop a mechanism to detail explicitly each member state's annual in-kind and/or cash contributions to PRAPAC activities. This documentation will be important in any future negotiations with donors on funding.

(m) Limit the number of on-farm trials, but emphasize on-farm trials in all research. For a particular trial, e.g., the dormancy breaking trial, eight to ten trials in each target area should be sufficient. It is better to have a few well-managed trials than to have many trials with inadequate supervision. There is no point trying to stretch limited manpower and material resources. A "control" (particularly a farmer's current practice and/or choice of varieties) should always be included in any on-farm trial. This makes comparison easier for both farmers and researchers.

(n) The quality of research proposals and research reports prepared by the PRAPAC's collaborative researchers needs to be improved. PRAPAC should establish strict editorial standards, and should consider organizing a workshop to standardize reporting procedures and to improve the writing skills of the participating senior researchers. Each publication should have a summary in both English and French.

(o) Consideration should be given to expanding the network. This would require additional outside funding as existing resources should not be diluted to expand the network. An early candidate for possible expansion would be Kenya. With its facilities and trained staff, Kenya would strengthen the scientific capacity of PRAPAC and provide some leadership. Specifically, Kenya has strengths in seed production, post-harvest technology, and

agronomy. In turn, Kenya might improve its capabilities in diseases, crop protection, and on-farm research by joining PRAPAC. Kenya is already involved indirectly in the network through the Muguga plant quarantine station near Nairobi.

(p) PRAPAC should work within the larger structure of the agricultural sector in each country to improve the linkages between potato research and clean seed production, and the agencies responsible for seed bulking, seed distribution, and extension. A continuing effort must be made to increase the availability of quality seed in all PRAPAC countries. This work must be based on a systematic assessment of farmers' needs. The research institutions should produce enough basic seed for distribution to multiplication facilities, and private sector multiplication should be explored. The research institutions should provide adequate training to key personnel in the extension system and in seed multiplication agencies.

(q) Collecting and monitoring of economic baseline data needs much more emphasis in the network, through end of the grant, to assist member countries to focus their limited research resources on farmers' priorities. One way in which this could be fostered would be the recruitment of a social scientist experienced in biological aspects of potato research as a replacement for the coordinator at the conclusion of his assignment. The institutionalization and integration of the socio-economic component into all other potato research requires sustained technical assistance over the remaining two years of project activities. PRAPAC should take a more active role in encouraging socio-economic research and monitoring by national scientists. Workshops should be organized on methods for diagnostic surveys of farmers' conditions and needs, farmers' economic returns, and for other socio-economic research tasks such as the monitoring of the adoption of new varieties and other technologies. Data collected from farmers should be diaggregated by gender, as the needs of women farmers may differ from those of male farmers.

(r) The PRAPAC coordinator should travel more frequently to Uganda and he needs to intensify his contact with the University, the Ministry of Agriculture, and the USAID Mission in Uganda. Using existing and available resources, much more could be accomplished by the national researchers. The PRAPAC Coordinator should attempt to stimulate innovative planning to this end.

(s) The viability of potato production at mid-elevations in central Uganda and southern Rwanda should be carefully evaluated. Key elements include a demand survey in the urban markets in Kampala and Kigali and a survey of the current cropping patterns and other alternatives which farmers have in the potential producing areas. Varieties and production technologies which have been developed at CIP should be screened under local conditions, with the direct participation of farmers. Introduction of these varieties would enable a larger area of smallholder potato production to be established in Uganda and Rwanda.

B. For REDSO/ESA

1. Through End of the Grant:

(a) REDSO and the USAID missions in each country should improve their mechanisms for consultation and joint planning. Financial support for the potato programs in each country should be included in the regular programs of each USAID mission in support of agricultural research. Network activities fall logically within REDSO's regional mandate, as does follow-up on the SPAAR proposal which was accepted but not funded.

(b) Funding must be found for the national potato program in Zaire, which has never received an operating budget from either INERA or the USAID country mission in Kinshasa. USAID/Zaire should be resolicited for funding.

(c) REDSO should develop a schedule with USAID/Kampala for release of funds for Uganda potato research, and formalize these financial contributions.

(d) The biennual Agricultural Development Officers' Conference should be used as a forum for reaching agreement between the REDSO Agriculture Office and USAID Missions in Rwanda, Burundi, Zaire, and Uganda on funding contributions and the scheduling of ancillary annual budget and congressional presentation inputs and obligation document presentation. The REDSO Agriculture Office should follow up by circulation of an annual report to missions in February of each year, as input to missions' preparation of their annual Budget Submission for AID/W.

(e) The REDSO Regional Pesticide Advisor should look into the use of chemical fertilizers and fungicides (primarily Dithane M45 and Ridomil 58 WP) in experimental and seed multiplication plots in Rwanda and Burundi, and a very limited use of Actellic, a low-toxicity insecticide, on seed potatoes stored on the research stations. These two countries are categorically excluded under USAID Reg. 16 Section 216.2(c)2(ii), and thus could use small amounts of 'cleared' pesticides for controlled experimentation. The major activity of concern was the use of Dithane M45 by the Rwandan farmers. The team was not able to verify if the farmers received adequate training in the safe use of fungicides before the technology was made available to them. The PRAPAC Coordinator should continue to seek REDSO's advice and approval before allowing participating researchers to use chemicals of any kind in their research activities.

