PN-ABL-744

SAPPRAD

Southeast Asian Program for Potato Research and Development

5-YEAR REVIEW

1982 - 1986

PN-ABJ-744
ISN 63164

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May, 1987

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Part I

The Summary Report

EXECUTIVE SUMMARY

General Comments

- The primary focus during the first five years, 1982 to 1986, has been on research and development to carry out the projects agreed upon by the SAPPRAD member countries.

- With minor exceptions reflecting the relative stage of development of a country, excellent progress has been made toward achieving the basic research and development objectives of the six projects. Institutional capacity has been greatly strengthened.

- The technology transfer project has been especially effective, and is serving as a model for other programs.

- Considerably more transfer of technology has occurred within countries than among countries.

- To ensure the successful transfer and verification of research results among the participating countries and the dissemination of technology among farmers, an extension of SAPPRAD for an additional five years is urged.

- It is proposed that a review of the continued effectiveness of technology transfer be undertaken in 1990.

- There is a consensus that an adequate supply of quality seed produced by either conventional or non-conventional means is essential in promoting greater use of this nutritious crop in SAPPRAD countries.

- The SAPPRAD initiative has stimulated a greater commitment to potato R&D in those engaged in policy making, agricultural research, extension and growing of potatoes.

- Administrative officials in five countries have endorsed the SAPPRAD approach through expanding counterpart participation and contributory funding support.

- Staffing in potato R&D promotion has increased substantially in all SAPPRAD member countries; increases since 1980 range from 55 percent to more than 400 percent.

- If the sweet potatoes are to be included in future plans, a logical first step would be a careful assessment of individual country needs.

Specific Country Observations

INDONESIA - Tropical Agronomy

- Agronomic methodologies developed through SAPPRAD activities are ready for dissemination.

- A strong interest in expanding potato production in mid-elevation areas has been shown. It is proposed that the present project be renamed, "Introduction of the Potato to the Mid-elevation and Lowland Tropics" to reflect activities currently underway.

- The team concurs with the country representative and others that the major future emphasis should be on applied R&D, and on the diffusion of information among farmers.

- The most immediate concern is the creation of a viable system to provide seed to mid-elevation and lowland farmers.

SRI LANKA - True Potato Seed (TPS)

- Sri Lanka's experience indicates that using TPS is a promising way to lower small farmers' costs and to extend potato production to non-traditional, humid environments.

- Very good progress has been made in breeding both open pollinated and hybrid TPS families producing high yielding and uniform progenies.

- A special 'Task Force' is being set up by the Department of Agriculture to coordinate TPS research, extension, training, seed production and distribution. The review team sees these as significant steps in the consolidation of an effective, client-oriented potato R&D program.

- The ban on the importation of certified seed has encouraged the Ceylon Tobacco Company to take up commercial seed tuber production using stem cuttings. Many small farmers have also begun experimenting with TPS. Careful monitoring of these experiences is urged, since they are on the frontiers of work in this critical area.

THAILAND - Storage and Utilization

- Staff resources dedicated to potato research have increased more than five-fold, largely due to the stimulus provided by SAPPRAD. The result is a high-calibre unit within the Department of Agriculture's Horticultural Research Institute.

- The Department of Agriculture has developed and shown farmers effective methods of storing potatoes. Since 1984, more than 200 farmers are known to have adopted diffuse light stores for storage of seed potatoes.

- The Agro-Industry Section of the Department of Agriculture has developed 17 different processed potato products, the recipes of which have been published and publicized on TV.

- Potato cultivation is being promoted by government agencies as a replacement for the opium poppy in the highlands.

- Thailand has made practical use of tropical agronomy technology developed in Indonesia and of clones and varieties sent from the Philippines.

- Useful information on the biology of the potato tuber moth (PTM) has been developed. Effective use of barriers of dried plant materials as well as other biologic methods are now available as practical measures for PTM control in storage. The demand for quality seed -- both for production of table and processing potatoes -- has grown in recent years and is now far greater than the supply.

- The International Potato Center (CIP) has posted a specialist in Thailand to service the region's postharvest R&D needs.

- The marketing study now underway is expected to provide useful information for orienting future potato R&D.

PAPUA NEW GUINEA - Practical Seed Production

- Published estimates appear to grossly underestimate the actual volume of potato production.

- Until recently, the program has generated few tangible results that could be transferred to other countries.

- Australian expatriates assigned to the program have shown in field scale the practicality of rapid multiplication by stem cuttings from "mother" plants grown from imported disease-free "tuberlets".

- The quality of seed produced is of pre-elite standards. Scale up by nationals aiming at somewhat less perfection in seed quality should be an immediate objective.

- The proposed government prohibition of seed imports has created a two fold seed demand. On the one hand there is high demand for processing quality tubers and on the other extreme the need to establish a seed source geared to the capabilities of native subsistence farmers.

PHILIPPINES - Breeding for the Lowland Tropics

- A working germplasm collection has provided the genetic material needed for establishment of a successful potato breeding and selection program for the lowland tropics.

- Varieties and clones selected in the Philippine project have been sent to Sri Lanka, Indonesia and Thailand as part of the early phase of technology transfer.

- The spectrum of races of the bacterial wilt organism in the Philippines has been characterized. Selections of resistant clones have been tested under both lowland and highland conditions. Lowland growers are encouraged to grow potatoes after paddy rice which supresses the bacterial wilt.

- Viruses are being eradicated from promising clones by meristem culture combined with heat therapy. This contribution to a successful seed program has been sponsored by SAPPRAD.

TECHNOLOGY TRANSFER PROJECT

- The Technology transfer Project has developed a unique strategy that integrates research, extension, training and farming.

- Potatoes are being grown together and in rotation, relay and intercropping systems with up to 7 other crops in large scale pilot tests. Farmers have already verified this system when the potato along with 4 other crops not only maximizes land use and return on investment but also spreads costs, risk and income.

- The SAPPRAD member countries are urged to implement this approach pioneered in the lowlands of Philippines and at mid-elevation in Indonesia in other areas and with other crops.

ABBREVIATIONS AND CURRENCY UNITS

Abbreviations

AARD	Agency for Agricultural Research and Development (Indonesia)
ACIAR	Australian Center for International Agricultural Research
ADAB	Australian Development Assistance Bureau
AVRDC	Asian Vegetable Research Development Center (Taiwan)
BSU	Benguet State University
BW	Bacterial wilt
CARI	Central Agricultural Research Institute
CIP	Centro Internacional de la Papa (Peru)
DAL	Department of Agriculture and Livestock (Papua New Guinea)
DLS	Diffuse Light Stores
ESCAP	Economic and Social Commission for Asia and the Pacific
FAO	Food and Agriculture Organization
GNP	Gross National Product
IDRC	International Development Research Council (Canada)
IITA	International Institute for Tropical Agriculture (Nigeria)
IPB	Institute of Plant Breeding (Philippines)
LEHRI	Lembang Horticulture Research Institute (Indonesia)
m.a.s.l.	meters above sea level
OP	Open Pollinated
PCARRD	Philippine Council for Agriculture and Resources Research and Development
PNG	Papua New Guinea
PTM	Potato Tuber Moth
R&D	Research and Development
RMT	Rapid Multiplication Technology
SAPPRAD	Southeast Asian Program for Potato Research and Development
TC	Tissue Culture
TOR	Terms of Reference
TPS	True Potato Seed
UPLB	University of the Philippines at Los Banos
USDA	United States Department of Agriculture
USAID	United States Agency for International Development

Currency Units

(at the time of the Review)

$	US dollar ($1.00 = 1.54 Australian dollar)
B	Bhatt, Thailand (B25 = $ 1)
K	Kina, Papua New Guinea (K0.86 = $1)
P	Peso, Philippines (P20 = $1)
Rp	Rupiah, Indonesia (Rp1,600 = $1)
Rs	Rupee, Sri Lanka (Rs28 = $1)

INTRODUCTION

Production and use of the potato in Southeast Asia gas traditionally been limited by a number of critical factors, including:

- Lack of good quality seed
- High production and marketing costs
- Limited areas for expansion in the highlands
- Limited knowledge about the potato's nutritional value
- Insufficient research manpower and funding, due to low priority on potato in these countries' R&D systems

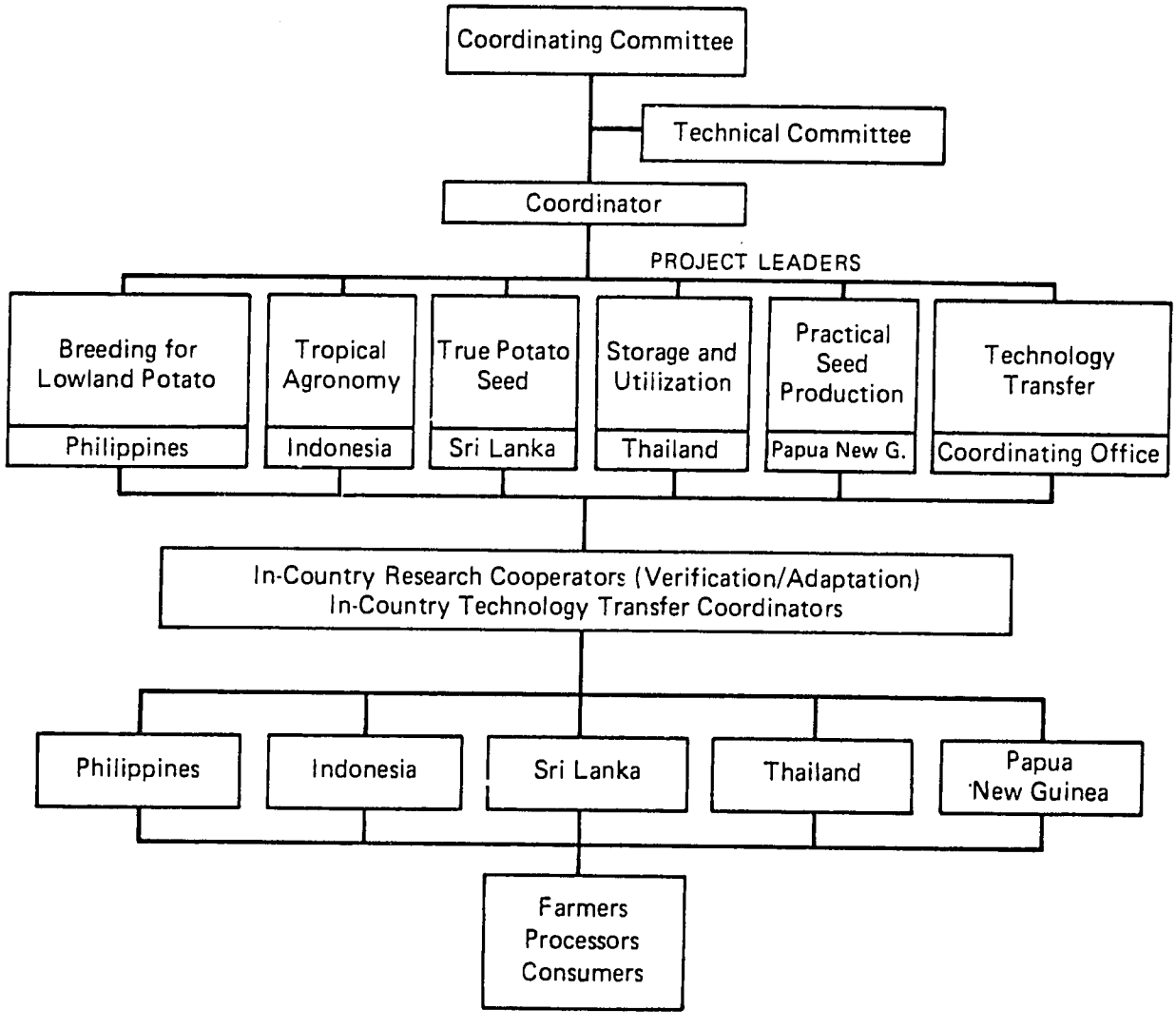
Based on the commonality of problems, Indonesia, the Philippines, Thailand, Sri Lanka and Papua New Guinea resolved to form a collaborative potato R&D program. In this way, the countries hoped to maximize the productivity of their meager resources by eliminating unnecessary duplication of efforts and by promoting synergistic complementation of activities.

To implement the plan, high-ranking representatives of each country, the International Potato Center (CIP), the Southeast Asian Center for Graduate Study and Research in Agriculture (SEARCA) and the Australian Development Assistance Bureau (ADAB) met in Jakarta in August 1981 and signed a declaration of intent to establish a regional cooperative program. In June 1982 representatives from the countries, CIP and ADAB met in Manila and signed a memorandum of agreement for implementation of a five-year program entitled "Southeast Asian Program for Potato Research and Development (SAPPRAD)."

The main objective of the program is to promote the development and utilization of the potato in the region through collaborative research and development. The research component consisted of five initial projects, each representing a problem area and assigned to a lead country. The development component consisted of catalytic activities to strengthen national research capability and technology transfer efforts to utilize the results of research for development purposes.

SAPPRAD is governed by a Coordinating Committee which serves as the policy making body (Figure 1). This committee consists of one representative of each of the five member countries, one of CIP and one of ADAB. The Committee's Chairmanship is rotated annually, and the Chairman's country hosts the annual meeting that year. The Coordinating Committee is assisted by a Technical Committee consisting of the SAPPRAD Coordinator (as Chairman) and one project leader from each member country. The two committees' annual meetings are usually held jointly.

Fig. 1. SAPPRAD Organization



CIP serves as the program's implementing agency and appoints the Coordinator in consultation with the Coordinating Committee. The first coordinator was Mr. Lindsay J. Harmsworth, former CIP Regional Representative for Asia and the Far East. Upon his retirement in February 1983, Dr. P.A. Batugal was appointed as Coordinator.

The program is funded by the countries themselves with ADAB providing about fifty percent of the operating funds. CIP also provides substantial in-kind contributions in the form of germplasm, training and technical assistance. CIP also funded half the salary of the Coordinator in 1982 and the full salary and perquisites of the Coordinator starting in 1986. From 1982 to 1986 the participating governments contributed about US$940,000, the ADAB US$1,250,900 and CIP US$110,100 (Annex 7).

Program Components

SAPPRAD has implemented six major projects (Table 1).

Table 1. SAPPRAD projects

Project Title	Lead Country/Office	Year	Project Leader
Breeding for lowland potatoes	Philippines	1982-86	Dr. E.T. Rasco Jr.
Tropical agronomy	Indonesia	1982-86	Ir. Surachmat Kusumo
True potato seed	Sri Lanka	1982-85 1985-86	Dr. SPR Weerasinghe Ms. Sita Abeytunge
Storage and utilization	Thailand	1982-86	Mr. Manoch Thongjiem
Practical seed production	Papua New Guinea	1982-83 1983-84 1984-85 1985-86	Mr. Bubia Muhuju Mr. Regan Roy Mr. Emmanuel Titimur Mr. George Gorogo
Technology transfer	Coordinator's Office	1984-86	Dr. P. A. Batugal

In addition, SAPPRAD has contributed to the research capacity of each country by supporting the training of country researchers and their

participation in meetings, workshops and conferences (Table 2). SAPPRAD also provided catalytic support for laboratory, screenhouse, and extension activities (Table 3).

Table 2. Participants in training, conferences, workshops, monitoring/observation tours and field days sponsored or co-hosted by SAPPRAD

Classification	Indonesia	Philippines	Thailand	Sri Lanka	PNG	Total
Researchers	31	60	36	35	8	170
Extension/trainers	20	50	30	579a/	46	725
Farmers	85	245	350	769a/	-	1,449
Industry reps.	15	25	15	20	5	80
Total	151	380	431	1,403	59	2,424

a/ Number represent actual count of people who may have taken more than one course.

Table 3. Aphid-proof screenhouses constructed with SAPPRAD assistance

	1982	1983	1984	1985	1986	Total
Indonesia			1	2	3a/	6
Philippines				3	2a/	5
Thailand		1	1	2	2	6
Sri Lanka				1	1	2
Papua New Guinea			1	2	3	6
Total		1	3	10	11	25

a/ Farmer's seed potato farms.

Project leaders are nominated by the government of the lead country. The country representative to the Coordinating Committee submits the nomination. The project leader for the technology transfer project is nominated and approved by the Coordinating Committee. Each country's project leader is an active researcher who plans and coordinates the

country's project. All project leaders submit annual workplans for endorsement by the Technical Committee and approval by the Coordinating Committee.

Strategies and Methodologies

Some potato research has been going on in the region for as long as 50 years. Over the last 15 years, CIP has conducted several studies that have further advanced the information base on the crop. SAPPRAD, therefore, adopted a strong development orientation in both its research and technology transfer projects. Each lead country was encouraged to conduct research that would build on what was already known, rather than attempt to "re-invent the wheel." In the third year of the program, 1984, each lead country was supposed to lead a regional training course that was co-sponsored by SAPPRAD and CIP. Four courses were conducted:

- Storage and utilization - Thailand
- Tropical agronomy - Indonesia
- True potato seed - Sri Lanka
- Germplasm management - Philippines

In these courses, attended by three to five researchers from each SAPPRAD member country, the state of technology from CIP Lima, Regions VI and VII and the national potato programs was assessed, gaps were identified and research workplans for verification/adaptation trials were formulated. Initial location-specific technology recommendations were tested in farmer's fields and the results of these trials provided the basis for formulating a potato production "technoguide," which contains the "best-as-of-the-moment" recommendation. The technoguide is upgraded periodically on the basis of new information. To date, Indonesia, Papua New Guinea, Philippines and Thailand have published potato technoguides. Sri Lanka is expected to publish its technoguide in 1987. The technoguides are now being used by students, researchers, extension workers and farmers of each country.

In 1984, the Technology Transfer project was also initiated, to further strengthen of potato R&D capacity and the practical application of results in each country. Efforts consisted of pilot testing and refining technology in farmers' fields in strategically selected potato communities which may serve as local point for expanded potato production. The seed potato system of each country was also strengthened through the introduction of new techniques such as rapid multiplication, true potato seed and diffused light storage.

In April 1984, a Mid-Project Implementation Review was conducted. The terms of reference included five points: (1) determine the degree of each country's commitment in developing its potato industry; (2) determine the extent to which the project objectives were being met; (3) determine if research undertaken was contributing to national and

regional capabilities in the field; (4) make recommendations for fucure development of the program in terms of objectives, methods, contributing organizations and management; and (5) recommend areas for future priorities.

Terms of Reference

The Five-Year Review's objective is to answer, and provide relevant documentation on, the following six questions:

1. To date, to what extent has SAPPRAD promoted the development, production and utilization of the potato to the benefit of low income groups of Southeast Asian countries? Other beneficiaries, and the degree to which they have benefited should also be identified.

2. What specific results has each project produced which could contribute to the solution of problems common to the region and which restrict more efficient production of potatoes?

3. What socially acceptable and environmentally sound technologies or technology components are now ready for dissemination or could be used for planning or policy formulation at the national, provincial or village level? (The emphasis should be on sustainable technologies.)

4. To what extent has collaboration among countries been achieved in research and technology transfer? What obstacles to, and risks of, collaboration have been identified? (PNG's potential will need specific attention.)

5. What would be the usefulness of extending the program into a further phase, and what modifications would be required? (Consideration of this question should focus on sustainability, social and environmental issues, and potential beneficiaries.)

6. What benefits, difficulties and costs could be expected if sweet potatoes were included in a further phase?

Methodology

The Five-Year Review was conducted from March 18 until April 17. The review team was composed of two experienced scientists: Dr. O.T. Page, previously CIP Director of Research and Dr. D.E. Horton, Head of CIP's Social Science Department. Dr. P.A. Batugal, the SAPPRAD Coordinator, served as a resource person and secretary to the team. Dr. J. S. Niederhauser was also expected to participate in the review, but did not.

The team reviewed the mid-project implementation review, each country's five-year summary, annual and special reports and program workplans. All participating countries were visited: Indonesia, Sri Lanka, Thailand, Papua New Guinea and the Philippines in that order. Each project leader and co-workers presented summary results of previous work, on-going activities and future plans. The team validated its initial findings with leaders of the research and development system of each country and also made an independent assessment through sample visits to research and technology transfer projects and interviews with field researchers, extension workers, marketing agents and potato producers and consumers.

A questionnaire specially prepared for the Five-Year Review was used to obtain the views of SAPPRAD participants on the major constraints to potato production and use, benefits and problems of the program and priorities for the future. (The quetionnaire is in Annex 1 and results are in Annex 2).

The team submitted a complete draft report to CIP immediately after the end of its field visit, which with minor revisions was forwarded to ADAB.

Outline of the Report

The Review Report contains an executive summary followed by six separate project reviews, presented in the order in which the countries were visited. The findings for each project are organized under six numbered headings that correspond to the points listed in the Terms of Reference (TOR).

1. Program Benefits
2. Research Results
3. Sustainable Technologies
4. Collaboration Among Countries
5. Extending the Program
6. Sweet Potatoes

Before these numbered sections, each project review begins with an introduction that places the project in the perspective of each country's level of development, the agricultural economy, and priorities for potato R&D in the early 1980s when SAPPRAD was established.

Annexes contain the questionnaire used by the review team, tabulations of the questionnaire results, statistical tables on the SAPPRAD member countries, and a summary of projects, personnel, training and budgetary figures.

A separate volume contains a set of the documents received by the review team in each country.

Review Itinerary

March		
18	Wed	Arrival of team in Manila/Travel by car to Los Banos
19	Thu	Review of TOR/Fly to Jakarta
20	Fri	Fly to Lembang/Project presentation
21	Sat	Fly to Yogyakarta/Travel by car to Magelang (Extension Service)/Wonosobo (Seed project)
22	Sun	Fly to Jakarta/Meet with project leader Overnight in Jogyakarta
23	Mon	Meet with country representative and project leader/ Fly to Singapore - Colombo
24	Tue	Travel by car to Peradeniya (Meet country representative) Visit Nuwara Eliya Station, farmers
25	Wed	Travel to Bandarawela/Project presentation (True Potato Seed)/Visit farmers
26	Thu	Travel to Peradeniya (Meet country representative and senior staff)/Travel by car to Colombo
27	Fri	Fly to Bangkok
28	Sat	Meet with country representative/Project presentation (Storage and utilization)/Fly to Chiangmai
29	Sun	Travel by car to Fang Hort. Station/Return by car to Chiangmai
30	Mon	Visit Chiangmai University, Maejo Inst. of Technology and farmers' fields/Fly to Bangkok
31	Tue	Meet with country representative/Fly to Manila
April		
1	Wed	Write draft report for Indonesia, Sri Lanka and Thailand
2	Thu	" " " " " " " " "
3	Fri	" " " " " " " " "
4	Sat	Fly to Port Moresby
5	Sun	Fly to Hagen/Visit Tambul Research Station
6	Mon	Project presentation/Visit projects at Tambul and Hagen, Western Highlands Province
7	Tue	Fly to Port Moresby
8	Wed	Fly to Singapore
9	Thu	Fly to Manila
10	Fri	Write draft report
11	Sat	Meet with country representative/project presentation (Breeding for lowland potatoes)
12	Sun	Rest day
13	Mon	Lowland Potato Conference (Technology Transfer)
14	Tue	Lowland Potato Conference (Technology Transfer)
15	Wed	Draft Report Preparation
16	Thu	Draft Report Preparation
17	Fri	Depart

Part II

Project Reviews

Tropical Agronomy

Indonesia

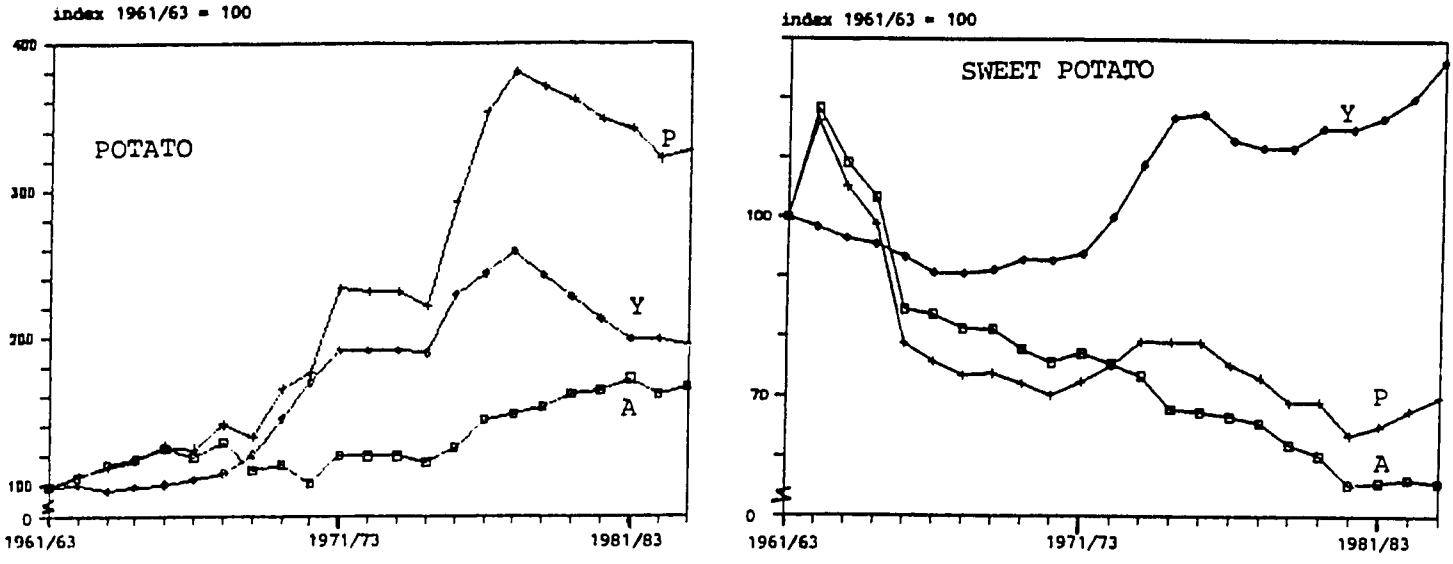
23

Indonesia: Basic country statistics

GNP per capita	$540	Population per ha arable land	
Population		-total	11
-total (million)	159	-rural	8
-rural	75%	Fertilizer use	74 kg/ha
Growth rates		Cereal imports	
-population	2.3%	-total (000)	1,926 ton
-GNP per capita	4.9%	-per capita	12 kg
-agriculture	3.7%	Daily per capita calorie supply	
Land area		-total	2,380 calories
-total (million)	181 ha	-% requirement	110%
-arable (million)	14 ha	-% from rice	58%

Source: Annex 3.

Indonesia: Potato and sweet potato production (P), area (A) and yield (Y) 1961-85 (3 year moving averages)



Indonesia: Estimates of Potato and Sweet Potato Production 1985

	Potato		Sweet Potato
	FAO estimate	Local estimate	FAO estimate a/
Area (000 ha)	26	33	211
Yield (t/ha)	7	11	9
Production			
-total (000 t)	190	372	1,876
-per capita (kg)	1	3	11

a/ The team did not attempt to obtain local estimates of sweet potato production.

Indonesia: Price estimates gathered during the Review

	Rp/kg a/	US Cents/kg a/
Figures presented at Review Seminar		
Farm-gate		
Potato	150-320b/	9-20
Sweet potato	30-50	2-3
Imported seed potato	1,000	62
Retail prices provided by Magelang extension office for September 1986		
Potato	360	22
Green bean	230	14
Cabbage	140	9
Carrot	205	13
Sweet potato	60-100	4-6
Cassava	55-80	3-5
Prices given by commercial farmer in Wonosobo		
Local seed		
April	400-500	25-31
October	400-500	25-31
Harvested potatoes		
July	200	12
February	300	19

a/ US$1 (100 Cents) = Rp 1,600 at the time of the review.
b/ Depending upon season.

"In the past, the national priority on potato was low. SAPPRAD has supported us and stimulated national interest. The potential benefits to farmers are clear to us, but the real impact is yet to come. This is why a Phase II is critical."

Surachmat Kusumo, Indonesia

INTRODUCTION

With a population of 160 million, Indonesia is the world's fifth most populous country. Total population is expected to exceed 210 million by the year 2000. Three quarters of all Indonesians live in rural areas where population density and the intensity of land use are high. There are eight persons per hectare of arable lands. Gross national product per capita is less than US$550, but the growth rate over the last two decades has been nearly 5 percent per year. Agricultural growth has also been a respectable 3.7 percent per year over the past decade. Nevertheless, Indonesia is a food-deficit country. In 1984, 1.9 million tons of cereal grains (mainly wheat) were imported.

Rice dominates the agricultural economy and supplies over half the country's dietary calories and protein. Among the root crops, cassava and sweet potatoes are considered to be low-status foods, and consumption per head has fallen in recent years. In contrast, potatoes are a high-status food, and potato production and consumption per head have increased.

In Indonesia, as in most developing countries, estimates of root crop production and use are imprecise and often controversial. It is generally believed that official statistics grossly underestimate actual potato production.

According to the FAO, Indonesia currently produces about 190,000 tons of potatoes on 26,000 hectares, giving an average yield of 7.4 t/ha. However, an Indonesian statistical source puts potato production at more than 350,000 tons and yields at 11 t/ha. Researchers and extension workers believe that the latter source is more accurate than the former.

In the past, potato cultivation has been confined to highland areas during the rainy season. Late blight and other diseases cause frequent crop failures and limit yields. Moreover, production costs are high, due mainly to the high price of seed, land rental charges, and wage rates in the highlands. Transport and storage problems, high marketing costs and post-harvest losses have made potatoes expensive in the cities and available only on a seasonal basis. Potato production on sloping highland fields has also led to problems of soil erosion.

For these reasons, when SAPPRAD was established in 1982, Indonesia chose to concentrate on agronomic research to extend potato production to mid-elevation and lowland areas. The project, "Tropical Agronomy" has been conducted under the leadership of Ir. Surachmat Kusumo of the Agency for Agricultural Research and Development (AARD) based at Bogor. The work has been carried out at a number of experiment stations and farms in East, Central and West Java.

"Over the last five years we have developed a tropical agronomy package. In the future we need more work on seed (especially rapid multiplication techniques), a dual-purpose variety that can grow both in high and low areas, and agro-economic studies of cropping systems."

Azis Azirin Asandhi, Indonesia

1. PROGRAM BENEFITS

Through participation in SAPPRAD, the Indonesian potato program has greatly strengthened its research capacity for lowland potato agronomy. The program has also begun work on a number of important complementary research topics, including variety testing, innovative propagation methods, seed storage and control of bacterial wilt. Furthermore, the reseach program has established working links with the extension service, Bank Indonesia and farmers. These have allowed the rapid diffusion of new technologies and introduction of the potato crop to mid-elevation areas where potatoes have never before been grown.

Institutional Benefits

A substantial amount of quality research has been conducted on various aspects of mid-elevation potato production and post-harvest technology. According to Indonesian researchers and policy makers, and in the view of the team, it is unlikely that most of this work would have been done in the absence of SAPPRAD. Three key factors stimulated this research. Perhaps most importantly, the pool of research information on potatoes that Indonesian scientists have to draw on has been greatly expanded by the interaction of scientists from the SAPPRAD countries and CIP, the sharing of experiences, training and the distribution of research reports, Second, giving their research an international dimension and peer review within the SAPPRAD network has motivated Indonesian researchers to do more and better work. Finally the funds provided for salaries, local travel and supplies were a useful complement to the physical facilities and human resources already available, and those provided by USAID and Japan International Cooperation Agency, JICA (for seed production). This was particularly important in a time of declining domestic funding for agricultural research.

One hundred fifty-one Indonesians have participated in SAPPRAD-sponsored regional courses, workshops and seminars since 1981. The benefits of this international training have been multiplied through local courses funded primarily from domestic sources.

Another benefit of participating in SAPPRAD, noted by local researchers and policy makers, was increased experience in research planning , management and reporting.

"Here (Magelang: 400 m) we have no bacterial wilt, late blight or erwinia. Our problem is seed. For this we need a dual-purpose variety for both highlands and mid-elevations."

Extension agent, Indonesia

Perhaps the most important institutional impact, in terms of SAPPRAD's short-term goal of benefiting poor producers and consumers, have resulted from the technology transfer project which aims to introduce potato cultivation to non-traditional mid-elevation areas. This project, drawing both on Indonesian tropical agronomy work and research in other SAPPRAD countries and CIP, has brought Indonesian researchers into direct personal contact with mid-elevation farmers and their problems. Through on-farm trials and dialogue with farmers, extension agents and bank officials, researchers have become more aware of the potential benefits as well as some problems of introducing potato cultivation to new areas. Of the seven mid-elevation areas where on-farm trials have been conducted (Yogyakarta, Magelang, Tegal, Karanganyar, Malang, Blitar and Tabenes) farmers, extension workers and financial institutions are eager to expand potato production in three areas (Magelang, Tegal and Tabenes) where yields and net returns have been high. In the immediate future, on-farm testing and transfer of technology will concentrate on those mid-elevation areas that have shown the highest yields and net returns. Many farmers in these areas have expressed a desire to grow potatoes, but the limited supply of seed tubers restricts the number that can be included in the project this year. The Indonesian Potato Program and SAPPRAD are working to remove this constraint. Dr. Azis (responsible for the transfer of technology project in Indonesia) and two progressive farmers recently traveled to the Philippines to obtain new information and skills in innovative propagation techniques. Arrangements are also being made to import seed of appropriate varieties from the Philippines (4 tons) and Australia.

In summary, the successful research and on-farm testing of potato production in mid-elevation areas have stimulated the interest of farmers, extension workers, financial institutions and in some cases local politicians. These groups are now pressing researchers for solution to remaining problems, most importantly those related to seed production and distribution. The experience has also made researchers aware of the need for studies of the market feasibility and socio-economic impact of expanded potato production in mid-elevation areas.

Farm-Level Benefits

To date, 45 small farmers have grown potatoes in mid-elevation areas on an experimental basis. In Magelang in Central Java 26 farmers are now growing a total of about 10 ha of potatoes on a commercial basis. A report made available to the team (Asandhi, 1987) and discussions with the local extention agent, indicate that in Magelang, at 400 m elevation, potato production costs per hectare are about 30 percent lower and net returns are substantially higher than in traditional

"On a study tour to the Philippines, two progressive farmers and I learned how to shorten the period between stem cuttings from 14 days to 5 days. We also reduced the age of mother plants. This is critical to increase productivity in our screenhouse."

Azis Azirin Asandhi, Indonesia

highland potato growing areas. It also reported that annual net returns from a rice-potato-rice sequence are more than four times higher than those from a rice-rice-rice sequence. Household surveys results reported by the FAO and CIP indicate that in Indonesia the income elasticity of demand for potatoes is positive and relatively high. The team did not have access to estimates of price elasticities of demand, but given the low current level of potato consumption and the inverse correlation observed between potato prices and consumption levels in other Asian Countries (Horton, 1987) it seems reasonable to expect that Indonesian consumers would respond to lower prices by eating significantly more potatoes.

On the basis of these findings, it seems likely that if quality planting material could be made available at a reasonable cost, potato production would expand significantly in mid-elevation areas, generating substantial benefits for potato producers, most of whom would be small, low-income farmers. At present, since potato prices are relatively high, most potatoes are consumed by relatively high-income households. Expansion of potato production in mid- and low-elevation areas close to urban markets would lower production and marketing costs and make potatoes available to a much broader spectrum of the population at affordable prices. In this way, the project is expected to generate significant future benefits, both for small farmers and for low-income consumers.

2. RESEARCH RESULTS

A report entitled "5 Years: SAPPRAD in Indonesia" summarizes results of research as they relate to problems constraining efficient potato production. The following information was derived from this publication and through discussion with Indonesian principals.

Agronomy

Trials were conducted to evaluate the influence of temperature and rainfall on selected potato varieties grown at mid-elevation (300-400 meters). Under Central and East Java conditions planting during May to July gave average yields of 24.7 t/ha for 6 varieties tested. Mulching with either rice refuse, sugarcane bagasse or dried grass effectively reduced soil temperature and increased yields in Red Pontiac, Cipanas and DTO-28 cultivars.

"In Jakarta we have a huge number of office workers who would eat french fries on lunch hour. There is a great untapped demand."

Subijanto, Indonesia

Field experiments were conducted to determine the influence of planting depth, row configuration and spacing on yield. It is recommended that as a general practice seed tubers be planted at a depth of 7 cm. in double rows with a spacing of 50 x 30 cm., the rows oriented in an east-west direction. Fertilizer applied at suggested rates of (kg/ha) 150-200 N, 120-180 P2O5 and 100 K2O were optimal; a single application of N at planting was preferred under East Java conditions.

Cropping Systems

Cropping system trials were confined principally to intercropping studies and included several crops of considerable economic importance in Java. At Kejajar in Central Java potatoes have been successfully intercropped with tobacco. In recent trials at Gondanglegi sugarcane yields were significantly increased when interplanted with potatoes. At the same time land use was optimized through the production of 21.8 t/ha. of potatoes between the rows of sugarcane. In 1986 in field studies at 4 locations each in East and Central Java, intercropping potatoes with shallots gave good potato yields which were supplemented by small yields of shallots.

Varietal Trials

Trials of selected named varieties, numbered clones, as well as a few indigeneous varieties have been conducted during each of the last five years. Given a benchmark yield of 8.7 t/ha between 1980 and 1982 (FAO data), through many trials during the five years, yields on average have doubled. However, as might be expected there are sharp varietal differences in response to climate and disease. Yield data are presented in tables 18 through 24 in "5 Years SAPPRAD in Indonesia."

Bacterial Wilt

Although farmers strive to optimize yield through good agronomic practice, diseases, such as bacterial wilt (BW), can seriously limit production. Varietal testing for bacterial wilt resistance is under study as part of the SAPPRAD program. Encouraging reduction of BW has been achieved by growing potatoes in paddy following rice. Good rotation practice and the use of BW-free seed is well understood by Indonesian specialists. Research successes achieved in Indonesia to control BW can have a useful impact on growing potatoes not only in other SAPPRAD countries, but elsewhere in the tropics where BW is a problem.

"We don't want to import seed because it often comes with diseases and this year with nematodes."

Subijanto, Indonesia

Seed Production

Developed countries have sophisticated systems to ensure standards for certification of seed potatoes. Seed production in developing countries may include novel methods of propagating potatoes achieving equally efficient levels of plant health.

The modern basis for disease free seed relies on tissue culture. Tissue culture facilities provided by USAID are being used in Indonesia to maintain introduced germplasm and to multiply basic stocks as a component of the SAPPRAD initiative. Although still in it's early days, it is anticipated that in vitro plantlets will be given directly to basic seed producers to ensure healthy plants for screenhouse propagation.

Stem cutting procedures are well in hand to multiply healthy seed stocks. Pilot scale multiplication by stem cuttings have reached practical farm application. Continued support is necessary to ensure wider use of this seed production system. Simple screenhouses built by seed growers are an essential feature of this system. A paper, "Rapid Multiplication Techniques for Tuberlet Production" (1987) by A.S. Karjadi, Lembang Horticulture Reasearch Institute, reports recent progress on stem cutting and tissue culture research. Because of the wasteful use of tubers as seed which might better be consumed as food, the unavailability of costly virus free seed, and the lack of seed tuber storage facilities have encouraged the use of true potato seed (TPS) instead of seed tubers in a number of developing countries. Vigorous plants derived from TPS were observed in the first TPS trial at Lembang. As part of the SAPPRAD network Indonesia can rely on the considerable expertise generated in Sri Lanka and the Philippines to accelerate future TPS research.

Modification of existing storages and the construction of new inexpensive simple storages permitting natural light diffusion are widely used in the Philippines for the storage of seed tubers. Expertise in the SAPPRAD network is helping Indonesia where similar diffuse light stores have been under observation since 1982. By permitting longer storage of seed than is possible in dark stores, diffuse light stores also improve seed quality and increase yield. Mr. P. Sihombing reported work on diffused light storage research in Lembang, in a paper entitled, "Potato Seed Trial in Diffuse Light and Dark Storage , 1982 to 1986."