2. For the Longer Term:

Assess the availability of funding for a Phase II of PRAPAC support, and the feasibility and cost-effectiveness of alternative ways of funding central African potato research, studies, and training. The major goals of PRAPAC are to encourage collaborative and complementary potato research, and to provide technical assistance and training. Alternatives to a Phase II REDSO grant to CIP for PRAPAC which could produce these outputs should be explored and weighed for their cost-efficiency in comparison with continued support for PRAPAC institutionalization, as PRAPAC is likely to remain heavily dependent on donor funding through the foreseeable future.

These alternatives might include one or more of the following options: (1) bilateral USAID mission or REDSO support for multi-national and short-term technical assistance workshops as a grant to CIP and/or to one or more national potato programs without PRAPAC overhead funding; (2) bilateral USAID mission support for short and/or long-term training for potato researchers under the cover of the existing multi-sectoral bilateral training projects; (3) local currency USAID mission support for national potato research as part of on-going and future bilateral agricultural research projects and/or sectoral programs; and/or (4) all four USAID bilateral missions contributing to a joint PRAPAC grant budget. Use of a USAID Mission buy-in mechanism for Phase II would simplify and concentrate financial management at the regional level. Support for national potato research programs is essential to the effectiveness of a Phase II regional grant. Unequal funding for the national programs threatens the integrity of the PRAPAC network.

C. For CIP through End of the Grant:

(a) Under the present grant to PRAPAC, a detailed proposal for use of the $188,000 contingency line item needs to be prepared by CIP to meet expected shortfalls in the budget line items for the Coordinator's salary, supplies and services, CIP should also assess whether these contingency funds can provide bridge funding from February 1991 - September 1992 to continue the support of PRAPAC through the completion date of A.I.D.'s overall Support to African Agricultural Research and Faculties of Agriculture Project".

(b) CIP should request that REDSO revise its grant budget to procure for each national program one micro-computer, and a set of standard software packages. The researchers should be trained in word-processing, spreadsheets, database management, and statistical analysis of data. Assistance should be provided in research design and data analysis.

(c) A CIP scientist with a vehicle and operating budget, seconded to INERA for work in the Kivu region of Zaire, would help strengthen Zaire's potato research efforts. Though funding is not available for this in the REDSO grant, CIP should solicit outside funds for these purposes.

(d) Explore interest of A.I.D. and other donors in funding the continuation of PRAPAC activities after the termination of the REDSO/ESA grant.

D. For Host Country Collaborating Institutions through End of the Grant:

(a) Assess long-term undergraduate and graduate level training needs for potato research and propose candidates for training to appropriate donors, including bilateral USAID missions. The USAID Missions in Burundi, Rwanda, and Uganda have separate human resources development projects that might be able to fund a limited number of external degrees, and proposals should be developed for A.I.D.'s bilateral consideration under these separate projects. More attention should be given to recruitment of women researchers for training.

(b) The Ugandan Ministry of Agriculture should consider moving the national potato program coordinator's office from Entebbe to the Kawanda research station. This move could help improve communications with potato research programs.

The national research program coordinator should take a more agressive leadership role in soliciting and managing resource allocations.

(c) In collaboration with Makerere University faculty members, the Ministry of Agriculture should conduct a socio-economic survey of potato farmers and consumers. The head of the Ugandan potato program, the PRAPAC Coordinator, and social scientists at the University should work together to make sure that these surveys document the regional as well as national importance of potatoes as a food and their potential importance as a cash crop. The findings should be integrated into national development plans.

(d) Potato should be incorporated in the Uganda Government's 5-year food crop research plan. A short proposal should be submitted to USAID by May 7, 1989, for funding (about $25,000 in foreign exchange plus local currency). CIP/Nairobi should help develop this funding proposal. Needs should be ranked in order of priority, and every effort should be made to get

the research program moving as soon as possible, even with less than optimal resources. Low-cost research facilities, such as the rustic storage structures and tissue-culture labs used elsewhere in the network, should be installed wherever possible.

E. For USAID Missions through End of the Grant:

(a) USAID/Burundi should consider incorporating studies on potato (e.g. production, marketing and consumption) and support for potato research into its on-going programs: the redesign of its separate Farming Systems Research Project and/or the design of its new Agricultural Marketing Economic Policy Reform Program.

(b) USAID/Rwanda should consider using project development and support funds to commission a study on the current and potential importance of potatoes in comparison with other commodity research, as input to the planned FY90 design of its new agricultural research project. Based on the findings of this study, USAID/Rwanda should consider funding the local costs of national potato research under its future new agricultural research project.

(c) USAID/Zaire should consider funding the local costs of national potato research in the Kivu through PRAPAC.

(d) Both USAID/Burundi and USAID/Rwanda should consider funding undergraduate and graduate level degrees for national potato researchers under the cover of their separate Human Resource Development Projects. USAID/Uganda should consider funding up to two Ph.D. degrees for potato researchers under its Manpower for Agricultural Development Project. Thesis research should be done in the host country, and returning graduate-degree holders should be required to devote at least two years to potato research for each year of training.