"One continuing problem is how to get the latest information from CIP and SAPPRAD. We need a newsletter."

Subijanto, Indonesia

3. SUSTAINABLE TECHNOLOGIES

Since 1982, basic agronomic practices suitable for low and mid-elevation potato production in Java have been developed. Planting dates appropriate for East and Central Java conditions have been verified over several years. Methods for modifying soil temperature have been tested resulting in increased yields. Basic requirements for the use of fertilizers have been determined. Early work on intercropping potatoes with several other local crops has been successful. In short, agronomic methodologies developed during the first phase of SAPPRAD activities in Indonesia are ready for dissemination.

It is expected that variety trials will be continued over an indefinite period as new clones are produced at CIP and elsewhere. It is an approach to improving potato production which is sustainable over a long period, particularly if there is a potential for higher yields and improved resistance to diseases and pests.

Research to 1987 has pointed to the need for additional work on cultural practices to reduce the incidence of bacterial wilt. This is considered as a useful approach, until better wilt resistant clones are developed by CIP and its contract institutions.

A clearly identified problem is the lack of high quality seed. Stem cuttings derived from virus-free "mother" plants are a highly practical and efficient way of producing small tubers to be used as seed. This technique is a useful "self-help" approach to providing seed for small scale operations or a basis for scaling up for larger plantings. The methodology for farmer use of stem cuttings is available and is now reaching on-farm application. Expanded use of stem cuttings should be encouraged in planning at the national level.

4. COLLABORATION AMONG COUNTRIES

The exchange of information facilitated by participation in SAPPRAD has allowed Indonesia to save the time and resources needed for effective potato R&D. Perhaps most notably, participation in SAPPRAD has given Indonesia direct access to the extensive work on lowland potato production carried out by CIP and by SAPPRAD's Technology Transfer Project in the Philippines. The variety "Cosima" was present in Indonesia, but local scientists first learned from the Philippines that it was suited for lowland cultivation. They also learned from the Philippine experience that "Berolina" was a potential dual-purpose

"Stopping now would be too early. Just now we have the technology, but we are just beginning to transfer it to farmers. Priorities for the future should be: transfer of technology, bacterial wilt, economic studies and seed production -- the common problem of all countries."

Surachmat Kusumo, Indonesia

variety that could be grown both in the highlands and the lowlands. Later, Indonesia received seed of this variety from the Philippines. Indonesian scientists do not anticipate widespread use of TPS or new varieties bred in SAPPRAD countries for several years to come. However, they value Sri Lanka's and the Philippines' pioneering work on these topics because it will allow them to base future adoptive work on genetic material and techniques that have been found to be promising in the Southeast Asian region. Information from research on diffused light seed storage carried out in Thailand, the Philippines, and Sri Lanka has already been put into practical application in Indonesia's seed program and on farms.

In 1987, Indonesian scientists conducted verification trials on germplasm evaluation, TPS, seed production techniques and storage. Verification trials on tropical agronomy were conducted in the Philippines, Thailand and Sri Lanka from 1984 onwards.

The only disadvantage of collaborative research that was noted by Indonesian scientists was that reliance on PNG for research on seed production technology may have delayed progress in development of the viable seed systems which are essential for expansion of potato production and use in all SAPPRAD countries.

5. EXTENDING THE PROGRAM

In the team's view, extension of SAPPRAD, making appropriate modifications in objectives and procedures, would generate significant benefits in Indonesia. As noted above, good progress has been made in the area of tropical agronomy, and strong interest in expanding potato production in mid-elevation areas has been shown by farmers and others. It has been demonstrated on a pilot scale that potato production in mid-elevation areas is both technically feasible and economically attractive for small farmers, but technology transfer is just now beginning. Hence, terminating the project now would be premature, because it would be just before significant potential benefits have become real benefits.

Several non-agronomic constraints to mid-elevation potato production have been identified, and potential solutions are being sought through experiment station reseach or on-farm testing. Therefore, the team recommends that the present project, "Tropical Agronomy," be renamed, "Introduction of the potato to the mid-elevation and lowland tropics." This title would more nearly reflect the activities currently

"Phase II should stress technology transfer. We need to show increased use of lowland potato. We should also stress seed production and varietal selection for processing. We should put more effort into socioeconomic studies."

Subijanto, Indonesia

underway and would allow for greater flexibility in resolving future constraints to expansion of the potato crop -- both technical and socio-economic ones -- as they arise.

The team concurs with the country representative, the project leader and others interviewed that the major future emphasis should be on applied R&D, and on the diffusion of information among farmers. The most immediate concern is creation of a viable system to provide lowland and mid-elevation farmers with adequate planting material. This will require both technical and institutional innovation. Hence, the basing of an experienced CIP agronomist with extensive on-farm R&D experience (M. Potts) in Indonesia is timely. The Indonesian authorities also noted on several occasions their desire to obtain technical expertise from CIP in the area of socioeconomics. A study on marketing and demand that is being planned by the Regional Co-ordination Centre for Research and Development of Coarse Grains, Pulses, Roots and Tuber Crops in the Humid Tropics of Asia and the Pacific (CGPRT) may provide useful information in this area. However, the team believes that this study should be seen as not a definitive work, and recommends that AARD explore means to strengthen its own capacity to conduct needed socioeconomic studies on a continuing basis in the future.

6. SWEET POTATOES

The sweet potato is a much more important crop in Indonesia than the potato. Between 1961 and 1980 the area planted to sweet potatoes remained static at about 333,000 ha. During the last 5 years the area has been reduced by one-third to an average total of 254,000 ha. The reasons for the decline in consumer demand during recent years are not well known. At present IITA and AVRDC are involved with improvement in sweet potato production in Indonesia. It was suggested that processing to produce snack foods would encourage greater use of this crop. It is also known that virus diseases are a problem. SAPPRAD could draw on the extensive germplasm maintained by CIP for field testing and selection of new clones and varieties to prevent further decline in the use of this valuable crop. In view of the expert international assistance on sweet potato production already offered to Indonesia SAPPRAD's contribution is likely to remain minimal during the next several years. The drop in production per capita from 30.8 kg between 1961 and 1965 to 12.8 kg during 1981 to 1985 merits study to determine the technical and socio-economic reasons for the decline.

True Potato Seed

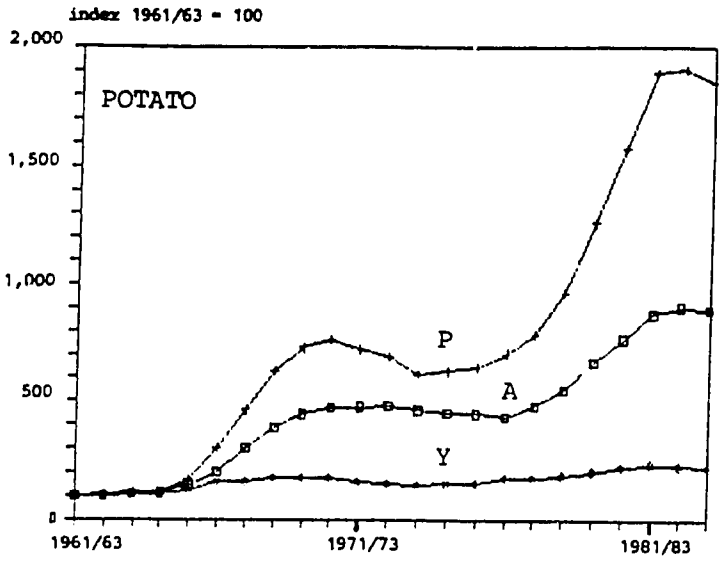
Sri Lanka

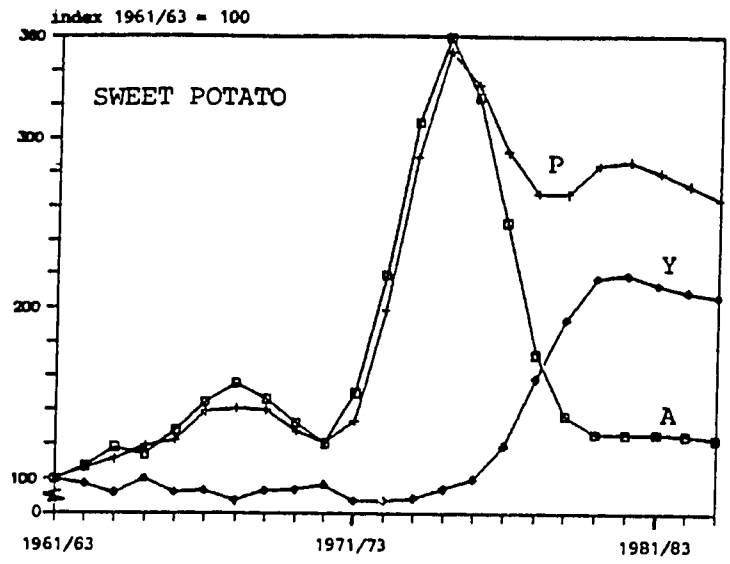
Sri Lanka: Basic country statistics

GNP per capita	$360	Population per ha arable land	
Population		-total	14
-total (million)	16	-rural	13
-rural	79%	Fertilizer use	74 kg/ha
Growth rates		Cereal imports	
-population	1.8%	-total (000)	658 ton
-GNP per capita	2.9%	-per capita	41
-agriculture	4.1%	Daily per capita calorie supply	
Land area		-total	2,348 calories
-total (million)	6 ha	-% requirement	106%
-arable (million)	1 ha	-% from rice	42%

Source: Annex 3.

Sri Lanka: Potato and sweet potato production (P), area (A) and yield (Y) 1961-85 (3 year moving averages)





Sri Lanka: Estimates of potato and sweet potato production 1985

	Potato		Sweet Potato
	FAO estimate	Local estimate	FAO estimate a/
Area (000 ha)	6	8	16
Yield (t/ha)	12	12	9
Production			
-total (000 t)	70	90	140
-per capita (kg)	4	6	9

a/ The team did not attempt to obtain local estimates of sweet potato production.

Sri Lanka: Price estimates gathered during the Review

	Rs/kg a/	US Cents/kg a/
Figures presented by researchers, extension agents and farmers		
Farm-gate price of table potato	14-20	50-71
Official price of government-produced seed	20	71
Market price for common seed	22-23	79-82
Price of sweet potato	3	10
Wholesale prices reported in Colombo market, April 1986		
Potato	21	75
Green beans	9	32
Carrot	10	36
Cabbage	6	21
Egg plant	5	18
Tomato	10	36
Pumpkin	5	18

a/ US$1 (100 Cents) = Rs 28 at the time of the review.

"The potato generates not only a lot of satisfaction for researchers but also a lot of money for farmers. The potato is a high income producer in 90 days. Now we must extend the crop to non-traditional lower mid-country areas after rice. The key constraint is seed."

E. Herath, Sri Lanka

INTRODUCTION

Sri Lanka is an island republic off the southern tip of India with a population of 16 million and a cropland base of only one million hectare. Since nearly 80% of Sri Lankans live in rural areas, there are 13 rural people for each hectare of arable land -- an exceptionally high man-land ratio, even by Asian standards. GNP per capita is a rather low $360 and the annual growth rate has averaged only about 3 percent over the last decade. The agricultural growth rate has been a more respectable 4.1 percent per year. Despite the growth of agricultural production, in 1984 Sri Lanka imported 658,000 tons of cereals, mostly wheat. This amounted to roughly 41 kilograms of imported cereals per head of population.

As in most of Asia, rice is the major crop and food, contributing 42 percent of the dietary calories. There is strong demand for potatoes, but the supply is limited and the price high -- around Rs 20 per kg (US$0.70 per kg) at the retail level at the time of the External Review.

Until 1967, large volumes of table potatoes were imported for direct human consumption. Since then, only seed imports have been permitted. Seed potatoes were imported in from Australia for the Yala (early) crop planted after the beginning of the southwest monsoon in mid-May and from Europe for the Maha (late) crop. In 1979 seed imports for the early crop, were banned. At the time of the External Review, the government was seriously considering banning the importation of all seed potatoes.

When table potato imports were cut off in 1967, potato prices increased dramatically. This stimulated domestic potato production, which increased from about 4,000 tons in 1960 to at least 70,000 tons at present.

Potato production expanded most in the highland districts of Nuwara Eliya and Bandarawela. Potato production also became established at sea level on the Jaffna peninsula at the northern tip of the island.

The ban on Australian seed imports for the early crop since 1979 caused a seed shortage which stimulated innovations in seed production, storage and distribution at both the governmental and the farm levels. One of the most striking examples of this has been the rapid farmer adoption of diffused light seed storage technology (Somaratne, 1986;

"It would be easy to expand potato production in many mid-elevation areas, but we can't due to seed shortage."

E. Herath, Sri Lanka

Rhoades, 1985). Another example has been the active experimentation with TPS both by researchers and by the farmers themselves.

The single most important constraints to potato production and consumption in Sri Lanka are the inadequate supply, poor quality and high price of planting material. For this reason, since the 1960s the Department of Agriculture has been working to establish a viable seed program for the country. In this context, when SAPPRAD was created in 1982, Sri Lanka chose to take a leadership role in TPS research and development. The project, "True Potato Seed" has been led first by Dr. S.P.R. Weerasinghe and since 1985 by Ms. Sita Abeytunge, based at the Bandarawela and Sita Eliya Agricultural Research Station, respectively.

1. PROGRAM BENEFITS

Institutional Benefits

Prior to the creation of SAPPRAD, potato research, extension, training and seed production were being conducted by different agencies, often with little interaction, coordination or common purpose. From the presentations and activities observed and our interviews with key people in various institutions, it is clear that participation in SAPPRAD has helped Sri Lanka focus its scarce financial and human resources for potato R&D on resolving the country's seed supply problem. Dr. Herath, the Deputy Director of Agriculture (Research) stated to the review team:

> "While SAPPRAD's financial contribution has not been very big, relative to other projects (like the World Bank extension project), the benefits have been important because SAPPRAD helped stimulate, orient and ensure the continuity of TPS research. It also stimulated people in training and extension to work together to get the concept of TPS into the field as a practical solution to an important problem of the small farmer."

It was also noted that although small in absolute magnitude, the funds made available by SAPPRAD often filled strategic gaps in local funding for potato R&D. The principle of counterpart funding also gave potato researchers and extension workers leverage in obtaining matching funds from their local institutions.

In addition to the substantial body of high-quality on-station research, a surprising amount of on-farm testing and extension work has

"The main advantage of TPS is that it lowers costs; the main disadvantage is that better irrigation and care are needed."

A farmer, Sri Lanka

been done with TPS. This was in a certain sense "putting the cart before the horse," since the basic TPS research (such as selection of well-adopted high-yielding lines) had not been completed, the criteria for selecting on-farm sites testing had not been carefully thought through, and preparation of extension workers was rather superficial. The production of TPS of the best lines also lagged behind schedule. Consequently, most on-farm trials have been done with open pollinated (OP) seed of the cultivar "Desiree," which segregates for tuber color and shape. It also yields less than several new OP lines and hybrids that have been identified in Sri Lanka and elsewhere.

A paper by Somaratne (1987) indicates that in the district of Nuwara Eliya alone, more than 2,000 farmers have participated in R&D activities related to TPS. These activities have included 480 on-farm trials, 78 field days, 10 farmer tours, and three seminars and exibitions.

This extensive on-farm work has highlighted several advantages of TPS over conventional use of seed tubers. The most obvious one is that TPS costs much less than seed tubers. It could probably be produced and made available to farmers for less than 5 percent of the current cost of seed tubers, which is about Rs 30,0000 (US$1,000 per ton). This would be especially important for small farmers in marginal areas who have not previously had access to, or been able to afford, seed tubers. A second major advantage of TPS is that it can be easily stored for planting at any time. This would allow farmers to plant potatoes when the weather and market conditions are best. This an important advantage over tuber seed, which is highly perishable and unless cold stored has a rather short period during which it is suitable for planting. A third advantage is that planting TPS can reduce the spread of viruses, fungi and bacteria which pose severe production problems for potatoes in Sri Lanka's warm, humid areas. In conclusion, Sri Lanka's experience indicates that using TPS is a promising way to lower small farmers' costs and to extend potato production to non-traditional warm, humid environments.

In the view of Somaratne (1987) rapid diffusion of TPS technology among small farmers is constrained by limited seed supply, lack of specialized training for extension agents, inadequate feedback of information from field trials and demonstrations, and little understanding of the position (actual and potential) of TPS in small farmers' production systems.

Other participants in the External Review noted the following possible constraints to widespread farmer use of TPS: the care needed for nursery management, the riskiness of potato production from TPS (due mainly to excess rain in the late crop and inadequate irrigation in the

"One problem for using TPS on the seed farms is that careful irrigation is needed at transplanting time."

C. R. de Vaz, Sri Lanka

early crop), field pests and diseases, and the variation in size, shape and color of tubers produced from TPS, which reduces their market value.

The review team was pleased to see that the various potential advantages and constraints to use of TPS were being actively and openly discussed. This reflects a high degree of institutional maturity and self-evaluation that augers well for the rapid development of appropriate TPS technologies and systems that meet small farmers' needs.

Farm-Level Benefits

To date, no comprehensive assessment has been made of the impact of TPS technology at the farm level. Given the team's short stay in Nuwara Eliya and Badulla districts -- one and a half days -- it would be inappropriate for us to make any blanket statement on this point. However, a few observations are in order. Farmers are certainly eager to experiment with TPS as a means to reduce their seed costs and to have quality planting material available at the most opportune sowing times, when clean seed tubers may not be available or in suitable physiological condition for planting. Several farmers are known to have experimented with TPS before the Department of Agriculture began its work in this area. Some farmers have planted TPS several times, usually in small plots to produce tubers which are multiplied one to three times before they are sold as table potatoes.

The team visited several farmers who were growing TPS. On one farm we observed four different uses of TPS and its offspring:

- A nursery for seedling production
- A small seed plot where seedlings had been transplanted to produce seed for the next crop
- A larger field plot that had been planted with first generation "seedling tubers" (which had been harvested the previous season in a seed plot)
- Another plot where second generation seedling tubers had been planted.

In addition to these fields planted with TPS and seedling tubers, the farmer had also planted imported tubers. In essence, he was experimenting with TPS to see how many times it could be multiplied it before yields dropped substantially. Each season he was comparing the results of TPS against the best planting material available: imported seed.

"Low-income farmers in non-traditional areas have been the main adopters of TPS."

M. Somaratne, Sri Lanka

An impact study for TPS has been proposed. The team feels that it is too early to assess the production impact of TPS at the farm level in an ex post sense, since researchers are only now beginning to produce TPS of the new lines which have been bred and selected for this purpose. However, we believe that better documentation of Sri Lanka's rich farm-level experience with TPS to date would be useful, not only for Sri Lanka but for potato R&D programs in other countries where quality seed tubers are scarce and costly. This type of study, which would require a careful planning and execution by an interdisciplinary team, could help identify the agro-ecological conditions under which TPS has been most successfull and the types of farmers that have shown the greatest interest in, and adoption for growing potatoes from TPS. It could also help pinpoint the priority areas for improvement of TPS technology. This information would be useful for setting priorities for future research and extension. Furthermore, it would provide baseline data necessary for assessing the future potential impact of TPS technology on potato production and use.

2. RESEARCH RESULT

Two principal potato-producing districts, Nuwara Eliya and Bandarawela, were visited in the mountainous south central region of Sri Lanka. At Sita Eliya (2060 m) near Nuwara Eliya TPS seedlings in screen house and in field plots were examined. Field plots were weed free and very orderly arranged with vigorous plants grown from both hybrid and open pollinated (OP) seed. Both the quality of plants and the excellent plot layout was of professional character. At Toppass near Nuwara Eliya a spectrum of TPS material was inspected at the farm of S. Perera including TPS direct seedling, TPS transplants, 2nd generation OP plants (from Mrs. Sita Abeytunge's material) and 3rd generation hybrids. This was a quality potato farm where success depends on TPS. Nearby at a small family operation the farm wife had been growing ware potatoes from TPS seedling tubers for several years. A healthy, well fed family had in its stores a supply of tubers for sale, for home consumption and for seed.

In late afternoon the review team visited the Pedro Seed Potato Production Farm of the Ministry of Agriculture. Field plots were observed where three OP lines of seedlings were being directly compared with imported seed of Desiree and Isna varieties. Plants were in flower at the time with no obvious differences between OP seedlings and varieties. We were told that on each of 10 local farms two OP varieties were being compared with one variety grown from imported seed.

"Potato processing and storage are not so important here because potatoes are not in surplus but scarce. Western foods, like chips and french fries are not consumed much. Due to the bimodal rainfall, people always have fresh food, so storage of table potatoes is not so important."

E. Herath, Sri Lanka

The following day we travelled to the Inservice Training Institute at Bindunuwewa near Bandarawela for a day long SAPPRAD External Review. Twenty-three potato specialists were on hand either to participate in the Review or as active observers in the Review.

Overview

An overview of Sri Lankan-SAPPRAD research activities was presented by the project leader, Ms. Sita Abeytunge ("Overview of TPS Project in the last five years, 1982-1986"). The urgent need for seed to relieve the prohibitive cost of European seed was stressed. Identification, evaluation and selection of genotypes for seed potato production from true seed as well as agronomic studies of selected TPS families were priority activities. Training of extension workers and farmers in TPS technology, conducting on-farm trials, and the establishment of a pilot scheme for seed tuber production from TPS on government farms were also important objectives.

Breeding

The principal objectives of the breeding program located at the Research Station in Sita Eliya, are to: (1) identify OP genotypes which produce both high quality and quantity of TPS; (2) select genotypes on the basis of their TPS progenies which have good vigor, tuber uniformity, disease resistance, early maturity and high yielding; and (3) select parents for hybrid TPS superior to OP lines. Genotypes 27/40-85B, 12/24, 260/39B and 14/19A are examples of TPS families with yields averaging 28 t/ha. An abundant production of TPS was obtained with one pollination, the number of seeds per berry ranging from 193 to 546 in 24 reported crosses. Research is being focused on 17 selected superior genotypes with plans to further evaluate progeny characters in 1987. It is the view of the review team that Ms. Abeytunge has made excellent progress in breeding both OP and hybrid TPS families (See Report "Breeding Studies on True Potato Seed (TPS)" by Sita Abeytunge).

Agronomy

During 1982-86 various field trials were conducted to establish techniques required to use TPS for the commercial production of potatoes. TPS obtained from a number of commercial varieties and CIP clones were used these being the only TPS material available during the first

"Our TPS program is very strong. Now we need to shift a bit to other areas of the seed business like rapid multiplication techniques and seed distribution schemes."

E. Herath, Sri Lanka

year of the program. Spacing studies confirmed that spacing of 45 cm within rows and 20 cm between rows gave superior tuber yield. In location trials for TPS production at 6 sites it was found that location had no influence on subsequent tuber yields. Studies of survival with different methods of transplanting including bare roots, banana leaf cups and soil blocks confirmed that at least 95 percent survival was achieved regardless of transplanting method. As observed in breeding trials, yields of progenies from hybrid TPS averaged 60 percent greater than yields from OP seed. There was no significant differnce in yield among clonal Desiree tubers and either first, second or third multiplication tubers grown from Desiree TPS seedlings. Estimated yields from nursery plots in which the influence of seedling density and the method of seedling establishment were studied was of the order of 40 t/ha with a mean of 561 tubers per m2. Seedling density did not influence yield although the number of tubers per unit area were highest at a density of 100 seedlings per m2. At Bandarawela field plots were inspected. Various trials on emergence and tuber production by 4 TPS families were under study.

Extension

In the area of Nuwara Eliya, where 4000 ha of potatoes are grown, 480 on-farm trials, 78 field days, 10 farmer tours, two seminars and an exhibition involved a total of 1998 farmers during the past few years. Early results testify to the need for further extension support to gain farmer use of TPS technology. In general, farmers of the low income groups were more responsive to TPS technology than larger farmers who have relied on conventional seed sources. Non availability of TPS to the farmers was identified as a major constraint.

A pilot TPS project on seed tuber production has been established at the government seed farm at Nuwara Eliya with seed from the Bandarawela research station. From a modest start in 1983, when 400 trays containing 600 seedlings per tray were sold to farmers, by 1986 4560 kg of sprouted tubers of the cross Atzimba x DTO-33 were sold to farmers as basic seed. During 1987 SAPPRAD has supplied seed for continued expansion of this program.

Stem Cuttings

In addition to the use of TPS in rapid multiplication of seed tubers, a study on stem cuttings was intiated at Bandarawela. Various planting soil mixes and containers were evaluated. Clone I822 was increased from 40 stem cuttings to 3000 plants in seven months with a

"To succeed, we need a task force to link research, extension, training and seed production."

E. Herath, Sri Lanka

yield of 500 kg of seedling tubers. This method of propagation has now been taken up by a commercial tobacco company for large scale seed tuber production.

3. SUSTAINABLE TECHNOLOGIES

One of the major problems facing potato production in Sri Lanka is the lack of quality seed. Rigid controls have been placed on the importation of European seed to conserve foreign exchange. It is now planned to ban importation of commercial quantities of seed. As a consequence emphasis is being placed on non conventional methods of seed multiplication with emphasis on the use of TPS and stem cuttings.

TPS is especially attractive as a low cost, self-sufficiency technology for small farmers who live on holdings with an average area of one-third hectare. Approximately 30 plants can produce 100 gms of TPS sufficient to plant one hectare. In addition to its very low cost TPS ensures a virus-free source of propagating material, is easily transported, requires no storage, and gives an additional 2 t/ha of food which is normally lost in the conventional planting of seed tubers.

While TPS can be planted directly to the field, experiences has shown that this method requires an unusual amount of care. One method developed in the Sri Lankan SAPPRAD project is to plant TPS in small nursery beds and to transplant seedlings to the field for the production of small tubers. These small tubers are used to plant the main crop. In another system 40 farmers were supplied with 1 g each of TPS resulting in the production of 3.5 kg/m2 of seedling tubers in the direct nursery production of seedling tubers. With this system the 2nd generation gives a normal increase of 1:150 or 425 kg of seed. It is apparent that this is a sustainable technology with the proviso that an initial source of TPS is available.

Research has shown that hybrid TPS usually produces a higher yield than open-pollinated (OP) seed. While open-pollinated TPS can most easily be produced by a small farmer, male sterile parents have been selected at Sita Eliya which permits the production of hybrid TPS without tedious emasculation of one parent. A number of proposals are being considered to ensure the availability of low cost hybrid seed. At present hybrid TPS are being produced at the Sita Eliya Station. An excellent opportunity exists for commercialization of high quality hybrid TPS. A very strong motivation exists to succeed in the production of TPS to offset the loss of imported basic seed. The excellent breeding work of Mrs. Abeytunge in selecting parental clones should be supported. Breeding work might be divided for two zones - Nuwara Eliya

"These (seed) schemes develop very rapidly when people are up against the wall, which will happen when the government bans all seed imports. I am convinced we can do it."

E. Herath, Sri Lanka

and Bandarawela. Breeding should be closely linked with TPS production, extension and training in a "field action team" approach aimed at the small farmer. The technology is pretty well worked out for Sri Lanka but ultimate success is when a large number of small farmers are using TPS to grow potatoes.

4. COLLABORATION AMONG COUNTRIES

The exchange of information and sharing of experiences was cited as one of the most valuable aspects of SAPPRAD. Dr. C. R. de Vaz, Coordinator of the Sri Lankan Potato Program, stated:

> "In SAPPRAD the exposure to experiences with TPS and rapid multiplication techniques in other countries and discussing problems of mutual interest with foreign scientists are of significant value."

Direct intercountry collaboration in TPS research has not been extensive. This is understandable, since Sri Lanka is much more advanced than any other SAPPRAD country in TPS research.

Two problematic aspects of participating in SASPPRAD were noted by some Sri Lanka researchers and policy makers. Enthusiasm for TPS may have biased the overall Sri Lankan potato program in this direction, at the expense of other areas that also merit attention. It was noted that it was difficult to design research trials that were relevant both to Sri Lanka's needs and to those of other countries. As indicated under point 5 below, measures are being taken to overcome these two potentially negative aspects of intercountry collaboration.

5. EXTENDING THE PROGRAM

In the view of the team, and of all the participants in SAPPRAD that we met, it would be highly desirable to extend the project. From 1982 to 1984, the project concentrated on agronomic trials. More recently, emphasis has been on breeding, centered in the Sita Eliya station. Throughout the project, Sri Lanka's excellent extension service has been demonstrating TPS technology to farmers. As noted earlier, this may have been somewhat premature. However, Sri Lanka now has extensive experience with TPS -- not only in research but also in training, extension and seed production -- on which SAPPRAD could capitalize in the future.

"People don't eat sweet potato leaves here, because we have an abundance of better tasting ones all over the place."

E. Herath, Sri Lanka

The Department of Agriculture has recently appointed a National Coordinator for potato R&D. A special "Task Force" is also being set up to coordinate TPS research, extension, training, seed production and distribution. The review team views these as significant positive steps in the consolidation of an effective, client-oriented potato R&D program.

Sri Lankan principals stated to the team that the next phase should emphasize "transfer of technology" to ensure that viable TPS technology reaches farmers in the shortest possible time. The review team concurs, but would like to make three suggestions. First, activities conducted under the heading "transfer of technology" should not focus on "packaging" and "demonstrating" finished technologies, but rather on farm-level testing, adaptation and dialogue among researchers, extension agents and farmers. At this early stage of TPS development, on-farm trials should be treated essentially as a vehicle for adaptive research rather than a tool for packaging, demonstrating proven technologies. This does not mean that technology transfer must be delayed. As they participate in on-farm trials, farmers will quickly pick up new technologies that they find advantageous.

Our second suggestion is that more information should be obtained on farmers experiences with TPS to date. To this end, the Task Force might consider organizing a systematic, interdisciplinary assessment of farmers' experiences with TPS. This would provide researchers with information to help them focus future work on the main constraints to small farmers' use of TPS.

Finally, we suggest that the potential role of TPS in farmers' production systems should be assessed. This would provide policy makers with an estimation of the benefits that are likely to be realized from the project in the future.

6. SWEET POTATOES

Sri Lankan officials expressed interest in including sweet potatoes as a useful crop for diversifying lowland rice-based cropping systems in areas where excessive moisture or drought prevented potato cultivation. Dr. de Vaz noted, "Every home garden in rural lowland areas has sweet potatoes."

The FAO and IDRC are supporting sweet potato research in Sri Lanka and sweet potato lines have been introduced from AVRDC, IITA and the Philippines. Hence, any SAPPRAD support should be designed to

complement these other sources of support. Dr. Herath expressed the view that support could be particularly useful for on-farm trials.

Sri Lanka's sweet potato program, based at Peradeniya, has a tissue culture laboratory and can receive in vitro germplasm.

In our discussion, Sri Lankan scientist noted some constraints to sweet potato production and use which differ sharply from those of the potato. It was noted that production per se is not problematic, but that market demand is limited. Most sweet potatoes are consumed by humans; potential uses for livestock feed or processing have apparently not been explored. It was noted that sweet taste limits use of the sweet potato in Sri Lanka's traditional curries. Urban consumption is also limited by the sweet potato's perishability, which makes it difficult for housewives to store.

Storage and Utilization

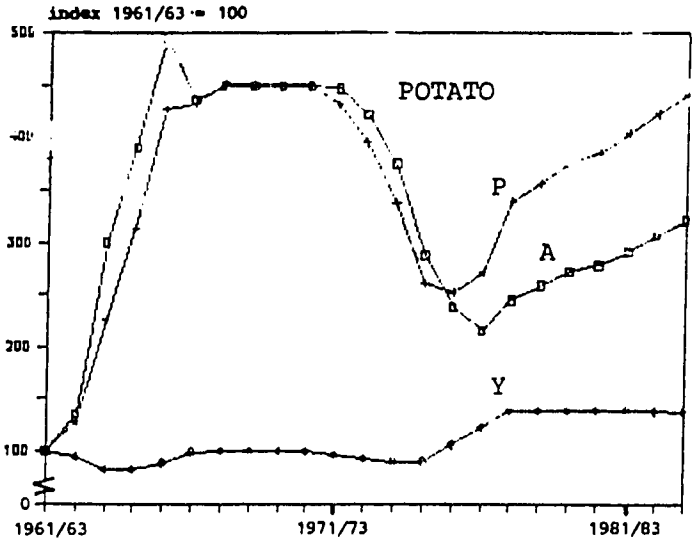
Thailand

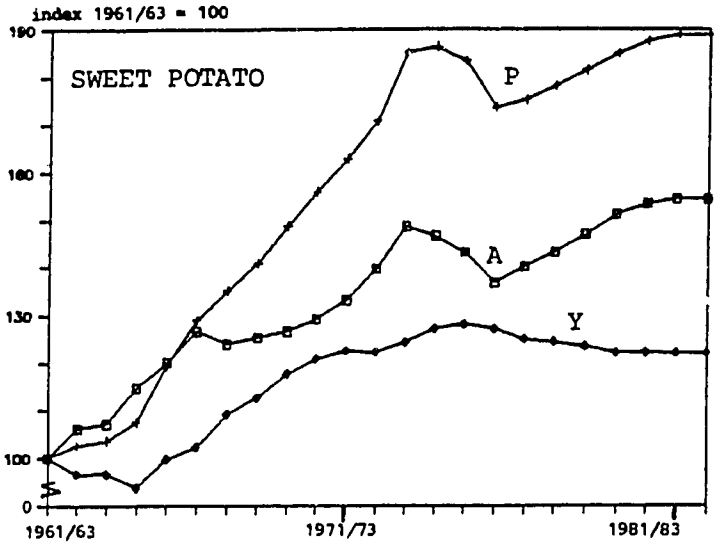
Thailand: Basic country statistics

GNP per capita	$860	Population per ha arable land	
Population		-total	3
-total (million)	50	-rural	2
-rural	82%	Fertilizer use	24 kg/ha
Growth rates		Cereal imports	
-population	2.2%	-total (000)	150 ton
-GNP per capita	4.2%	-per capita	3 kg
-agriculture	3.7%	Daily per capita calorie supply	
Land area		-total	2,330 calories
-total (million)	51 ha	-% requirement	105%
-arable (million)	18 ha	-% from rice	64%

Source: Annex 3.

Thailand: Potato and sweet potato production (P), area (A) and yield (Y) 1961-85 (3 year moving averages)





Thailand: Estimates of potato and sweet potato production 1985 a/

	Potato	Sweet Potato
Area (000 ha)	1	40
Yield (t/ha)	11	9
Production		
-total (000 t)	8	355
-per capita (kg)	-	7

a/ Local estimates were not available.

Thailand: Price estimates gathered during the Review

	B/kg a/	US Cents/kg a/
Retail price estimate for Bangkok given by researchers and extension agents		
Potato	16	64
Sweet potato	2	8
Rice	7	28
Cabbage	2-10 b/	8-40
Prices given by a farmer in Fang		
Spunta 1987 harvest	2	8
One month after harvest	5	20
Imported seed	31	124
Cost of 100 rooted cuttings produced by Fan Research Station	15	60
Break-even price of table potato	3	12
Kennebec sold on contract to processor		
1987 price	3.8	15
1986 price	4.1	16
Prices given by a farmer in Sunsai		
Price Spunta at harvest		
1987	2	8
1986	3.5	14
Price on month after harvest		
1986	5	20
Price of imported seed		
Spunta (Holland)	31	124
Kennebec (Australia)	15	60
Contract price for Kennebec to processor 1987	3.4	14

a/ US$1 (100 Cents) = B 25 at the time of the Review.
b/ Depending on season.

"There are may benefits of SAPPRAD. One is that you increased the awareness of researchers and of government officials of the potential value of the potato for local consumption, as a cash crop, and for export. Training is also very useful. Another benefit has been seeing lowland potato production in the Philippines."

Ampol Senanurong, Thailand

INTRODUCTION

With 50 million people and 18 million ha of cropland, Thailand has the lowest population density of any SAPPRAD member country. GNP per capita, which grew at 4 percent per year over the last two decades, reached $860 in 1985 -- the highest income level in SAPPRAD. Agricultural production has grown at about 4 percent per year and food production per capita has increased by 15 percent over the last decade.

Rice is the base of the Thai diet, but an abundance of other foods is also consumed. While importing a small amount of wheat, Thailand is a net agricultural exporter. Among its principal non-traditional exports is dried cassava, which is shipped to Europe to be used as livestock feed. All the cassava is exported and it is virtually unknown as a food in Thailand. Sweet potatoes are grown in small garden plots throughout the country, but in the past potatoes have been grown only in and near the mountainous areas along Thailand's norther border with Burma. A report by Scott (1986) presents useful summary information on Thailand's potato sector in an economic perspective.

Motivated in part by the desire to offer highland farmers an economically attractive alternative to poppy cultivation (for opium), since the early 1970's Thailand's government has become interested in potato research and development. Potato production in the northern highlands depends on rainfall, which is highly seasonal. Hence, storage is needed to even the supply of potatoes to urban markets. Seed storage is also needed to reduce dependence on imports. Outside the northern production zone, the potato is not well known in Thailand's traditional dishes. However, the demand for snack foods and french fries is growing rapidly in Thailand's main cities as well as in Hongkong, Singapore, Malaysia and other nearby foreign countries. For these reasons, within SAPPRAD, Thailand has specialized in potato storage and utilization.

1. PROGRAM BENEFITS

All Thai researchers and policy makers iterviewed expressed the clear view that participation in SAPPRAD had allowed them to greatly strengthen their potato research capacity, improve linkages among local institutions, focus their efforts on priority topics and achieve a practical impact at the farm level.

"The best planting date for the lowlands is mid-November, but imported seed arrives too late for this. So farmers have great interest in local seed production and storage."

Researcher, Fang, Thailand

Institutional Impact

According to estimates of Manoch Thongjiem, the country project leader, the human resources dedicated to potato research have increased more than five-fold, from the equivalent of only 5 man-months in 1980 to 28 man-months at present. This, he feels, is due primarily to SAPPRAD. Potato research has shifted from the earlier emphasis on agronomy and variety trials in highland areas to new ones: primarily storage and utilization, but also pest management, tropical agronomy, and innovative potato propagation methods. The result is a surprisingly complete and high-calibre potato research unit within the Department of Agriculture's Horticultural Research Institute (HRI). (This program is supplemented by other special projects aimed at replacing poppies with potatoes. Based at Chiangmai University and the Maejo Institute of Agricultural Technology, these are supported by USDA.)

Thailand's capacity to disseminate information about potato production has also been greatly strengthened. Home economists and nutritionists working with the HRI are publishing and broadcasting on TV information on how to prepare and utilize potatoes in household menus. The government is also including potatoes in school lunch programs in some areas. Perhaps most importantly, workers at the Fang and Chiangrai Experiment Stations are showing farmers effective means of storing seed and table potatoes. These methods employ simple structures made of cheap local materials and apply the principles of diffused light seed storage. They also use barriers made up of rice hulls and repelant plant materials or non-toxic chemicals to control the potato tuber moth. (Previously the highly toxic product Aldrin was used.)

One final indication of the degree to which Thailand's potato research has been strengthened is the national symposium, "First Potato National Conference," held in January 17-19,1986. Organized by the Department of Agriculture, the symposium was held at Chiangmai University and had 200 participants.

Production Impact

One of the most concrete benefits of SAPPRAD has been the adaptation of diffused light seed storage technology to Thai conditions and its adoption by farmers. While no comprehensive study has been made, it is estimated that at least 200 farmers have begun to store seed potatoes in diffused light. This approach is useful in all of Thailand's production zones, but particularly in lowland areas where previously farmers could not keep their own seed from one season to the next. Appreciatig the significance of this innovation in seed storage requires a brief digression on Thailand's seed potato system.

"There are many places in the North East and Central Thailand where potatoes could be produced, but they aren't because there is no seed."

Surasak Intrakamhaeng, Fang, Thailand

Two highland crops are grown: on early crop is planted in April and harvested in July; a smaller late crop is generally planted in July and is usually harvested in October. Farmers keep some of the potatoes from their late harvest to plant the next year's early crop. Before the introduction of diffused light storage, it was difficult to store seed tubers from October until July, and for this reason seed for the late crop was usually brought up from lowland areas where most potatoes are planted in December and harvested in March. A small amount of seed is imported each year from Europe, North America or Australia to plant the lowland crop. The remainder is brought down from the highlands.