(e) USAID/Uganda should consider programming at least $25,000 for immediate foreign exchange needs plus local currencies to support potato research through end of the REDSO grant. To preserve this foreign exchange for imported lab and screenhouse

62

inputs, purchase of a vehicle with local currency should be considered. Potato research and its budgetary needs at both the Ministry of Agriculture and at Makerere University should be incorporated into USAID's on-going assistance towards development of a five-year national agricultural research plan.

XII. LESSONS LEARNED

1. Networking cannot substitute for development of the national research programs. A network is only as strong as its weakest link. The importance of long-term training for institution building should not be overlooked. Donors should build up national program strength through support for graduate training to promote networking. As REDSO/ESA manages seven regional agricultural research projects, the annual Scheduling Conference should be used as a forum for coordinating bilateral USAID Mission support.

2. Links between research and extension need to be improved. This is a problem worldwide, not just with PRAPAC. In general, extension services are particularly weak, or even nonexistent, in many parts of Africa. Donors need to explore ways of helping governments upgrade their extension services and link them more closely with research efforts.

3. In all commodity research networks, special attention should be paid to the improvement of seed multiplication and distribution services. These services are often poorly developed, and located in different ministries from the research function.

4. Agricultural research is a long-term process; dramatic results at the farm level cannot be expected within the first few years. Rather than expecting breakthrough research achievements involving very difficult problems, in networking, early emphasis should be on exchange of information such as on successful varieties, growing seasons, storage management, and assessment of real farmer problems with a crop.

5. During the early years of a network, its Coordinator should be able to devote full time to creating an atmosphere conducive to cooperation among the collaborating countries. Though ideal, it is difficult to recruit a Coordinator with both technical science and administrative (e.g. funds negotiation) skills. If major construction of any kind is necessary, a full or part time local engineer should be hired by the grantee to manage this construction to avoid inefficient use of scientists' time.

6. Many of the benefits of networking among institutions -- better use of scarce scientific manpower, better communication between researchers working on similar problems, or better capacity to adapt international scientific knowledge to local conditions -- are much more difficult to measure than the discrete outputs provided by other kinds of development projects. Chronic problems of transportation and communication are barriers which affect the rate of progress in network development.

Appendix A: CIP/PRAPAC Interim Evaluation Scope Of Work

Section One: Activity to be Evaluated.

The Potato Research Network of Central Africa is a ten year collaborative Research Project, funded initially for five years by USAID through grants to the International Potato Center (CIP). The project is being implemented by CIP in collaboration with PRAPAC (a French acronym for Regional Potato Improvement Program for Central Africa) and the National Potato Programs of Rwanda, Burundi, Zaire and Uganda. The Project base is in Rwanda where the CIP/PRAPAC Coordinator is located. CIP African headquarters is located in Nairobi and some advanced breeding work for the PRAPAC network is provided by the Government of Kenya.

Authorization Number: 698-0435.04

Title: CIP/PRAPAC Potato Research Network Project. A sub-project of the Support to African Agricultural Research - (698-0435)

Cost: Regional (REDSO/ESA) US $1,557,000, USAID Rwanda US $251,100, USAID Burundi US $690,000, and USAID Uganda is providing support through its local currency accounts. No bilateral funding for project activities has been found for the Zaire program. Additionally, PRAPAC member countries will contribute about US $289,000 in local resources allocations during the life of the project (LOP).

Life of Project Dates: 02/14/1986 -- 02/13/1991

PACD: February 13, 1991

Section Two: Purpose of the Evaluation

This interim evaluation provides a timely opportunity to review CIP's multi-country networking concept and its present validity as a research coordinating unit. The review should produce a consensus of opinion between the evaluation team and key project collaborators on PRAPAC's immediate operational needs and future programming requirements. In addition, it will afford REDSO/ESA an opportunity to assess the adequacy of grant management arrangements. Evaluation recommendations will serve to guide project management in its planning for the remaining LOP, and hopefully lead to greater project sustainability and eventual growth of the PRAPAC Network and its collaborating national programs.

The purpose of this first collaborative interim evaluation is to provide project management with recommendations and strategies in the following key areas: (1) is the present configuration, management and working relationship of PRAPAC producing expected and needed outputs in (a) a regional collaborative forum and coordinated research network, (b) institutional and manpower development of national programs and (c) improved genetic materials that are accessible to local farmers? (2) can present funding, including all sources, provide sufficient services to both the new Member State of Uganda and the "unfunded"Kivu province of Zaire without serious curtailment of other planned activities? If not what are the alternatives? (3) should PRAPAC remain a priority regional program for REDSO/ESA? (4) Do REDSO's management arrangements assure adequate monitoring of the grant?

Section Three: Background

(a) Introduction

In response to an unsolicited proposal presented to A.I.D. by CIP and the PRAPAC member countries, grants were made by both the Africa Bureau and two bilateral USAID Missions. The Grants support CIP's efforts in the establishment of a potato research network in Central Africa under the framework of PRAPAC. PRAPAC is an inter-governmental organization formed in September of 1982, by an agreement between the Governments of Rwanda, Burundi and Zaire. Uganda joined PRAPAC in June 1987. PRAPAC has no legal status and it is optional for other countries in the region to become members or collaborators. At present Uganda, Kenya and CIP Nairobi also participate in PRAPAC activities. PRAPAC coordinates potato research and manpower development in the Central Africa region.