Highland seed (produced at 1,000 - 1,300 m), generally has high virus levels and is infected with late blight and bacterial wilt. No experimental comparisons are available, but researchers and extension workers estimate that farmers harvest about 30 tons of potatoes for every ton of imported seed planted, in contrast to only 15 tons per ton of local seed planted. A farmer interviewed in Sunsai, near Chiangmai, reported that in 1986, highland seed of the variety Spunta yielded only 10:1, whereas cut imported seed yielded 40:1. The same farmer reported that imported seed cost B31 (approximately US$1.25) per kg, whereas local seed cost B3 (US$0.12) per kg. The selling price for table potatoes was B3.5 per kg at harvest time and B5 after two months of storage.

A simple cost-benefit calculation shows that these prices for seed and table potatoes would make it advatageous for the farmer to use imported seed even if it produced a much smaller yield advantage over local seed than the one reported. Seed imports were restricted, however, and imported seed was rationed to farmers in small lots.

In view of the government's decision to restrict seed potato imports (which has political, economic and phytosanitary bases) the HRI as well as farmers themselves are actively seeking new ways of improving the quality and reducing the cost of local seed.

In this context, in early 1987 workers from the Fang Experiment Station trained approximately 300 farmers in the Sunsai area in the principles of diffused light seed potato storage. Several farmers in the area are reported to be storing their own seed this year for the first time.

In addition to its successful work with appropriate seed storage, the Fang Station has embarked on promising, innovative R&D with rapid multiplication techniques, TPS and consumer potato storage. Rooted stem cuttings, produced by the station for approximately B0.15 each, have been distributed and successfully grown by farmers giving economically attractive yields. Low-cost, effective means of extending the period and reducing losses in table potato storage are also being tested and refined through on-farm testing of prototype storage units.

"The highland crop, grown from May to October, has many disease problems and the harvest stores poorly. In the lowlands we have fewer diseases."

Researcher, Fang, Thailand

2. RESEARCH RESULTS

Three principal areas of research were reported: potato tuber moth studies, diffuse light stores and processing. SAPPRAD research was coordinated through the Horticultural Research Institute (HRI) adjacent to the Kasetsart University. Mr. Manoch Thongjiem, the project leader is Head of Vegetable Research in Thailand.

Potato Tuber Moth (*Phthorimaea operculella*)

The potato tuber moth (PTM) is the most serious insect pest of potatoes grown in the tropics. PTM research in the SAPPRAD project was carried out under the leadership of Miss Pisamai Chouvalitwongporn. Early surveys established the serious nature of PTM in Thai stores in which the larval stage tunnels into the tubers followed by subsequent rot.

In studies of PTM in storage, the general biology of the insect was investigated. The life cycle- egg, larval, pupal, adult-spans 24-39 days. Peak egg laying occurs two to 6 days after emergence of the adult moth the number of eggs being dependent upon the ratio of males to females with about 130 eggs being laid with a sex ratio of 1:1. The peak population of adult PTM in storage occurs during May through July, varying somewhat among years and locations.

In the field the moths first appear several weeks after planting, peaking about a month later. The first observable damage is leaf mining by the young larvae followed by invasion of branches, stems and tubers.

The ideal control of PTM would be by plant resistance. AT HRI two clones B-71.240.2, CIP 720087 and the variety Serrana had good quality after 8 months storage. In diffuse light stores infestation by female moth was prevented by layering potatoes with either dried *Lantana* leaves or rice hulls during one to two months storage. Various chemicals applied as a dust prior to storage or as sprays during storage gave protection for up to 7 months in storage. Control was also maintained by the combined use of *Bacillus thuringiensis* ("Agrona") and *Lantana* leaves both of which are "biologics" innocuous to humans. (See SAPPRAD report by Pisamai Chouvalitwongporn in "Storage and Utilization, Thailand" and copies of tables by the same author).

"We need a variety that grows well and stores well in hot areas. So we like (the CIP clone) 720088."

Researcher, Fang, Thailand

Storage and Utilization

Storage research was designed to improve present methods of storing in piles in the dark or in unventilated baskets. Under these conditions losses due to rot up to 60 percent are not uncommon. Under the direction of Mr. Manoch Thongjiem storage studies were focused on farmer use of diffuse light stores (DLS). Such stores have been widely adopted in the Philippines, Sri Lanka and elsewhere with about 3,000 in use since their introduction by CIP. As an adaptation of the old European system of "chitting" the effect of indirect sunlight is to produce short, stout sprouts rather than the long, etiolated sprouts that occur in the dark. By simple modification of existing stores by means of plastic covered openings or by building simple, thatch or metal roofed stores with screen or plastic sides, seed potatoes can be successfully stored under tropical conditions for up to 8 months. Yields of potatoes are comparable to those when seed tubers are held in cold stores. Weight loss of stored seed tubers is less than in conventional unrefrigerated stores. From 1984 through 1986, 200 farmers have adopted DLS in Thailand.

The breeding program in the Philippines has been forwarding a number of promising clones to Thailand for adoption trials. Of these, CIP cultivars 720087, 720088 and 800926 had good storability. In reviewing storage research Mr. Manoch also referred to preliminary trials involving the use of TPS, stem cuttings, straw mulching and selection of potatoes for the lowlands.

The Agro-Industry Section, Agricultural Division of the Department of Agriculture has been responible in the SAPPRAD project for household-village level potato processing. This work has involved 5 technicians. Poonsri Jirathana presented recent results in innovative processing. Seventeen different processed potato products including 4 snack foods, 7 main dishes and 6 desserts have been prepared and accepted by a taste panel. Recipes have been published and are reported in "Storage and Utilization, Thailand."

The review team was shown slides of various potato dishes and had the opportunity to taste some of the processed products. This reviewer is familiar with a wide variety of processed potato products produced in China but found the Thai snacks more palatable with better eye appeal.

Tissue Culture and TPS

Two potato tissue culture facilities were visited in Chiangmai which should be more closely integrated into the SAPPRAD project. At

"We were the first to produce potato chips in Thailand. Speaking frankly, the main problem is red tape. If we could import seed, we could get on with the job."

Processor, Chiangmai, Thailand

Chiangmai University Dr. Prasart Porn is reponsible for potato tissue culture funded by the King. In addition to germplasm maintenance, rapid multiplication in vitro provides seedlings for greenhouse propagation. This tissue culture facility and greenhouse was the best I have seen in a developing country. At the Maejo Institute of Technology Dr. Weesasak Prokati showed the team the integrated tissue culture and "meristem cuttings" multiplication facilities. In a screenhouse, stem cuttings derived from plants produced from in vitro seedlings are rooted and grown in the field for one generation. The seedling tubers are distributed to highland farmers.

Dr. Pritana Pradipasen who attended a TPS course in Sri Lanka in 1984, came back to Chiangmai University to conduct research on TPS. His initial efforts with TPS from CIP and also seed from Dr. P. Batugal and Mr. Manoch gave poor germination. Causes for this were discussed in detail with Dr. S. Wiersema, a CIP scientist recently posted to Thailand who travelled with the review team in Thailand. Seedling tubers produced from TPS of Serrana x DTO-28 gave a yield of 8 t/ha in 2 row spacing, CFK-69 x DTO-33, 16 t/ha and Atzimba x 128.6, 18 t/ha. This latter hybrid produced very uniform tubers, the size 100-150 gm ideal for the local market with good potential for small farmers. Studies of flowering in the lowlands were more successful than in the highlands. It was decided to test flowering in the highlands at different seasons; early maturity and heat tolerance are required for the north eastern part of the country.

3. SUSTAINABLE TECHNOLOGIES

Among Thailand, Sri Lanka, Indonesia and the Philippines, Thailand has the largest percentage of people economically active in agriculture. At present there are exportable surpluses of traditional foods such as rice and cassava. With the government decreed reduction in rice acreage, an opportunity exists to expand potato production. However, since Thailand was never colonized by Europeans the potato was not popularized as in some Asian and African countries - e.g. India, Kenya.

In the Thai SAPPRAD project, potato utilization studies accounted for one-quarter of the budget allocation. Seventeen innovative processed products have been produced and publicized. Potato utilization is being promoted by government action in seeking replacement for the opium poppy (Contract no 53-32 U 4-4-233 Third Report "Research on Seed Potato Production as Opium Poppy Replacement"). The success from 1984 to 1987 in the SAPPRAD program by small farmers adoption of 200 diffuse light potato stores testifies to farmer interest in this high value crop. Processing and diffuse light storage for seed potatoes are ready

"The SAPPRAD budget is limited, so we specialized on post-harvest technology. But the future of the crop depends on the whole system. This is why we benefit from projects in the Philippines and other countries."

Ampol Senanarong, Thailand

for dissemination. Dr. S. Weirsema has been posted to Thailand from CIP, Lima, as a post-harvest specialist to follow up research, including ware potato storage. Greater consumer utilization of fresh potatoes offers the best potential for increased production of this nutritious crop.

All major crops have their special pest and disease problems such as the brown leaf hopper on rice and smut and rusts on cereals. In the tropics, bacteria wilt and potato tuber moth are the most important disease and pest of the potato. In the SAPPRAD "network", Thailand was allocated research on potato tuber moth (PTM) with verification of control procedures to be tested in Sri Lanka. Research has focused on the life cycle, population dynamics and control of PTM in potato stores. Basic data on the behavior of PTM under S.E. Asian conditions is essential to determine if there were patterns which differed significantly from other widely separated areas. Pheromones were used successfully in field trapping in Thailand, verifying the effectiveness of the species specific synthetic mating attractant previously used in Peru and Queensland, Australia.

Adaptation of control measures developed by CIP and tested under Thailand conditions performed as expected. Use of dried natural products, such as layered barriers of Lantana leaves to exclude female moths from egg laying on tubers in storage, are being evaluated in farmer trials. (A particular weed, Muna, was used in Peru by Inca farmers for centuries). Other local plant species in addition to Lantana may prove useful under farm conditions.

Dr. Ampol Senanarong, Deputy Director of Agriculture for Research spoke strongly of the need for research, to continue post-harvest management and technology transfer, local seed production and variety trials for the lowland including processing varieties.

4. COLLABORATION AMONG COUNTRIES

Thailand has probably capitalized more on intercountry collaboration than other countries in SAPPRAD. Beginning, as it did, with a very limited potato research capacity, but the will to strengthen its program, Thailand has taken advantage of the exchange of information and germplasm as well as training. The post-harvest work done in Thailand has benefitted other countries in the network, and it is likely that tissue culture and rapid multiplication will also do so in the future.

"Over participation in the network has attracted the attention of the government which has strengthened the program."

Manoch Thongjiem, Thailand

Research on PTM control offers a good example of collaboration. Through SAPPRAD organized training, Ms. Pisamai Chouvalitwongporn went to CIP headquarters. In addition to her excellent research in Thailand, noted under TOR 2 above, she has also served as a lecturer in a regional storage course in Thailand in 1984.

Another example of collaboration is the documentation of existing, and development of new, potato preparations in SAPPRAD member countries. Under this project, 35 potato recipes have been documented in Sri Lanka, 20 in the Philippines and 11 in Thailand. Seventeen new recipe have been formulated in Thailand and 11 in the Philippines.

Through SAPPRAD, the Philippines and CIP have supplied Thailand with promising genetic material which is being locally evaluated.

In 1984, Mr. Pritana Pradipasen travelled to Sri Lanka for training in TPS research. He is now leading a TPS project at Chiangmai University.

Results of tropical agronomy research in Indonesia and the Philippines, like those on mulching and depth of planting to lower soil temperature and planting after irrigated rice to avoid bacterial wilt, have been useful for Thailand's work in the lowlands. Dr. Manoch Thongjiem stated that he feels Thailand has benefitted to some degree from the research in every SAPPRAD member country with the exception of Papua New Guinea, where frequent changes in project leaders and program discontinuity have made collaboration difficult.

5. EXTENDING THE PROGRAM

Thailand's Director of Agriculture and the country project leader stated that they believed an extension of SAPPRAD would be highly beneficial. In their view, the post-harvest research should continue, and increased attention should be paid to four additional areas:

- On-farm testing and transfer of technology
- Local seed production
- Selection of new varieties adapted to local conditions and processors' needs
- Marketing and demand studies

"The biggest problem is lack of information to direct potato and sweet potato research. Scott's study on the potato helped us, but we need farm surveys, as well as market studies to get the whole picture. Until 1982 we didn't even know we had the PTM. The case is even worse with sweet potatoes. No one knows what the problems are."

Manoch Thongjiem, Thailand

The review team concurs with these priorities, but would caution Thai researchers and policy makers to avoid spreading their resources so thinly that little progress is made in any one area. The review team notes with favor CIP's basing a senior researcher in Thailand with ample experience in seed and post-harvest research and with close working ties with CIP's Social Science Department. Although this scientist has regional responsibilities, he is expected to provide useful technical backup for Thailand's relatively advanced storage work and incipient seed system development. He can also facilitate socioeconomic backstopping from CIP headquarters for marketing and demad studies.

In the future, Thailand's potato program is expected to benefit from greater exchange of information and experience between Thai researchers and policymakers and their counterparts in other SAPPRAD member countries. Additionally, funds made available by SAPPRAD can be used to support needed work in areas not previously included in the potato program. Adding a socioeconomic component to the work on seed systems and post-harvest technology would be a priority area for this type of support.

6. SWEET POTATOES

During the last 20 years the area devoted to sweet potato has ranged between 31,000 and 41,000 ha with an average of 36,000 ha. In recent years the country has received some varieties from both IITA and AVRDC. Staff has been sent to IITA for training and they have brought back cultivars. There are about 150 accessions in the Thai collection and varieties are now being tested in various regions.

The principal field problem is the weevil, *Cylas fornicarius*. Starch and sugar levels in sweet potato are considered important in processing to make supplementary food for school children when mixed with milk. There is a possible use as livestock feed. A vine type plant is desired with yellow or red fleshed storage roots. Yields to 20 t/ha are reported on first planting land to sweet potato, but through repeat cropping over four or five years yields may be as low as 6 t/ha. The need for a drum dryer and research on pelleting sweet potato for animal feed -- possibly for export -- was mentioned.

SAPPRAD might contribute a limited amount of support on the biology of the sweet potato weevil. This insect is the dominant pest wherever

sweet potatoes are grown. SAPPRAD could profit by gaining a better knowledge of the weevil which would be also useful in devising practical control of this insect in other Southeast Asian countries.

The review team found more interest in expanding utilization of the sweet potato as a livestock feed and source of starch than as a food crop. In particular, Thai policymakers expressed interest in exploring possibilities to export processed sweet potato products. It was noted that sweet potatoes should not be viewed as competing with cassava in the cropping system, since these crops are grown in different areas. Cassava is grown in drought-prone areas. Sweet potatoes require more soil moisture and are subject to more insect pest problems. Technology is needed for growing sweet potatoes after rice on paddy land or to interplant them with upland crops like maize.

SAPPRAD support for sweet potato R&D would find an ideal institutional setting, since the country project leader, Manoch Thongjiem is responsibile for coordinating both potato and sweet potato research within the HRI.

Practical Seed Production

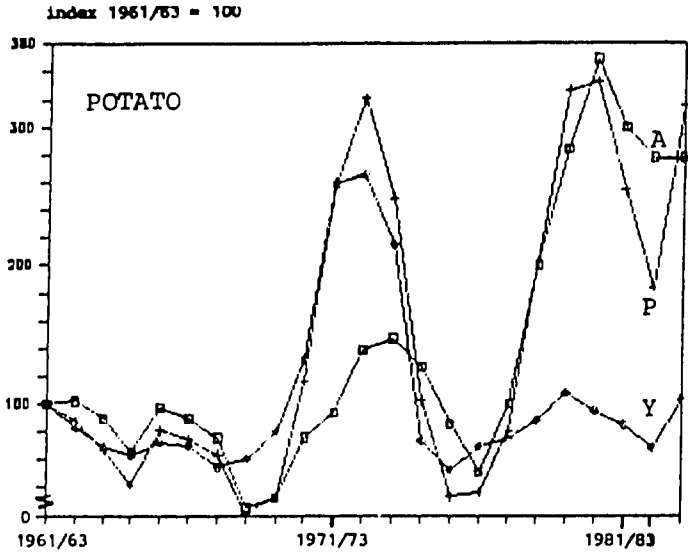
Papua New Guinea

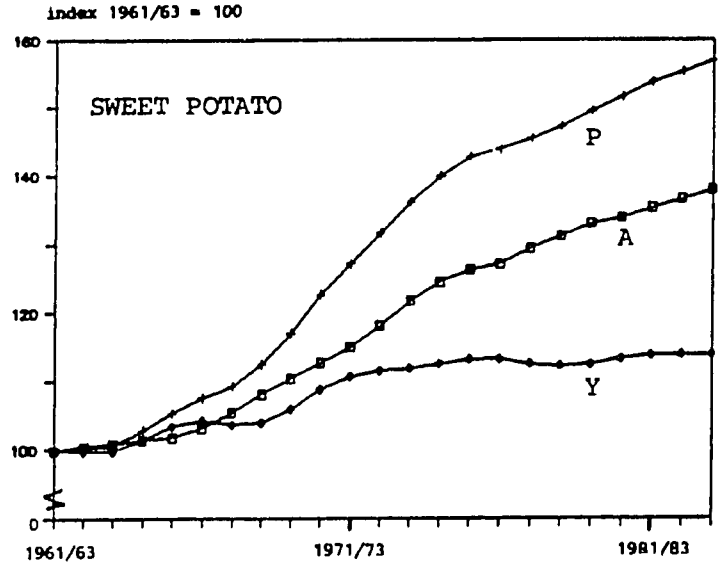
Papua New Guinea: Basic country statistics

GNP per capita	$710	Population per ha arable land	
Population		-total	131
-total (million)	3.4	-rural	112
-rural	86%	Fertilizer use	18 kg/ha
Growth rates		Cereal imports	
-population	2.6%	-total (000)	174 ton
-GNP per capita	0.6%	-per capita	58 kg
-agriculture	2.6%	Daily per capita calorie supply	
Land area		-total	2,109 calories
-total (million)	45 ha	-% requirement	79%
-arable (thousand)	26 ha		

Source: Annex 3.

Papua New Guinea: Potato and sweet potato production (P), area (A) and yield (Y) 1961-85 (3 year moving average)





Papua New Guinea: Estimates of potato and sweet potato production 1985

	Potato		Sweet Potato
	FAO estimate	Local estimate	FAO estimate a/
Area (000 ha)	-		103
Yield (t/ha)	9		5
Production			
-total (000 t)	1	4	469
-per capita (kg)	-	1	134

a/ The team did not attempt to obtain local estimates of sweet potato production.

Papua New Guinea: Price estimates gathered during the Review

	Toea/kg a/	US Cents/kg a/
Prices reported by researchers, extension agents (Sequoia)		
Farm-gate prices		
Table potato	25-30b/	29-35
Common seed	40	46
Imported seed	65	76
Improved seed	30	35
Prices in Port Moresby		
Landed price	55-60	64-70
Wholesale price	65	76
Retail price	90-150	105-174
Prices reported by farmers (Sequoia)		
Table potatoes	30	35
Imported seed	70	81
Common seed	40	46
Improved seed	30	35
Cabbage	15-20	17-23
Prices observed in Gordon's Market, Port Moresby c/		
Potato b/	120	140
Sego	100	116
Cassava	40	46
Sweet potato	65-70	76-81
Taro	50-60	58-70
Cabbage	100	116

a/ US$1 (100 Cents) = K 0.86 (86 Toea) at the time of the review.

b/ A processor estimated that to compete with Australian supplies, Kennebec would have to be available in Port Moresby for T 37/kg. He sells chilled, per fried chips to retailers for T 115/kg.

c/ Commodities are sold in this market by volume rather than weight. These estimates are based on approximate conversions, and hence, should not be considered exact.

"Previously potatoes were only in the supermarket, but now they're also in the local open markets, both in the highlands and in Port Moresby. Potatoes are becoming local peoples' food."