(b) Project Goal and Objectives:

The regional grant provided support to CIP to continue and expand a potato improvement and research network in Central Africa, PRAPAC. The goal of PRAPAC is to establish collaborative research activities which will facilitate the efficient utilization of a relatively few scientists currently conducting potato research in the region. The objectives of the project are to support and train local research personnel so that they might develop appropriate production technologies as well as potato varieties that are specifically adapted to the region and thereafter, establish mechanisms that will bulk seed stock and disseminate these to smallholder producers in the region.

Section Four: Statement of Work

The evaluation team is asked to review several priority areas to determine project progress in relationship to expected outputs of the CIP Unsolicited Proposal, the USAID Project Agreement, PRAPAC's Regional and National Research Agenda and the collaborating National Research Agencies' work plans and priorities. The analysis of this data and the Team's conclusions lead to specific recommendations to improve PRAPAC operationally and assist PRAPAC management in developing a long-term strategy.

(a) Study Areas:

(1) Determine the present status of the potato research network in the region, identify its staffing configuration, establish what are its management and working relationships and delineate its principle activities and accomplishments. (As a benchmark for measuring project progress the team should review the project proposal and the baseline data established at the outset of the project.)

(2) Determine whether direct and in-kind project inputs are being made as needed and establish whether these inputs, as well as the level of performance of all participating institutions, are consistent with the original project agreement. To what degree have these inputs contributed towards achievement of the stated project objectives of regional research collaboration, farmer access to improved genetic planting materials, host country manpower training and institutional development?

(4) Assess the impact of project activities on National policies, resource allocations for potato research and the improvement in management or organization of participating country program. What has been the role and accomplishments of CIP/PRAPAC relative to the institutional development of a regional network and its eventual sustainability?

(5) Assess the effectiveness of PRAPAC's technology information system and the extent to which it is being utilized to disseminate relevant project outputs to the interested parties and targeted groups in the region.

(6) Determine the level of commitment of the member countries, bilateral Missions, Special Programs for African Agricultural Research (SPAAR), or other donors towards supporting current and future project activities in the region. The evaluators must delineate financial problems that must be addressed and recommend possible solutions. Determine the best form of project financial support for current, as well as future project activities, including coordination responsibilities.

(6) Estimate the nature and extent of any further involvement of member countries, USAID (REDSO/ESA or Bilateral Missions) or other donors in follow-on project activities after the completion of the current five year regional A.I.D. Grant to PRAPAC. The team should also propose a strategy and organizational structure that will enhance prospects of project sustainability after the PACD.

(b) <u>Additional Project Activities to be Analyzed</u>:

(1) Assess the quantity as well as the quality of collaborative research sub-projects that are being conducted by the National Agriculture Research Systems (NARS) and in the case of those funded by PRAPAC establish what were the selection criteria and screening processes. Determine whether research objectives are consistent with those of A.I.D., CIP and PRAPAC as stated in the Grant Agreement and other official project documents. Establish whether these sub-projects are perceived by National Programs to be relevant to their priority needs or only those of PRAPAC.

(2) Evaluate the training being offered through the project and the effectiveness and utilization of the training materials that have been developed.

(3) Assess (from the beginning of the project) the direct input of CIP professionals and consultants and establish whether it is consistent with the grant agreement and the stated needs of the member countries.

(4) Determine the number of new potato varieties that have been selected as well as cultivation practices that have been validated as ready for transfer. Establish whether these new varieties and practices have been adopted by farmers in the region.

(5) Review the baseline data summary assembled at the beginning of the project and its periodic up-dating in relation to the current status of the project and present levels of potato production in the region. Assess the PRAPAC baseline information use of participating agencies.

(6) Identify additional areas of support or resources needed by the National Programs that may have resulted directly or indirectly from project activities.

(7) Review the project budget and cumulative level of expenditure by line item, recommend revisions if warranted. Review internal and external CIP system for financial audits.

(8) Review CIP's policies and those of national programs concerning future potato research work in the region and establish initiatives. Does the active participation of Research Directors in the management and direction of PRAPAC detract from their national duties and obligations?

(9) Determine if the National Research System in Rwanda will be able to support the operational costs of the PRAPAC training center. Are there alternatives that must be considered?

(c) <u>Management Considerations</u>:

(1) Determine whether the existing institutional arrangements between PRAPAC, CIP and the National Agricultural Research Systems have facilitated effective project coordination and contributed to efficient project implementation. Has the presence of the Network promoted and supported collaborative potato research within the region?

(2) Review the effectiveness of REDSO/ESA, USAID and CIP project management arrangements and financial controls recommend improvements where appropriate.

(3) Review CIP/PRAPAC annual workshops and operational budgets and assess the effectiveness of these as management tools for project implementation. (Also assess compliance with grant agreement covenants.)

(4) Do REDSO management provide arrangements for sufficient monitoring of grant funds?

(5) Do, or should, bilateral missions (e.g. USAID/Rwanda, USAID/Burundi, USAID/Uganda) have staff assigned to monitor implementation of PRAPAC bilateral activities?

(6) Do combined A.I.D. staff resources provide CIP with timely monitoring and approvals, as required?

Section Five: Methods and Procedures

The Evaluation will take place from March 14, 1989 through April 2, 1989 in Rwanda, Burundi, Kivu province of Zaire, Uganda and Kenya. The Evaluation will be done in accordance with the provisions of the grant agreement which calls for a midterm evaluation during this period. The evaluation will assist with regular project monitoring and oversight requirements.

The CIP regional office in Nairobi, in consultation with REDSO/ESA, will prepare a travel and study program for the Evaluation Team to follow. The CIP regional office, the PRAPAC coordinator and CIP scientists will also provide office space, accommodation and logistical support for the Evaluation Team.

The team will follow the format and guidelines established by USAID in the supplement to Chapter 12, AID Handbook 3, Project Assistance, entitled, "AID Program Design and Evaluation Methodology Report No. 7". The team will use the following data collection, and interview methods:

(1) Review, since the beginning of the project, all A.I.D. project documentation, the records of the PRAPAC Executive Committee's deliberations, those of PRAPAC Director's Committee, the Coordinator's formal presentations and the consultants' reports. Examine the Executive and Directors committees' actions and responsibilities in programming and managing PRAPAC.

(2) Interviews and discussions with appropriate scientists involved in the project and an examination of their activity records, data and conclusions. Interview trainees that have participated in formal and informal training activities.

(3) If necessary, to gather further data, visits to field research sites, training facilities and farms in the participating countries; i.e. Rwanda, Burundi, Zaire and Uganda.

(4) Visits to collaborating institutions and agencies for discussions with National Research Directors, USAID Director, Program Leaders and Project Managers.

(5) Visit CIP country and regional offices where financial and administrative records are maintained. Discuss procedures with staff responsible for maintaining the records.

Section Six: Evaluation Team Composition

A five person evaluation team will be composed of representatives from the (1) REDSO/ESA (Agronomist and Project Development Officer), (2) CIP Headquarters, (3) the PRAPAC Executive Committee and (4) an independent consultant mutually selected by REDSO/ESA and CIP. Resource personnel for the evaluation team will be available from REDSO/ESA, the USAID Missions in Rwanda, Burundi and Uganda; the CIP regional office, PRAPAC and participating national programs. A REDSO/ESA PDO will have overall responsibility for preparing the evaluation including required A.I.D. documentation (e.g. PES face sheet); while the independent consultant will be the team's technical Leader.

Section Seven: Reporting Requirements

The format of the evaluation report will follow A.I.D. guidelines established in "The supplement of Chapter 12 of AID Handbook 3", and will include an executive summary, a table of contents, the body of the report, not to exceed 30 pages since spaced, and appropriate appendices (e.g. Executive Summary, evaluation scope of work, contact list and bibliography.)

The evaluation team will specify conclusions based upon the findings of the study and prepare a set of recommendations for improving future project implementation process. The report will be written jointly by the evaluation team under the coordination of the team leader, who will be responsible for submission of the document to the relevant institutions and in leading the debriefing sessions with USAID missions, national consultation with other team members, will assign to individuals responsibility for drafting sections of the evaluation report.

The draft of the evaluation report is due prior to the team's departure from Kenya. The final report, fully vetted by both USAID and CIP, is due in REDSO/ESA within 30 days after receipt of formal comments from CIP and REDSO/ESA. REDSO will prepare required A.I.D. documentation (PES facesheet and mission recommendations) based on the team's final report.

8990D

Section Eight: Funding

Cost of the evaluation is estimated at US$ covering the following items:

	REDSO	CIP	PRAPAC	CONSULTANT
International travel	-	-	-	Approx.$2,000
Regional Travel	(2x740)= $1,480	$740	(2x74)= $1,480	740
Per diem	(2x1188)= 2,376	1,188	(2x1188)= 2,376	1,178
Secretarial services and miscellaneous less	100	100	500	-
Consultant fees	-	-	-	5,250
Sub Totals	$3,956	$2,028	$4,356	$9,160
				$19,500

Appendix B: List of People Contacted

Alanyo, Mrs. Mildred, Agriculture Assistant, Uganda.

Aluba, Isaac, Agronomist/Project Manager, Uganda.

Akemo, Mary Christine, Plant Breeder, Kawanda Research Station, Uganda.

Akimanzi Deo, Co-ordinator, National Potato Research and Development, Uganda.

Ayo, Dr. Christopher, Scientific Officer/Agronomist, Acting Head of Horticultural Research Programme, Kawanda Research Station, Uganda.

Bahaya, Georges. Farmer-seed multiplier working with INERA potato program, Zaire.

Baliddawa, Callistus W., Associate Professor and Head, Department of Crop Science, Uganda

Bicamumpaka, Martin. Ph.D. candidate (on USAID funding through FSIP at Cornell). Former head of PNAP (ISAR), Rwanda.

Biranguza, Evariste. On-farm potato research specialist, potato program, ISABU, Burundi.

Bouwe, N.B. Ing. Agronome, Potato Program, INERA, Mulungu station, Zaire.

Bweyo, Lome. Head of the Munanira Station, ISABU, Burundi.

Carlo, Carlo. Seed Multiplication Specialist, CIP-Nairobi.

Crawford, Paul. Agricultural Development Officer, USAID, Rwanda.

Dominessey, Larry. Agricultural Development Officer, USAID mission, Burundi.