George Gorogo, Papua New Guinea

INTRODUCTION

Papua New Guinea (PNG) occupies the eastern portion of New Guinea, the world's second largest island, just north of Australia. The country has a total land area of 462,000 square kilometers; an abundance of timber, minerals and petroleum reserves; and some of the world's most exotic flora and fauna. Average GNP per capita is over $700. However, income is highly concentrated in mining, commerce and plantation agriculture, leaving over three-quarters of the people near the margins of subsistence in isolated rural areas. Agricultural growth has been relatively slow and per capita food production has fallen over the last decade.

PNG depends heavily on food imports. In 1984, 60 kg of cereals were imported per head of population. Fresh vegetables, canned goods, dairy production and meat were also imported primarily for consumption by expatriates and tourists in the capital city Port Moresby, and in a few towns like Lae and Mount Hagen. Even with these imports, the daily per capita food supply contains only about 2,100 calories -- 20 percent less than the FAO's estimate of the requirement for good health.

Prior to introduction of the sweet potato some 300 years ago, taro (Calocasia esculentum) and bananas (Musa sapientum) were the main foodcrops. Ideally suited to PNG's generally rainy, frost-free conditions, sweet potato cultivation spread rapidly, expanding the total food supply and allowing significant population growth. Today the sweet potato is PNG's principal foodcrop, with average per capita consumption estimated be over 130 kg. In some highland areas sweet potato consumption is more than one kg per day -- perhaps 400 kg per head per year.

Prior to independence in 1975, private companies and colonial programs conducted a limited amount of R&D on the major plantation crops including coffee, tea, oil palm, cocoa and rubber. However, until recently, virtually no R&D programs addressed foodcrops. The indigenous population employed age-old methods to produce its "subsistence crops" -- mainly sweet potatoes, taro and bananas. The expatriate population lived mainly on imported "European foods" -- including potatoes -- most of which were brought in from Australia.

Numerous anthropological studies have been conducted, but agricultural statistics have never been systematically collected for PNG. In many areas crops are grown throughout the year for home consumption. Typically foodcrops are grown in mixed stands on small irregularly shaped garden plots. This makes it difficult to estimate area and crop production and practically meaningless to compare yields per ha on different fields.

"There's been great change in the last four to five years; even over the last 12 months. We probably have 5,000-10,000 tons of production now."

Andrew Hayton, Papua New Guinea

The FAO estimates that in 1985 PNG produced only 550 tons of potatoes on 61 hectare giving an average yield of 9 t/ha. However, these figures grossly underestimate actual potato production. In 1985, experiment station in highland areas produced and sold to farmers nearly 300 tons of seed potatoes. An additional 75 tons of seed were imported from Australia. While no systematic farm surveys have been conducted, it is known that most farmers keep some of their output to use as seed the next season and that some exchange of seed takes place among farmers. For these reasons it seems likely that government experiment stations and imports provide no more than one-half the total seed supply. Based on our observations and discussions with researchers and farmers, the output per unit of seed is estimated to be around 5:1.

Combining these estimates, PNG's potato production in 1985 must have been at least 3,500 tons. In 1986, when goverment farms and imports supplied 425 tons of seed, it is likely that more than 4,000 tons of potatoes were produced. In other words, PNG's potato production is probably at least six times the published FAO estimate.

PNG's initial interest in potatoes, and in SAPPRAD, came not from the potatoes' importance as a foodcrop, but as an import and a potential cash crop for small highland farmers. Imports of both table potatoes and seed posed a drain on foreign exchange and created dependence on foreign supplies. To reach Port Moresby, highland potatoes must be trucked down to Lae and then shipped by boat around the eastern end of the island. Many potatoes are harvested premature and are handled roughly. Some are infected with bacterial wilt or other diseases that cause tuber decay. Imported seed, on the other hand, must be shipped by boat to Lae and trucked up to the highlands. The scarcity and high cost of seed potatoes and high transport costs coupled with high losses have traditionally made potatoes expensive and have limited their consumption to high-income groups, mainly expatriates.

When SAPPRAD was established, the most obvious constraint to potato production and use in PNG was the inadequate seed supply. In light of the country's recent independence and the dearth of trained people, PNG needed a practical approach to potato R&D. Hence, the project, "Practical seed production" was selected. This project has been implemented by the Department of Agriculture and Livestock (DAL), formerly the Department of Primary Industries.

"Potato production has increased so tremendously that requests for seed have shot out of sight."

George Gorogo, Papua New Guinea

1. PROGRAM BENEFITS

Within SAPPRAD, PNG has been a "problem country" in some senses. The project leadership has changed three times, and discontinuity of staffing coupled with domestic political and financial problems has acted as a break on potato R&D. Consequently, until recently the program has generated few tangible results that could be transferred to local farmers or to potato programs in other SAPPRAD member countries.

However, relative to the previous situation and to the situation with other foodcrops in PNG, the potato program has progressed significantly, especially over the last 18 months.

PNG has a two-tiered agricultural R&D system. At the national level, the DAL is responsible for planning, research and monitoring. In 1985, the DAL began a national seed potato program based at Taluma. Provincial governments are responsible for seed multiplication and agricultural extension work. However, the national government, through the DAL, has no control over staffing, funding or management of the provincial programs. Coordination is also made difficult by the relative isolation of the highlands from the national government in Port Moresby.

Since 1985 a "Regional Horticulturist" has been based in Mt. Hagen, to coordinate national and provincial research and extension work on vegetables, with major emphasis on potatoes. While he has no direct financial or managerial control over work at the provincial level, program workers feel that the regional horticulturist has facilitated communication, coordination of efforts and consolidation of a more coherent potato R&D program that is capable of reaching highland farmers.

While SAPPRAD has made only a small financial contribution, PNG program workers state that SAPPRAD membership has contributed to national program capacity in three areas. SAPPRAD has provided new ideas, like the use of rapid multiplication techniques which help strengnthen and expand the seed program. Participation in SAPPRAD has given program workers more leverage in negotiating for additional resources. Finally, participation in international meetings and reviews has motivated program people in different institutions to work more effectively together for a common purpose. As Mr. E. Cena, seed specialist in the Eastern Highlands, stated, "One achievement of SAPPRAD has been getting the differet programs coordinated and integrated. Previously each one worked more-or-less separately."

At present, among PNG's foodcrop programs, the potato program is considered to be the strongest, after the highlands program focusing on sweet potatoes. Hence, while it may still be weak relative to the

"Once the farmer sees something that makes money he goes for it. That's why they're all going for potato."

Michael Hughes, Papua New Guinea

others in the SAPPRAD network, PNG's potato program has become one of its country's strongest.

PNG's seed program has been highly innovative in some aspects. The original scheme was for PNG's national seed potato unit at Tambul to multiply conventional imported seed tubers and distribute them to the provicial units for further multiplication and distribution to farms. Soon it was realized that virus-free tuberlets produced in tissue culture in Australia could be rapidly multiplied in screenhouses using stem cutting techniques. Hence, the second scheme was for the Tambul Station to use rapid multiplication techniques (RMT) to produce basic seed from imported tuberlets and to distribute the basic seed to provincial units for further multiplication and distribution. Finally, the provicial units have begun producig their own basic seed using RMT. Hence, the technical scheme for seed production has evolved far beyond the original one, and has the potential to produce far greater benefits at the farm level.

In the review team's view, inadequate local staffing may jeopardize the future of PNG's seed program. The team noted with some concern that all key positions in the seed program -- including head of the national seed program (based at Tambul) and the officers in charge of seed potato production in the Eastern Highlands (Goroka), Western Highlands (Mt. Hagen) and Enga Provinces (Taluma) -- are occupied by expatriates.

The Tambul and Mt. Hagen programs have local counterparts, but the expatriates in Goroka and Taluma work alone. The team feels that it is of the utmost importance that provincial governments involve local people in order to ensure necessary human resource development and program continuity. This is especially urgent in the Eastern Highlands where the present expatriate's contract terminates in June, 1987.

The team also noted that the Eastern and Western Highland Programs do not have their own land and have to make special arrangements to rent or "borrow" suitable land for seed production each year. In this regard, the team urges PNG leaders to reassess the roles of the national and provincial governments and the private sector in seed production. If provincial governments cannot obtain long-term control over suitable land for seed multiplication, perhaps other arrangements, such as contracts with private farmers, should be explored.

A third problem cited by staff in the provincial programs was inadequate, undependable funding, which can have a devastating effect on any seed program. One way to justify necessary funding and support of the corresponding agencies and the private sector would be to conduct regional seed trials that compare the agronomic and economic performance of improved seed and farmers' common seed, and to use these results to

"The demand for seed is phenomenal. We could easily double or triple our production and have no problem selling it."

Michael Hughes, Papua New Guinea

estimate the seed program's net benefits. This is discussed further under Chapter 5.

2. RESEARCH RESULTS

Introduction

At the inception of SAPPRAD in 1982, PNG was importing certified seed from Australia which, after two multiplications, was made available to farmers. This has been costly for the government of PNG and has resulted in a reduction placed on potato imports. In January 1987 the government further imposed a 50% tariff on supplementary imports. As a result traders are now encouraging more local production. Growers are assured of a market. The government is obliged by its decision to maintain the availability of clean seed and to improve post-harvest management.

In 1983 SAPPRAD recommended that PNG should form a potato advisory body to assist the government in planning and execution of potato research and development. The center piece of the research has been the development of rapid multiplication technology (RMT) based on stem cuttings. The first step was to familiarize staff with the techniques, for which technical and material support was provided by SAPPRAD headquarters in the Philippines.

Since 1982 home consumption of potatoes has increased from 3,100 to 4,200 tons, while processed consumption increased from 1,000 to 4,700 tons. Total seed production increased from 17 to 340 tons during the past 5 years. The request for seed has increased beyond expectation.

Rapid Multiplication Techniques

In a typical RMT scheme small tubers ("tuberlets") derived from virus-tested plants initiated in tissue culture are imported from Australia. At locations such as Mount Hagen, Tambul, Goroka and Kuk, "mother plants" are grown from the tuberlets (300 tuberlets = ca 4 kg) under quarantine conditions in screenhouses provided by SAPPRAD funding. As an example, at Mt. Hagen in 1986, from 15,968 stem cuttings obtained from 300 mother plants, 15,491 transplants survived. These transplants produced 962 kg of small tubers in the screenhouse. Planted in the field the small tubers produced 1.7 tons of seed from the original 4 kg of Australian tuberlets. From January 1986 to January 31, 1987, 3.4 tons of seed were harvested at Mt. Hagen. With the construction of a

"Not only is the potato becoming a cash crop and a local food. Processing is also coming up. Everyone likes french fries."

George Gorogo, Papua New Guinea

second 50 m^2 screenhouse in April, 1987, from 400 to 450 mother plants are expected to produce about 9.6 tons of seed during the year. Of this total, the Department of Agriculture and Livestock will produce 8 tons and farmers 1.5 tons from first generation small tubers supplied by DAL. In another example, at Goroka, in the Eastern Highlands, from October 1985 to January 1986, 793 kg of small tubers were obtained for field planting from 10,353 transplants obtained by stem cuttings from mother plants.

Multiplication of seed by conventional means, the seed originally obtained from Australia, is also being carried out at Taluma, Enga and Tambul. The demand for seed for ware potato production is extremely high. The desire by small farmers to grow consumer potatoes as a substitute cash crop where coffee cannot be grown is aggravated by demands for potatoes for processing. Home consumption of potatoes by the indigenous population and for processed french fries by the fast food outlets in Port Moresby has created an expectation for the potato industry to double over the next four years. In this situation, sophisticated processing already active in Port Moresby contrasts sharply with the difficulty of training small farmers in the use of rapid multiplication techiques (RMT). The present rate of training techicians, two per year during the past three years, is inadequate; only two trainees are still involved with seed production.

Disease Problems

Insofar as known, and probably unique to PNG, is the absence of the late blight disease. How long this will continue in the highlands of PNG where the climate is ideal for the late blight fungus, is dependent on the non introduction of the organism. Extreme precaution must be taken to avoid introduction of this devastating disease.

Unquestionably, the presence of bacterial wilt (BW) is caused by indigenous strains of the pathogen. The program staff are attempting to use rigorous sanitation procedures in the field. But their practicality and effectiveness are questionable. Although suppression of the wilt bacteria is possible where potatoes are grown following paddy rice and also, but to a lesser extent, following (or itercropping) sugarcane, the presence of BW in PNG is a serious potential constraint to commercial potato production. From variety trials in PNG there are hopeful indications of limited resistance in some potato varieties.

"The processing industry has three requirements: consistent supply, consistent quality and contract prices. If you can guarantee these, I'd love to process local potatoes. But without them, I have to continue importing. Consumer potatoes and processing potatoes are worlds apart."

W. Golding, Papua New Guinea

Varietal Trials

Two varieties are presently recommended for PNG, "Sequoia" for ware potato home consumption and "Kennebec" for processing. During the SAPPRAD program a number of varieties were imported for testing from Victoria, Australia, and from CIP in the Philippines. Accessions are held at Kuk where 20 cultivars are being screened for yields superior to Sequoia and Kennebec. It is the intent also to test the Kuk cultivars at Taluma, Tambul, Aiyura, Lelet and Keravat through an altitude range from 2700 meters down to sea level in both mineral and organic soils.

3. SUSTAINABLE TECHNOLOGIES

The conventional method of producing potatoes in PNG has been praticed since the 1930's. Reliance has been placed on the multiplication of imported seed primarily to supply potatoes for the expatriate community. This approach is still important but the high cost of imported seed has brought about government prohibition of seed imports. As a consequence non conventional rapid multiplication technologies are being explored. At the same time a high yielding, processing variety to replace Kennebec and a suitable substitute for Sequoia are being sought.

The principal problem then is to adopt and make acceptable to the small farmer rapid multiplication techniques which have been successful in other countries. Because of the unfamiliarity of farmers with potato culture, adaptation may be slower than normally encountered in developing countries. Although RMT are highly practical in the short term it will rely on importation of small amounts of "tuberlets" from Australia.

It is suggested for the immediate future that provincial institutions should provide seed to farmers through rapid multiplication stem cutting procedures. Training of technicians to pass along the technology to farmers is essential. The high demand and large returns from potatoes will accelerate farmer acceptance of the "new" techniques. Experience elsewhere has shown the practicality of the simple technique of rooting cuttings and producing seedling tubers. It should be noted that normal commercial seed is multiplied five to six times from plants produced in tissue culture. In effect, the quality of seed now offered through RMT is of the order of "pre-elite," somewhat less than elite, but adequate seed could be produced by farmers without screenhouses using the earth mounds so common in PNG. Effort should be directed to

"One achievement of SAPPRAD is getting the different programs coordinated and integrated. Previously each one worked more-or-less separately."

Emmanuel Cena, Papua New Guinea

farmer demonstration of RMT. Private companies, which are now experimenting with both conventional and rapid multiplication technologies could also play a usefully role in future seed production.

4. INTER-COUNTRY COLLABORATION

Up to this point, PNG has benefited from interaction within the network but has provided relatively little to the other member countries. In view of PNG's recent independence and the incipient state of the country's agricultural R&D, this is understandable. Potato researchers and extension workers in PNG stated that many research findings at CIP and in SAPPRAD member countries were useful for them. In this regard it should be noted that CIP's regional representative based in the Philippines has not visited PNG since the network was established. Hence, virtually all contact between CIP and PNG has come via SAPPRAD.

Specific research projects that were cited as providing useful results for PNG are the storage project conducted in Thailand and the technology transfer project conducted by the SAPPRAD Coordinating Scientist.

5. EXTENDING THE PROGRAM

Over the last five years, PNG has gone through a rather difficult process of establishing priorities and the basic elements of a seed program. Only during the last year have all of the program's budgeted positions been filled. As noted earlier, the seed program has evolved through a number of stages. First, it multiplied imported certified seed. Then it attempted to introduce RMT on the village level. Later it focused on rapid multiplication of imported virus-free tuberlets by the national seed scheme based at Tambul, for later distribution to provincial seed schemes and farmers. Finally, the provincial seed schemes are now capable of multiplying the imported tuberlets directly.

Priorities for PNG and future program, as spelled out by Mr. George Gorogo, Chief Horticulturist, are:

- Consolidate seed production at Tambul and provincial seed centers, utilizing imported high-quality minitubers and RMT

"SAPPRAD has given us another hope to solve the problem of depending on imported seed, which makes production too costly and would eventually bring us late blight."

Faustino Dadpaas, Papua New Guinea

- Establish a commercial seed production system to multiply the seed produced at Tambul and provincial centers
- Continue with the multilocation cultivar evaluation to select improved varieties for table and processing
- Improve post-harvest technology and marketing
- Continue training
- Formalize a Potato Advisory Committee

The review team concurs with these priorities with the following qualifications, observations and recommendations. The seed program is being established in a considerable information void. Very little is known about farmers' current potato production and seed management systems. Data are required on the distribution of pests and diseases in farmers' fields (such as viruses and bacterial wilt) and on farmers' production and seed management practices (such as varieties grown, extent of cultivation, frequency of seed renovation, seed sources, selection and storage practices). This information could help the seed program managers estimate present seed requirements and identify farmers who are presently supplying seed to their neighbors or to others. By distributing improved seed to these known seed producers, the seed program could achieve an early multiplier effect, without instituting a complex certification system and training new producers.

The team feels that the scheme for "commercial seed production" presented during the review is too complex, both technically and institutionally, to be feasible in PNG — or in most developing countries for that matter. It is recommended that a simpler scheme be devised which dovetails with the farmers' existing "informal" seed system. This should be a "flush-out" system, with new introductions of a small amount of clean basic seed each year. In the team's view, it would be counterproductive to set up elaborate certification criteria which cannot be adhered to because of inadequate facilities, personnel, and the necessary legal and institutional base.

A system of annual on-farm trials comparing improved and common farmer seed would be useful to monitor the relative value of the program's seed each year. The "yield gap" between improved and common seed provides an indication of the relative value of, and demand for, improved seed. Results of these trials are also needed to estimate the program's net benefits.

Finally, it is recommended that the program gradually raise the price of seed until it reflects more nearly its productivity, relative to common seed. At present, the program sells improved seed for K30 per bag, while common seed sells for K40 per bag and imported seed sells K60 per bag. Hence, it is possible that the strong demand for seed reflects its low price rather than its high quality. To ensure that adequate quality standards are maintained and that seed is distributed rationally, the on-farm comparisons should be conducted and the price of improved seed should be raised above the price of common farmer seed.

SAPPRAD can play two critical roles in strenthening PNG's seed program:

- Provide the training and information exchange that is essential to put the system on a sound technical base
- Provide funds and technical support for innovative R&D areas like socioeconomics and RMT

However, it should be kept in mind that the program cannot establish a sound base of continuity unless national staff are assigned to the program, receive appropriate training, and have adequate remuneration and support.

6. SWEET POTATOES

During the period 1981 to 1985 per capita annual consumption of sweet potato in PNG was estimated by FAO to be 134 kg. This was more than triple the combined per capita consumption of this crop in Indonesia, Sri Lanka, Thailand and the Philippines. However, the yield of 4.6 t/ha was approximately half of that in the other SAPPRAD countries. Clearly research is necessary to determine the reason for this low yield which, incidentally, is only half the very low average yield of "white" potatoes in PNG.

In discussions at Kuk Agriculture Research Station, where sweet potato research is centered, there was no clearly defined cause for the low yields. That is, a number of potential but not definite causes for low yields were mentioned, including: feathery mottle virus, little leaf mycoplasma (possibly spread by leaf hoppers), black rot and root-knot nematodes. The station maintains a relatively large germplasm collection of approximately 1,000 accessions. This collection has been studied by Dr. Takagi from AVRDC, Taiwan, and computerized in accordance with International Board for Plant Genetic Resources (IBPGR) descriptors. A nematode survey has also been conducted by a specialist from Rothamsted, U. K. Some lowland and highland material has been taken to Burnley, Victoria, for clean up. A tissue culture facility for sweet potato is under construction at Kuk.

The operation of the tissue culture facility would permit SAPRAD-CIP assistance in providing germplasm exchange and the possible clean up of material to free from virus and/or mycoplasmas.