Fernandez-Northcote, Enrique. Virologist from CIP-Lima, on short-term assignment to quarantine station at Muguga, Kenya.

Gahamanyi, Leopold. Director, ISAR, Rwanda.

Graham, James. Mission Director, USAID, Rwanda.

Habyarimana, Fulgence. Ing. Agronome, PNAP (ISAR), Rwanda (TPS and storage).

Haile-Michael Kidanemariam. Regional Breeder, CIP-Nairobi.

Kashosi, N. A3 technician, INERA potato program, Mulungu station, Zaire.

Kayitare, Laurent. Ing. Agronome, PNAP (ISAR) Rwanda (germplasm management).

Kiutukwonka, Aggrey, Agricultural Director of Research, Namulonge Research Station, Uganda.

Kloos, Jeroen. Coordinator of PRAPAC, based in Ruhengeri, Rwanda.

Lolema, Onyembe Pene Mbutu, Jr. President Delegue General INERA/Kinshasa.

Lone, B. A2 technician, INERA potato program, Mulungu station, Zaire.

Lyvers, Ken, Agricultural Development Officer, USAID/Kampala, Uganda.

Magala, Gervais. Farmer-seed multiplier working with INERA potato program, Zaire.

Majisu, B.N., Director General, KARI, Kenya

Masambu, Hudson. Agriculture Division, REDSO/ESA. Nairobi.

Mathu, Ruth W. Head, Virology Laboratory, KARI Quarantine Station, Muguga, Kenya.

Mbasua, S. A3 technician, INERA potato program, Mulungu station, Zaire.

McColaugh, Robert. Agriculture Division, REDSO/ESA, Nairobi.

Miller, Don. USAID representative, Burundi.

Mukambilwa, L. A3 technician, INERA potato program, Mulungu station, Zaire.

Munyawera, ___. Extension specialist, PNAP (ISAR) Rwanda.

Murhandikire, R. Diploma in extension, INERA potato program, Mulungu station, Zaire.

Mutiso, B.N. Director General, KARI, Kenya

Mutombo, T. Ing. Agronome, Potato Program, INERA, Mulungu station, Zaire.

Muvira, Charles. Head of Pre-extension Program, ISABU and representative of ISABU at PRAPAC.

Mwesige, K. Robert, Economist, Kawanda Research Station, Uganda.

Mwaule, Y.W., Director of Research, Ministry of Agriculture, Uganda.

Mzoyilierda, Zacharie. Agronomist with potato program. ISABU, Burundi.

Ndayizamba, Andre. R2 technician with potato program, ISABU, Burundi.

Ndoreyaho, Valens. FSN Agricultural Officer, USAID/Rwanda.

Nganga, Sylvester. Regional Director, CIP-Nairobi.

Ngilutor, Simon. Head of the Mwokora seed multiplication station, Burundi.

Niyonaro, Anicet. Agronomist with the potato program, ISABU, Burundi.

Niyongabo, Edouard. Director General of ISABU, Burundi.

Njoroge, I.N. Director, National Potato Research Station, Tigoni, Kenya.

Nkakyekorera, Mrs. F.N., Agronomist, Kawanda Research Station, Uganda.

Ntaganda, Jean-Pierre. R3 technician with potato program, ISABU, Burundi

Ntagunama, Frederic. Head of the seed program, CVHA, Burundi

Nyezimiania, Marcien. Head of the southern sector, CVHA, Burundi

Nzara, D. A2 technician, INERA potato program, Mulungu station, Zaire.

Odogola, Wilfred Richard, Storage Engineer, Uganda.

Ojacor, Faustin, A., Commissioner for Agriculture, Uganda.

Okioga, D.M. Director, KARI Quarantine Station, Muguga, Kenya.

Podol, Richard, Mission Director, USAID/Kampala, Uganda.

Pyndji, M.M. Director of Mulungu station, INERA, Zaire.

Rubaihayo, Elisabeth, Director of Research, Kawanda Research Station, Ministry of Agriculture, Uganda.

Rubirigi, Alphonse. Ingenieur Agronome, potato program, ISABU, Burundi.

Rueda, Jose Luis. Scientist, CIP and Co-leader of potato program, ISABU, Burundi.

Rutto, J.K. Director of Research, KARI, Kenya

Sekayange, Leonard. Ing. Agronome, PNAP (ISAR), Rwanda (agronomy and on-farm trials).

Simenya, Diomede. Assistant head of the Munanira Station, in charge of the potato seed multiplication program, Burundi.

Sinding, Monica. Deputy Director of REDSO/ESA

Sinduhije, Antoine. A3 technician with potato program, ISABU, Burundi.

Ssonkko, N. Robinah, Lecturer, Crop Science Department, Makerere University.

Standard, Jean J. Program leader AGCD (Belgian Cooperation), Burundi.

Tabaro, L. A3 technician, INERA potato program, Mulungu station, Zaire.

Tegera, Pierre, Director PNAP (ISAR), Rwanda.

Trubish, Mrs. Vera, Agronomist, Kawanda Research Station, Uganda.

Turner, Caroline. Scientist, CIP/ODA, potato program, ISABU, Burundi.

Ughenzo, V. A2 technician, INERA potato program, Mulungu station, Zaire.

8990D

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8990D

Appendix D: Technical Tables

TABLE 7: Distribution of Coordinator's Travel Time
February, 1986 - September, 1988 (31 Months)

COUNTRY	NUMBER OF TRIPS	DAYS	PERCENT
Rwanda	13	45	21
Zaire	17	40	19
Burundi	10	30	14
Uganda	2	7	3
CIP Regional Office, Nairobi	7	46	22
CIP Headquarters LIMA	3	42	20
TOTAL	52	210	100
AVERAGE/12 months	20	81	-

Visits from External Consultants:

- Han Beukema - Holland, Review of PNAP
- J. Bryan - Germplasm introduction and Handling
- Haile-Michael K.M. - Germplasm Management
- G.L.T. Hunt - Storage and Processing
- C. Carlo - Seed Production
- L. Turkensteen - Late Blight
- B. Parker - Insect Pest Management
- P. Schmiediche - Breeds for Bacterial Wilt resistance
- K. Brown - CIP Regional Research Director
- H. Masambu - REDSO Grant Administrator
- E. Armstrong - REDSO
- J. Landeo - Breeder for late Blight Resistance

TABLE 8: Research in National Potato Programs by Country in March, 1989

	Rwanda	Burundi	Zaire	Uganda
Germplasm evaluation				
Germplasm maintenance				X
Screening for adaptation	*	*	X	*
Late Blight resistance	X	*	*	
Bacterial Wilt resistance	*	X		
Seed production				
Tissue culture	*	*		
Basic seed production	*	X	*	X
TPS	*			
Plant protection				
Pathology	*	#	*	
Entomology		*		X
Agronomy	*	*	X	
Post-harvest storage and use	*	X	*	
On-farm research	*	*		
Socio-economic studies			*	
Extension	*	#	*	
Training	X	*		

* Projects in progress
X PRAPAC leadership role
\# Research done in cooperation with other divisions of the National Agricultural Research Systems

8990D

TABLE 9: PRAPAC: Basic indicators of potato production and research in member countries*

	RWANDA	BURUNDI	ZAIRE	UGANDA
Area in Potatoes (Has)	42,000	10,000	30,000 (Kivu) 50,000 (All Zaire)	90,000
Yield/Ha	6-9	5-7	2-6	2-7
Estimated Annual Production (1)	330,000	60,000	128,000 (Kivu) 150,000 (All Zaire)	360,000
Total Population (Million)	6.3	6.0	32.0	15.5
Average Per Capita Consumption (K)	52	10	4.5	23
Population Density/km^2	240	215	14	66
National Program Seed Production (T/yr)	500	100	8	

NOTE: Figures are drawn from various sources for various years in the mid-1980's and are approximate at best.

8990D

Appendix E: True Potato Seed (TPS)

Worldwide, potatoes are propagated asexually by planting a tuber or sprout-bearing part of a tuber. Potato plants also flower. The flowers contain the sexual parts, stamens and pistils. As the result of pollination and fertilization the flower produces a small, green tomato-like fruit which contains a dozen to several hundred seeds. These are the true seeds of the potato, the TPS, not the tubers which are commonly called "potato seed".

Despite their small, pin-head size TPS contain all the genetic information to produce a vigorous tuber-bearing plant. What are the advantages and disadvantages of growing potatoes from TPS?

Advantages of TPS

1. Saves putting up to two tons of food tubers into the ground to grow a crop.
2. Pathogenic bacteria, fungi and viruses are not carried by TPS. (Virus "T" is a very rare exception)
3. TPS does not require refrigerated for diffused light stores but can be kept for several years in a bottle on a shelf.
4. TPS can be carried in a farmers pockets sufficient to plant several hectares.
5. If the plants produce fruit the seed is free.

Disadvantages of TPS

1. The use of TPS requires more gardening skills to handle the weak seedlings.
2. TPS may not be locally available.

Appendix F: The Ugandan National Potato Research Program

Uganda is the largest potato producer in the PRAPAC network. Approximately 90,000 hectares per year are harvested in two highland regions. The most important is the Kabale district in the southwest, near the border with Rwanda, where potatoes are a major food staple. The crop is also important in the southeast, on the slopes of Mt. Elgon. Yields average 7 tons per hectare. The major commercial market is in Kampala and surrounding areas, where retail prices are nearly three times the farmgate price, due to high transportation and other marketing costs. There is significant potential demand in these urban markets if prices can be reduced by the expansion of production in nearby, mid-elevation areas. This would require the introduction of new disease-resistant varieties adapted for these lower elevation sites.

History of the Program

Research on potatoes after independence was initiated in 1968 with a USAID-funded project at Makerere University under the direction of Dr. R.T. Wurster. He worked closely with the Ministry of Agriculture at its Kalengyere sub-station in Kabale. Germplasm was introduced from the USDA in Beltsville, Maryland, and from CIP.

The principal objective then, as now, was to identify varieties with "multigenic" or "horizontal" resistance to Late Blight. Although this goal was not achieved, ten good, high-yielding, moderately resistant varieties were released and widely distributed by 1974. Four of these varieties are still widely grown throughout the PRAPAC region. An effective seed production and quality certification program was established. This first round of potato research in Uganda formed the basis of the programs later established in Rwanda, Burundi, and Zaire. Research was interrupted in the mid-1970's by political turmoil.