Since the sweet potato is PNG's major foodcrop and the principal source of food for low income groups, improvements in sweet potato production and use could have widespread social and economic benefits. Hence, it is recommended that SAPPRAD add sweet potatoes to its brief in PNG. Given the limited amount of systematic information on which to base priorities, a field survey would be useful to characterize the major sweet potato growing areas, farmers' production methods, use of the crop, and the major constraints to its production and utilization.

Breeding for the Lowland Tropics

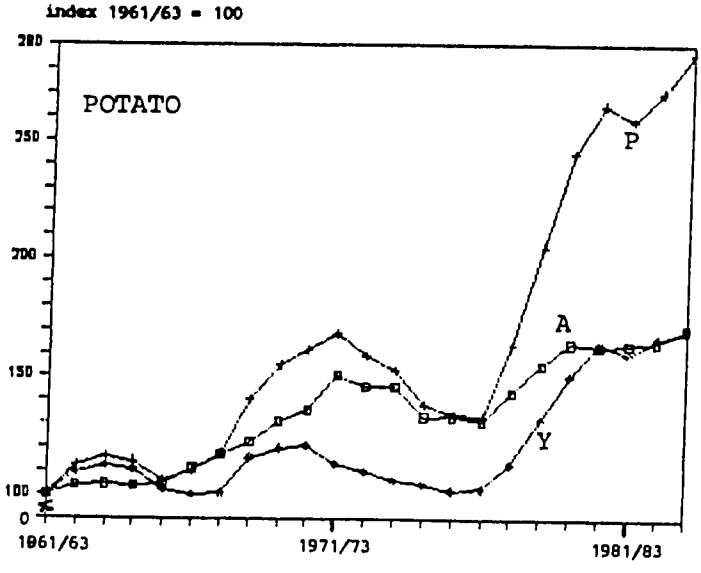
Philippines

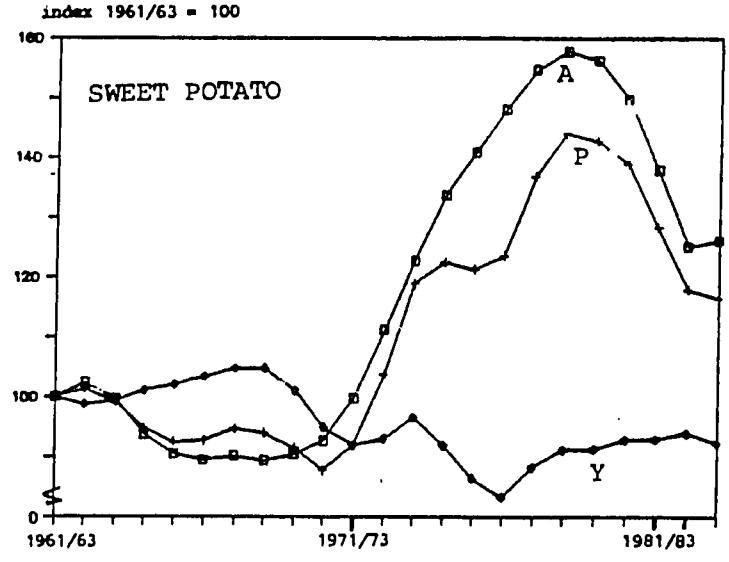
Philippines: Basic country statistics

GNP per capita	$660	Population per ha arable land	
Population		-total	7
-total (million)	53	-rural	4
-rural	61%	Fertilizer use	32 kg/ha
Growth rates		Cereal imports	
-population	2.7%	-total (000)	964 ton
-GNP per capita	2.6%	-per capita	18 kg
-agriculture	4.0%	Daily per capita calorie supply	
Land area		-total	2,357 calories
-total (million)	30 ha	-% requirement	104%
-arable (million)	8 ha	-% from rice	38%

Source: Annex 3.

Philippines: Potato and sweet potato production (P), area (A) and yield (Y) 1961-85 (3 year moving average)





Philippines: Estimates of potato and sweet potato production 1985 a/

	Potato	Sweet Potato
Area (000 ha)	4	214
Yield (t/ha)	11	5
Production		
-total (000 t)	48	1,005
-per capita (kg)	1	18

a/ Local estimates were not available.

Philippines: Price estimates gathered during the Review

	P/kg	US Cents/kg a/
Farm-gate prices	4-5	20-25
Prices noted in San Andres Market, Manila		
Potato	9 b/	45
Sweet potato	5 c/	25
Yam	5	25
Cabbage	7	35
Onion, red	7	35
white	4	20
Rice	6	30

a/ US$1 (100 cents) = P 20 at the time of the review.

b/ The market agent noted that the average potato price was P10/kg with a range from P 8/kg to P 18/kg.

c/ The market agent noted that sweet potato prices generally ranged from P 3/kg t P 5/kg.

"Without SAPPRAD, in 1982 our breeding program for the lowlands would have stopped."

E. T. Rasco, Jr., Philippines

INTRODUCTION

After Indonesia, the Philippines has the second largest population of any country in the SAPPRAD network (53 million) and it has registered the highest rate of population growth over the last decade. By the year 2000, the Philippines' population is expected to exceed 76 million. Within the SAPPRAD, the Philippines has the smallest share of its population (about 60 percent) living in rural areas. Average rural population density is relatively low, as is the use of purchased inputs, like chemical fertilizer.

Agricultural growth has kept ahead of population growth. Nevertheless, cereal imports were nearly a million tons in 1984, or about 20 kg per person. The diet is heavily rice based, but sweet potatoes are a staple food in the Visayas and some other areas, particularly where incomes are low and rice is scarce.

Nearly all potatoes are grown in highland areas, mostly in northern Luzon, and consumed as a luxury vegetable in the big cities. Per capita potato consumption, which averages about 1.5 kg, is near the world's lowest. The demand for potatoes -- both fresh and processed -- is strong, but the supply is limited and potato prices are high. As long as the potato crop remains confined to highland areas, supply will be limited, the price will be high and consumption will remain limited to high-income groups.

The Philippines has one of the most advanced agricultural R&D systems of any developing country. Beginning in the 1970's potato research and extension efforts began in several institutions, coordinated by the Philippine Council for Agricultural Resources Research and Development (PCARRD). Private groups including multi-national corporations, also began showing interest in producing potatoes on a large scale to supply the rapidly growing market for processed potatoes (mainly for frozen french fries to be used in restaurants).

In 1976 a young plant geneticist returned to the Philippines after completing a dissertation on the potato at Cornell University. Thus, when SAPPRAD was established, it was logical that the Philippines assumed responsibility for the most scientifically challenging project, "Breeding Potatoes for the Lowland Tropics."

"Seed supply will always be the major constraint to potato production in the lowlands."

E. Fernandez, Philippines

1. PROGRAM BENEFITS

Researchers are quick to note that without SAPPRAD there would be no breeding program for lowland potatoes in the Philippines. The potato ranks too low in the list of national priorities to justify a breeding program. Hence, there is no doubt that SAPPRAD has strengthened the Philippines' potato breeding capacity. As noted in the following section, capacity in tissue culture, RMT and related fields has also been strengthened. It is far too early in the life of the breeding program to observe an impact at the farm level. However, having a strong breeding program has helped the Philippines select better varieties from among the available foreign cultivars.

2. RESEARCH RESULTS

Introduction

The Philippines was given the mandate for a project in SAPPRAD to breed potatoes for the tropics. Prior to the initiation of the SAPPRAD program there was considerable activity in the introduction and selection of varieties in the country. Since 1976 variety releases have included Arka, Cosima, Berolina, Granola, Kennebec, and Up-to-Date. Cosima, Berolina and Granola are at present the principal commercial varieties.

The SAPPRAD investment in 1982 increased the funds available to improve a breeding program which had relied on open-pollinated seed from plants which had superior flowering capacity. It became apparent that major changes in breeding procedures were necessary including improved germplasm maintenance, multilocation testing, controlled pollination and screening for heat tolerance and bacterial wilt resistance under controlled conditions.

Germplasm

From 1982 to 1986, introductions to the germplasm collection increased from 1,772 to 3,007 accessions, including 67 varieties, 302 CIP clones, 2,622 clones from TPS evaluation and 16 "others", all in tuber form. Through strict selection in breeding and seed multiplication the efficiency of the collection has recently been improved. By December 1986, the collection was reduced to 61 commercial varieties and 1,028 clones for a total of 1,089. The field collection is maintained at Buguias, at 2,500 m.a.s.l.

"The seed problem is so difficult that 60% of our operating budget for breeding goes for contract seed production."

E. T. Rasco, Jr., Philippines

At present, 319 accessions are also maintained in tissue culture. This collection is being assessed for rate of growth and in vitro tuberization; the in vitro tuberlets are held in aseptic cold storage for future use. Studies on tissue culture techniques include evaluation of media components, single node transfer and the effect of light quality on in vitro germplasm maintenance at air conditioned room temperature. This approach is necessary because illuminated chill facilities (8° C) are not available.

Non conventional methods of multiplication are used to multiply advanced clones for field trials. Tissue culture and stem cutting techniques have been developed for both highland and lowland systems. These systems are based on a coir dust-hog manure rooting media for stem cuttings supplemented under hot lowland conditions with a mulch at time of establishment in propagation beds. Mulches such as shredded paper, corn cob bits and rice hulls favored high survival and growth of stem cuttings.

Breeding

Hybridization work to produce hybrid seed was started in 1982, with the objective to combine high temperature adaptation and resistances with superior horticultural qualities. This work is done in the greenhouse at Benguet State University. During the past five years, 557 crosses have been made involving 13 clones and varieties as parents. A total of 62,008 seedlings from 395 TPS families were screened for heat tolerance at the University of the Philippines at Los Banos (UPLB) under greenhouse conditions. Overall, 21.8% of the seedlings were finally selected attesting to the success of hybridization involving selected parents. It was noted, however, that percent final selection during the years 1982-3-4 was ca. 41% in contrast to 8.8% finally selected under more strict guidelines in 1985 and 1986.

Promising clones selected in greenhouse heat tolerance tests were grown as "seedling hills" at Baguias to evaluate their general performance and potential as a variety or as a parent. From 1982-1986, 596 clones were selected for preliminary 4-hill evaluation under low and high elevation conditions. In summary, 9 clones were selected for low elevation and 12 clones were considered promising under highland conditions. In advanced replicate trials, which are normally done over two seasons, a few promising local clones, as well as clones received from foreign sources were assessed. T-204, Barka and Famosa were consistently the best yielders under lowland conditions at Laguna, while imported varieties such as Berolina, Desiree and Arka gave superior performance in the highlands at Buguias. Additional clones recently bred in the Philippine program are now being evaluated in advanced trials

"Since we had no entomology work whatsoever in vegetables, in 1983 we were caught flat-footed by the thrips problem in the lowlands."

E. Fernandez, Philippines

against international varieties. At this early stage it would be fortuitous to have arrived at a level of excellence in yield and quality comparable to established old European varieties.

Regional trials, at different test sites in SAPPRAD countries, were initiated in 1984 to evaluate the performance of promising clones from the Philippine program. Seed tubers for Indonesia, Sri Lanka and Thailand are multiplied in the field at Buguias (7,000 ft. a.s.l.) or by stem cutting at Benguet State University. Prior to shipping all clones are tested serologically.

During 1984-85, Indonesia selected 12 of 142 clones sent from the Philippines, Sri Lanka 4 out of 72 and Thailand 11 of 78; 32 clones sent to each country in 1986 are in on-going trials. The Cornell clone 44-34 was selected in Indonesia and Sri Lanka and appears very promising in the Philippines. Although yield is an important factor in selection, resistance to bacterial wilt was an important selection criterion in Sri Lanka, Indonesia and Thailand.

The selection of potential hybrid or open-pollinated clones for true seed production and as parents with good combining ability was part of the progeny evaluation carried out in the breeding program. In the overall evaluation carried out at UPLB, the CIP variety Molinera and clones PPC 4-17, A-66-32 were good combiners, while PPC 4-10 and the cultivar Rebus were superior sources of open-pollinated TPS.

Screening for Disease and Pest Resistance

According to FAO data, the average yield of potatoes in the Philippines during 1961-65 was 6.1 t/ha which increased to an average yield during 1981-85 to 10 t/ha. Contributing to this relatively low yield are a number of diseases, such as bacterial wilt, late blight, X, Y and leaf roll viruses, as well as thrips and root-knot nematode pests.

As part of an on-going study of bacterial wilt, 133 isolates of the causal agent (*Pseudomonas solanacearum*) have been characterized, 81% being Race 1 (biovar III: biovars IV in the ratio 3:1) and 19% Race 3 (biovar II). Of interest is the identification of the normal highland potato Race 3 persisting in low elevation areas. Of a total 609 potato accessions that have been screened against both Races of *P. solanacearum*, 21 clones showed a high percent survival. However, in another study, it was observed that for some clones, which survived under highland conditions, that their resistance broke down under high temperature in the lowlands.

"Having SAPPRAD has given the potato priority. Also, the technology transfer project has been a great success and is a model for other crops."

P. Gapasin, Philippines

Worldwide, with few exceptions, late blight, which caused the devastating famine in mid-nineteenth century Ireland, is still a serious disease of potatoes, especially under cool, humid conditions. Studies in seven locations in the northern province of Benguet identified 13 races of the late blight fungus (Phytophthora infectance). Of 81 accessions screened in the field using rows of susceptible varieties to intensify the disease, 9 hybrid clones had a late blight rating from 25-35 percent infection at 75 days after planting, compared to 98% infection of susceptible accessions.

Screening for virus resistance under natural field conditions has just begun. It is intended to screen field selection resistance under more vigorous controlled conditions. Viruses are being eridicated from promising clones by meristem culture combined with heat therapy. Triplicate in vitro culture are being assessed serologically by ELISA for X, Y, S and leaf roll viruses at the Serology Laboratory, Bureau of Plant Industries (BPI), Baguio. Of 187 entries tested 77 were virus free. It has been decided to also develop a capability for antisera production and virus detection at the institute.

Some 40 potato accession were screened in pot tests for resistance to the root knot nematode, Meloidagyne incognita (Race I). Only Atika and CIP 800938 were moderately resistant as based on the average number of root galls and egg masses. Berolina and Kennebec were moderately susceptible while the varieties Spunta, Red Pontiac and Conchita were rated susceptible.

A total of 330 clones were evaluated in the field in 1986 for combined thrip and mite resistance. Sixteen of the 116 clonal introduction from CIP had field resistance, 9 of which also had desirable horticultural and tuber characteristics. Twenty-eight of the 214 entries from the Institute of Plant Breeding (IPB) exhibited field resistance and were saved for further screening.

Postharvest Management

In the evaluation of postharvest behavior and quality four varieties were selected: IPB Sel #1, Conchita, Barka and Famosa. Following curing under ambient conditions (24.5-29°C, 75-92% RH) at Buguias, IPB Sel #1 and Conchita were cured for an additional week at 15°C, 82-89% RH. Tubers of Famosa and Barka harvested one week later were cured for 2 weeks at 15°C, 82-89% RH. Tubers were subsequently stored at either 5-8°C or at ambient 24.5-29°C and evaluated weekly for specific gravity (SG), total sugars, starch, weight, visual quality rating (VQR) and sprouting.

"All the technical information we present should be put into peso terms, since our ultimate goal is to improve farmer's income."

Dr. Palomar, Philippines

Barka and Famosa, cured under controlled conditions, consistently had better VQR under ambient storage without incipient sprouting and had a longer period of saleability than either IPB Sel #1 or Conchita. While Famosa and Barka did not shrivel even up to the eighth week under ambient storage, shrivelling aggravated deterioration in Conchita and to a lesser extent in IPB Sel #1 by the fourth week. However, firmness and increase in total sugars over initial levels did not vary significantly among varieties and the IPB clone. Barka had the highest starch content among the four samples. Only color varied after cooking; discoloration, texture, sweetness and general acceptability were not considered to be significantly different among the three varieties and the IPB clone.

In storage at 5-8°C, sensory evaluation including color, discoloration, texture, sweetness and acceptability of cooked samples were similar to those stored at 24.5-29°C. Sprouting incidence was lower under cool conditions. SG did not vary among samples, nor was there much change in firmness when stored at 5°C.

3. SUSTAINABLE TECHNOLOGIES

Breeding to develop potatoes for tropical conditions is a relatively new venture. Although a native of the highland tropics, potato breeding has largely been confined to developed countries with a temperate climate. The genetic base on which developed country breeders have relied has been narrow and confined principally to manipulation of the species Solanum tuberosum. However, an essentially untapped wealth of some 160 tuber-bearing species of Solanum offers a spectrum of heritable characteristics with the potential for the development of cultivars suitable for tropical lowlands. No other major food crop can be grown through 100° of latitude and more than 4 kilometers of altitude. Few crops can produce a marketable yield within two months of planting under conditions found in SAPPRAD countries.

Breeding potatoes is an open ended pursuit always hopefully leading to a still better variety. The breeding and selecting program in the Philippines has demonstrated that there are existing varieties suitable for SAPPRAD countries. Clearly, the export of tubers of selected varieties sent to Sri Lanka, Indonesia and Thailand following field trials in the highlands and lowlands of the Philippines are themselves packages of acceptable and environmentally sound technology. In the longer term, clones and varieties will be bred with the additional feature of better resistance to the special diseases and pests found in the tropics. Some clones bred in the Philippines are now on the threshold of wider field

"The potato is much sought after. Farmers want to grow it. There is also political will, since poor rural people need income opportunities. SAPPRAD must have a Phase II since only now are we showing the feasibility of growing potato in lowland areas and generating interest. Seed is the key problem."

R. Valmayor, Philippines

trials. Given the seven to ten years which it commonly takes to produce a significant new variety in developed countries, it is expected that crossing pre-selected parents will accelerate breeding to produce acceptable varieties for the tropics within a similar time frame.

The capability has been developed under the aegis of the SAPPRAD program to export disease free in vitro varieties and clones from the Philippines to other SAPPRAD countries. The use of tissue culture has expanded so that most developing countries, including four of five SAPPRAD countries, can make practical use of the technique for rapid multiplication. Thus, in vitro technology has been a useful step in the non conventional approach to the production of clean seed. Coupled with stem cuttings even small samples sent by air can be rapidly multiplied and made available to farmers. This approach provides an alternative to countries with hard currency problems which limits the importation of certified seed.

Now having observed the useful impact of the SAPPRAD research approach in five widely seperated countries, the impression is that a number of technologies are ready for transfer. The Philippine achievements in breeding and variety testing has, in a relatively short time, developed a very worthwhile program capable of providing a continuing supply of potato clones and varieties suitable for other SAPPRAD countries. The embryo postharvest management program has made a useful start in assessing the effects of storage environment on a spectrum of quality factors. This experience can be readily transferred to countries such as Thailand and Papua New Guinea which have immediate ambitions for processing a variety of snack foods.

4. INTERCOUNTRY COLLABORATION

The Philippine program has distributed genetic material in the form of tubers, for evaluation in Indonesia, Thailand and Sri Lanka. In the first two countries, researchers expressed their appreciation for this material and their interest in future shipments. In Sri Lanka, the review team was informed that some materials received from the Philippines were diseased. Unfortunately, no formal report of this has been made to date. Philippine program leaders expressed great concern, and doubt, that material sent abroad might have been diseased. To avoid future problems, they would prefer to send in vitro materials. This is an area for directing greater attention in the future.

"Prospects for the lowland potato are really bright."

V. Baloing, Philippines

The Philippine project leader noted that feedback of information from other SAPPRAD member countries on performance of genetic materials was poor. This phenomenon is rather common, and should not be a source of great concern. The germplasm management course scheduled for later this year in the Philippines should also help remedy this situation.

5. EXTENDING THE PROGRAM

This excellent national potato program is recognized and supported to the ministerial level. It is a vigorous program integrated from the research to farm level. The third annual conference recently held on the "Potato for the Lowlands" was well organized and very well attended. Leaders of farm committees presented their results of on-farm performance, including their returns on investment. If SAPPRAD had accomplished little else during the past five years than develop the Philippine program it would be a worthwhile achievement.