Re-establishment of Potato Research

In the early 1980's, Uganda participated in discussions about the formation of a regional potato research network, but was not able to formally join PRAPAC until 1987. At that time Uganda was given leadership responsibilities for three research areas:

1. Breeding and selection of disease resistant germplasm
2. Integrated pest management
3. Basic seed production

Progress has been slow in the last two years, limited by lack of funds for national research operations. The Ugandan program has not yet been able to provide any technology to the other countries in the network. Nine Ugandan scientists have participated in workshops and training programs sponsored by PRAPAC, and the national program has received assistance in financial proposal development from both CIP and REDSO in Nairobi. The PRAPAC Coordinator has only visited the production district in Kabale and the national offices in Entebbe/Kampala once.

The national research program concentrates on the screening of germplasm, both at Kalengyere and as a thesis project at the University. Some initial work is demonstrating the principle of diffused light stores to seed producers. Planting densities for potatoes in mixed cropping systems are being recommended. Research on integrated pest management has not yet been initiated. No socio-economic surveys have been carried out to evaluate constraints at the farm level, and no on-farm trials have been established.

A basic seed program has been re-initiated, using contract farmers who work under the direct supervision of researchers on plots of land provided on a state farm. Seed and fungicides are also supplied to them by the program. A second round of multiplication is carried out in the potato-producing districts under the supervision of seed specialists from extension, many of whom have been trained at CIP's regional headquarters or in Holland. Nevertheless, the integrated program is only in the early stages of re-establishment.

The following constraints on the research program were cited by the scientists interviewed:

1. Inadequate funding from the national government and from donors. Particularly limiting has been the lack of foreign xchange for screen houses, storage facilities, and lab equipment for the Kalengyere (high elevation) and Kawanda (mid-elevation) research stations.

2. Legacy of political instability in the past.

3. Lack of a vehicle assigned to the potato program, given the distance from Kampala/Entebbe to the Kalengyere station and from there to potential on-farm testing sites.

4. Lack of suitable varieties for testing under mid-elevation conditions.

5. Inadequate training for research and extension staff.

Human Resources Available for Potato Research

Despite a long hiatus, the human resources available for potato research in Uganda are perhaps the best trained of the PRAPAC countries. The program in the Ministry of Agriculture currently has seven full-time researchers: three with M.S. degrees, and four with B.S. degrees. As a horticultural crop, the program is based at the Kawanda station near Kampala, though research is currently carried out in the highlands at the Kalengyere station. The national coordinator, who has worked with potatoes for nearly 20 years, is fully occupied with administrative tasks and is based in Entebbe.

Uganda is the only country in the PRAPAC network with a close, formal link between government-sponsored research and the University, although the level of activity has been limited by lack of funds. At present, only one member of the staff at Makerere University (with an M.S. degree) is assigned to work full-time on potatoes, though three faculty members with Ph.D.'s have agreed to work with the program if funding becomes available.

Despite of this relatively high level of staff training, there are some good arguments for donor support for additional external graduate degree training. Makerere University is just re-estabishing its work in potato research after a long period of inaction. There are too few supervisors for M.S. and Ph.D. candidates at Makerere, so it takes several more years to finish a degree in Uganda than in the United States.

Capabilities of Extension

Research and Extension are separate divisions within the Ministry of Agriculture. In the eight districts of the country where potatoes are grown, the District Agricultural Officer has an officer specialized in the crop on his staff. They work together to organize training sessions for the extension workers to teach them about technology available for diffusion. Each extension worker supervises a number of field assistants. Theoretically, there are enough field personnel to maintain contact with the farmers. Their effectiveness is limited by a shortage of transport and by their meager salaries. They are forced to find supplementary means of livelihood, and are only on the job for a few hours per week.

The Status of Potatoes in National Research Plans

Senior scientists in the Ministry of Agriculture and at Makerere University highlighted the current importance of the crop as a basic food in the two highland regions, and its potential importance as a cash crop in mid-elevation areas in the center of the country, if appropriate varieties and technologies can be found.

Nevertheless, this has not been recognized in the 5-year research planning exercise currently being carried out under the USAID-funded Manpower for Agricultural Development Project, which is implemented through a contract with Ohio State and Minnesota Universities. To date the draft plan has not included potatoes in the list of priority crops; currently grains and oilseeds head this list. Explicit reference to the potential of potatoes in national planning documents of this type would give the national research program great importance in the allocation of research funds.

Support from USAID/Kampala

USAID/Kampala allocated 16.5 million Ugandan shillings for potato research over the nine months from September, 1988 through June, 1989. The importation of ten tons of basic seed from Rwanda and the purchase of 1,500 kgs of fungicides for the seed program have been financed from this source of funds. USAID/Kampala would consider providing bilateral support of up to approximately $25,000 in foreign exchange and additional local currency for potato research if the following conditions can be met:

- (a) A brief summary proposal including budget items listed in order of priority must be submitted by early May, 1989. It should clearly document the current status of the program and the objectives for the next five years of potato research. The budget should separately identify the funding needs of the Ministry and the University.

- (b) REDSO/ESA must take full responsibility for monitoring and reporting on these funds. USAID/Kampala is already over-burdened with its large bilateral portfolio.

- (c) Steps must be taken to integrate the potato program into the Ministry of Agriculture and University five-year plan for research on food crops.

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