Farmers in the lowlands need a new cash crop that can be integrated with the traditional rice culture. The potato is ideally suited, being a short season crop which can be readily grown in paddy. There is demand for potatoes to make it available to low income people, whereas in the past it has been a rich man's food. Only under the SAPPRAD umbrella has the crop gained its present high level of interest, which has sustainability now with only a little continuing support. The connection with farmers and the demonstration of how potatoes can be one of several other crops, along with rice, to optimize land use in rotation has stimulated small farmer interest. The limited highland production of potatoes in the past can now be augmented by lowland production. It is important to continue breeding and selection to improve still further the varieties already shown to produce good yields under lowland conditions. The potential flow of seed potatoes from the highlands to lowland areas also enhances the value of the highland producer's crop.

6. SWEET POTATOES

Sweet potatoes are an important crop in the Philippines, where an average of about 210,000 ha have been grown annually during the past ten years. During the last 25 years, yield has remained relatively static at just under 5 t/ha. However, during the period 1976-1985 the area planted to sweet potatoes was about one-quarter larger than during the previous decade, resulting in an 11 percent increase in average annual production. In addition to the roots, the young shoots of sweet potato plants are also eaten. It is important to note that available production statistics do not include this nutritious food supplement.

Sweet potato research, which began several years ago in the University of the Philippines at Los Banos, is now centered at the Root Crops Center, Visayas State College of Agriculture (VISCA). The Philippines has the stronget sweet potato researchh program of any developing country, with the possible exception of Taiwan. The germplasm collection assembled in the Philippines includes about 1,080 accessions. The ability to handle the plant in tissue culture simplifies additions to the collection via in vitro samples. High yielding, high dry matter, yellow types of sweet potatoes are desirable for animal feed, which accounts for about 8% of current usage. For human consumption, there is a preference for white, dry fleshed types.

Several general constraints in the crop have been identified by researchers. These include resistance to the Cylos weevil and reduction in the bitter flavor, as well as agents causing flatulence. Rapid multiplication of desirable clones possible through in vitro techniques has been suggested as an area of research interest.

The Philippine sweet potato program places highest priority on expanding production for industrial processing and livestock feeding, rather than for human consumption. Therefore, emphasis should be placed on reducing production costs and identifying the most appropriate varieties for these end uses. Useful work has begun on post-harvest technology, but widespread practical application requires further refinement and piloting.

In the team's view, it would be desirable to include sweet potatoes under the SAPPRAD umbrella in the Philippines. Given its strength, the Philippine Program could perhaps serve as a model for other countries. Simultaneously, the Philippines could benefit from the exchange of germplasm and information with other countries, and, via SAPPRAD, with CIP and other foreign-based institutions.

Technology Transfer Project

"PCARRD is looking at the lowland potato project as a model for R&D with other crops like rice, corn and sweet potatoes."

D. Gapasin, Philippines

INTRODUCTION

The project was proposed and approved at the third annual coordinating committee meeting at Peradeniya, Sri Lanka in April 1984, and implementation started that same year. The purpose of the project is to translate results of the other five SAPPRAD research projects and of other national and international potato research programs into viable technologies, and to institutionalize their diffusion and utilization in the SAPPRAD-member countries.

In each country, the most critical areas for technology transfer were identified as: (1) strengthening the seed programs of each country using new seed technologies such as rapid multiplication techniques (RMT), true potato seed (TPS) and diffused light seed storage (DLS); (2) refinement, packaging and disseminating of potato technology; and (3) establishment of new potato communities in the mid-elevation and low-elevation tropics as focal points for expanding potato production.

The project was introduced in each country using a stepwise process:

- Train researchers and extension workers to verify or adapt the technology
- Establish local facilities and organizations to handle the new technology
- Train extension workers and farmers to pilot-test the technology
- Pilot-testing
- Refinement of the technology
- Institutionalization of the technology transfer process

Depending on the particular technologies and country situations, the activities were undertaken sequentially or simultaneously. The last step is crucial to ensure continuity after termination of SAPPRAD. The technology transfer activities in each SAPPRAD-member country are summarized below.

"In a place like the Philippines it's easy to find problems. We have many problems. The more difficult thing is to identify and explore opportunities for the future."

P. A. Batugal, Philippines

INDONESIA

Strengthening the Seed Program

Mr. R. F. Acasio trained Indonesian research/extension workers and farmers in Wonosobo, Central Java and Sumberbrantas, East Java. Two Lembang researchers (Ati Srie Duriat and Asih Kartasih) were trained on rapid miultiplication and seed production in the Philippines. An educational tour was hosted for two Indonesian researchers, one extension worker and two farmers to visit stations and farmers using RMT and planting lowland potatoes in the Philippines. Three screenhouses for rapid multiplication were constructed in Lembang to complement the USAID-funded glasshouse. Two farmer screenhouses were also constructed in Wonosobo and another at Sumberbrantas to pilot test RMT as a seed production system. The farmers have produced second generation (G2) seed tubers in Wonosobo and G1 seed tubers in Sumberbrantas. One researcher (Sjarifudin) was trained on TPS in Sri Lanka, and the station pilot-tested seed production using TPS. The station has produced G1 seed tubers using Serrana x DTO-28, Atzimba x R128.6 and Atzimba x DTO-28. DLS technology was pilot-tested in a government seed store and 10 farmer stores in Sumberbrantas and 10 farmer stores in Lembang.

Refinement and Dissemination of Technology

Ten agronomists from Indonesia, three from the Philippines and three from Thailand were trained on Tropical Agronomy in Batu, East Java, Indonesia.

Previous work on the potato from 1932-1984 was abstracted to document available technology and to serve as the baseline for technology packaging. This will be published in English in 1987 as "Indonesian Potato Abstracts." Initial technology recommendations were issued in "technoguides" for researchers and for farmers, both in Bahasa, Indonesia. On-farm trials were conducted in East Java, West Java and Bali to refine the initial technology recommendation (technoguide).

Establishment of New Potato Communities

Twenty-five extension workers and 50 farmers were trained on potato production technology. Initial mid-elevation potato technology was tested in 10 new sites in West Java, East Java, Central Java and Bali. A mid-elevation potato seminar was conducted in January 1987 to document

"What you have been doing over the last few years is making an important contribution to research management.... Linking research, extension and farmers can teach us very much about how to improve our research and extension programs."

D. Gapasin, Philippines

the state of knowledge gained from previous R&D studies. The results are being used to sharpen research priorities and upgrade current recommendations for farmers.

SRI LANKA

Strengthening the Seed Program

Dr. Alfinetta Zamora, tissue culture specialist in the SAPPRAD-Philippines breeding project, travelled to Sri Lanka to train the Department of Agriculture tissue culture laboratory specialist at Peredeniya and to help establish tissue culture facilities at Bandarawela Agricultural Research Station. Two Department of Agriculture seed program staff were trained in the Philippines: one on seed production (Mr. A. W. Albert) and one on virology (S. Jayaratne). One technician (Mr. Viswanathan) of the Ceylon Tobacco Company (CTC) was trained at CTC expense on RMT at the Philippine Bureau of Plant Industry and at the CIP Regional Germplasm Center in the Philippines. Subsequently CTC has established a project to produce basic seed from rooted cuttings of standard Sri Lankan cultivars. Three aphid-proof screen-houses were constructed (at Bandarawela ARS, Sita Eliya ARS and Sita Eliya Government Seed Farm) to produce basic seed from pathogen-tested materials. Production of basic seed from rooted cuttings was pilot-tested with the Government Seed Farm at Sita Eliya (now on third generation ,G3) and with CTC (now on G2). Ten research, extension and training officers of the Department of Agriculture were trained on TPS technology in Sri Lanka. The project assisted in pilot-testing basic seed production technology from TPS, both at the Government seed farm at Sita Eliya and in farmers fields at Nuwara Eliya and Bandarawela. These are now at G3 and G2, respectively. A Department of Agriculture staff member (Mr. A. W. Albert) was trained on DLS in Thailand and SAPPRAD assisted him in disseminating this technology to farmers. To date Sri Lanka, the Philippines and Thailand have successfully disseminated DLS among farmers.

Refinement and Dissemination of Technology

Two Department of Agriculture researchers (S.Karupurrachchi, and N. Jayawardene) were trained on tropical agronomy in Indonesia and assisted in refining tropical agronomy technology in the West Coast and North Central region. Mr. S. Karupurrachchi has assisted in upgrading and

"Our impression is that the potato offers farmers great opportunities to increase their incomes and productivity."

Representative of Land Bank, Philippines

promoting lowland potato technology at sea level in Kalpitya, on the West Coast.

Potato abstracts of work completed in Sri Lanka up to 1985 were compiled to serve as a baseline of knowledge on the potato for the country. This will be published in English in 1987. Thirty-three potato recipes compiled in Sri Lanka will be published in English in 1987.

Establishment of New Potato Communities

Mr. S. Kurapurrachchi has assisted in the promotion of low-elevation potato technology at Kalpitya, a new area at sea level on the West Coast. This work is now in its fifth year. Sri Lanka recently decided to pilot-test potato production in mid-elevation areas including uneconomical tea estates.

THAILAND

Strengthening the Seed Program

Three researchers (Chalit Phongsupasamit, Chatchai Soontrusawat, Vinai Charoenkul) were trained on RMT in the Philippines and Mr. Ric Acasio helped establish aphid proof screenhouses in Thailand. One screenhouse was constructed at Maejo Institute of Agricultural Technology, two were constructed at Fang Horticulture Station and two others at Chiangmai University. These are for rapid multiplication and production of basic seed from rooted cuttings and TPS. The use of rooted cuttings was pilot tested for basic seed production at Fang Station, Chiangmai University Station and farmers fields in Sansei. The two stations have now produced G2 tubers from rooted cuttings and farmers have produced G1 tubers. One Chiangmai University instructor (Pritana Pradipasen) was trained on TPS in Sri Lanka. The use of TPS for basic seed and table potato production was pilot-tested at Chiangmai University and at Fang Station. Both have produced G1 tubers. Two Thai researchers (Surasak Intrakamhaeng and Kittisak Kiratiya-angul) were trained in seed production on the Philippines. Mr. Kittisak is currently being further trained at CIP Lima on antisera production and SAPPRAD will fund his project upon his return. Thailand will then service the antisera needs of SAPPRAD countries.

Refinement and Dissemination of Technology

Three Thai researchers were trained in Indonesia and one was trained in the Philippines on Tropical Agronomy. Lowland potato production was pilot-tested at 0-50 m in Chuchangsao, Rayong, Hatyai and Puhet provinces. This year pilot testing will be done in the mid-elevation areas of Khao Khor (500-700 m). Initial recommendations were published in a potato technoguide in the Thai language. Current potato utilization and Thai potato recipes were also documented and published in the Thai dialect. The First National Potato Conference was held. The published proceedings serve as a baseline document for future potato research in the country.

Establishment of New Potato Communities

Pilot-testing will be done one more season before a decision is made on where to establish potato communities in the lowlands.

PAPUA NEW GUINEA

Strengthening the Seed Program

Mr. R. F. Acasio helped contruct five screenhouses in the Western Highlands Province (two at Hagen and three in Tambul). Three were also constructed in the Eastern Highland Province (two at Goroka and one at Taluma). One screenhouse was constructed in Enga Province. PNG staff and expatriates were trained on RMT, both locally and in the Philippines. Production of basic seed was pilot-tested in Hagen (now G3), Goroka (now G3) and Taluma (currently on G1).

Refinement and Dissemination of Potato Technology

The Papua New Guinea Potato Technoguide was published in 1986.

Establishment of New Potato Communities

Papua New Guinea is currently testing varieties and potato production technology in middle and low-elevations. The result of this work will determine new expansion areas at lower elevations.

PHILIPPINES

Strengthening the Seed Program

Fifteen researchers, 10 extension workers and 20 farmers and family members were trained in RMT. Three aphid-proof screenhoues were

constructed at the Bureau of Plant Industry and two were constructed on farm along the Mountain Trail. Seed production using rooted cuttings was pilot-tested in farmers' fields (now on G2). One researcher was trained on TPS in Sri Lanka and 10 were trained in the Philippines. Use of TPS in seed production was piloted in farmers' fields (now on G2). Use of DLS was tested in five new lowland communities.

Refinement and Dissemination of Technology

Three researchers were trained on tropical agronomy in Indonesia. The Philippine Potato Abstracts of potato work undertaken from 1934 to 1984 was published. Thirty-five tropical agronomy verification trials were supported from 1984 to 1986. Three annual lowland potato conferences and planning workshops and one highland potato conference and planning workshop were conducted to update current production technology. A preliminary lowland potato technoguide was published in 1983. An updated lowland potato technoguide was published in 1984 and translated into four dialects.

Establishment of New Potato Communities

Lowland potato production was piloted in five communities in 1984 and in 20 communities in 1985 and 1986. Twenty-five farmers participated in 1984, 120 in 1985, and 250 in 1986.

THE PHILIPPINES LOWLAND POTATO PROJECT

The most advanced and best documented example of the Technology Transfer Project is the Philippine initiative to introduce the potato crop to new lowland areas. (For more detailed information, see Horton, Batugal and Acasio (1987) in Volume 2 of this report). The lowland potato project has been undertaken by SAPPRAD, PCARRD, and the Northern Philippine Root Crop Research and Training Center, in collaboration with a number of other Philippine institutions and lowland farmers. The objectives are to develop and disseminate methods for producing potatoes in the lowlands that are technically feasible, economically viable, socially acceptable, and environmentally safe. The immediate principal beneficiaries are small-scale farmers near big population centers. The ultimate goal is to make the potato an economically valuable crop for small lowland farmers and unaffordable food for poor households. The target is to introduce the potato as one component of diversified farming systems on 6,000 to 10,000 small farms over a six-year period.

Project Resources

SAPPRAD has committed a rather small proportion of its total resources to the project: about ten percent of the coordinator's time, one-half of a consultant's time, local travel expenses, initial loans to farmers for their first crop of potatoes, and secretarial and office support.

Local agencies implement the project in each site. In the first season, 1984/1985, 21 local institutions were involved; in 1985/86, more than 30; in 1986/87, more than 50. Rather than hiring special personnel, local agencies have reassigned existing staff members to work part-time on the Lowland Potato Project. During 1984/85, eight technicians were assigned to the project on roughly a quarter-time basis for 4 months. In 1985/86, 45 technicians were assigned to the project for a similar period of time.

Philosophy and Strategies

Rather than "push" technology from a particular source (like CIP), and depend on a single funding source, or work with a single institution, the project draws on all possible sources of information, technology, funding, and institutional support. For example, the project's technology is an amalgam of research results from CIP, numerous local universities, research institutes, and farmers themselves. Funding comes not only from the SAPPRAD budget, but numerous local sources -- both public and private -- as well as CIP and other international agencies. Project implementation involves a range of public agencies as well as interested private companies.

The project has established a broad participatory network and devolves responsibility to PCCARD-mandated local institutions and farmers as quickly as possible. The institutions and farmers, who participate actively in project planning, execution, and evaluation, take full credit for accomplishments in their localities. In 1984 a single national training course for all technicians and farmer-collaborators was conducted by SAPPRAD at Benguet State University (BSU). In 1985, five regional training courses were conducted. In 1986, local training sessions were conducted at the village level in 12 sites. Local technicians and leading farmers provided training, with technical support and backstopping from regional specialists and SAPPRAD personnel only in three new sites.

The project does not pay honoraria or give free inputs to farmers, but provides professional and economic rewards for outstanding performance. The outstanding farmers of each community have been rewarded with a knapsack sprayer donated by a chemical company and with local training for themselves and their wives in rapid multiplication techniques for potatoes. Technicians and farmers have also participated in "Lowland Potato Field Days" during the growing season. A national "Lowland Potato Conference" is also conducted after the harvest each year. During this conference each technician presents his research results and outstanding farmers report on their experiences. The participants also plan activities for the following year. For the first time, several technicians have had the opportunity to present papers at the "Annual Scientific Meeting of the Crop Science Society of the Philippines."

In sharp contrast to the conventional, top-down model of technology generation and transfer, the project conducts university training, experiment station research, on-farm trials, and extension activities

simultaneously at various sites. In some places, like Jones, Isabela and Sto. Niño, Cayman farmers yields have exceeded yields on the experiment station. The frequent interaction among farmers, extension agents, researchers, and local political leaders facilitates the rapid communication of new results on the experiment station to policy makers, extention agents, and farmers, and the communication of farm-level results to researchers and policy makers.

The Technology

Since virtually none of the farmers and few of the technicians participating in the Lowland Potato Project had ever grown potatoes before --many farmers said they had never even seen a potato plant-- it was necessary to provide them with an initial "recipe" for growing potatoes in the lowlands. Lowland potato research and development work in the Philippines and elsewhere was reviewed (PCARRD, 1985), and based on the current state of knowledge, a preliminary "lowland potato technology package" was designed in 1984. The recent research results of CIP, accumulated in a series of Working Papers (CIP, 1983, 1984), were particularly useful for this phase of the work. Copies of a mimeographed brochure, which included information on how to prepare land, plant, fertilize, control pests and diseases, manage water, harvest, and other relevant aspects of potato production, were distributed to all participating technicians and farmers and served as the basis for practical training.

After the first lowland potato harvest in 1985, leading farmer cooperators, technicians, and researchers met to discuss and revise the initial technology package, based on their own experience with the crop. The result was an upgraded set of recommendations that was issued as a Lowland Potato Technoguide (PCAARD, 1985) in PCAARD's series of semi-technical bulletins for farmers. These technoguides were translated by the local technicians into the four major dialects of the country included in the 1985 training courses.

Results to-Date

In the first season, the project was implemented in five farming communities near market centers in northern and central Luzon. Within each community, three to five farmer cooperators were selected on the basis of a farming systems survey which assessed their interest in growing a new crop, land suitability, availability of labor and access to necessary irrigation water. Local teams conducted on-farm trials with 23 farmers. During the growing season, technicians from SAPPRAD and BSU visited each area periodically to assess problems and cooperators' needs, and an inter-agency monitoring tour was organized. At harvest time local teams conducted field days, and after harvest researchers and outstanding farmers presented results during the first lowland potato workshop.

In the 1984/85 season, three-quarters of the farmer-cooperators succeeded in growing potatoes in the lowlands, obtaining yields ranging up to 25 t/ha. The plot size ranged from 50 m2 to 1000 m2. In the

second year, 1985/86, the project expanded its geographic scope to cover a range of more difficult environments for potato production. Of the 120 farmers participating in 20 provinces, about half were in northern and central Luzon and the other half in southern Luzon and the Visayas. Most of the first group obtained better yields and higher economic returns than the second. This was partly due to cooler and generally more favorable growing conditions for potatoes in northern and central Luzon, and partly due to more careful site selection and supervision on the part of the project team and better farm management practices. For example, farmers in Ilocos and Cagayan are known for the aggresive, entrepreneurial attitude and management abilities, in contrast to those in Negros who have little farming experience aside from sugar cultivation.

Nearly all farmer cooperators in northern and central Luzon succeeded in growing potatoes in 1985/86, achieving yields of up to 35 t/ha, with an average of 18 t/ha. The average harvest was 454 kg on a plot of 252 m2. Participating farmers' return on investment (ROI = (net returns/total cost) x 100) was up to 600%, with an average of 190%. This average ROI is higher than that offered by any other food crop in the Philippines. In contrast to the situation described for northern and central Luzon, about 60% of the farmer cooperators in southern Luzon and the Visayas failed to harvest or had yields of less than 5 t/ha. Only 7 out of the 58 farmers in these areas obtained yields of more than 10t/ha. This was due in part to floods and poor drainage but most of it was due to heavy bacterial wilt damage which, in turn, was due to poor site selection by local technicians.

In 1986/87, project implementation continued in 20 communities and expanded to reach 250 farmers. Greater expansion was limited by the shortage of seed.

Local Response to the Project

The project's initial results have created a kind of "potato fever." Virtually all farmer cooperators in northern and central Luzon plan to grow potatoes next season and many of their neighbors would like to grow them as well. The project has also developed a prototype diversified farming system in cooperation with International Agricultural Research Centers (IRRI, IITA and CIP) and national agencies. In 1986 the outstanding potato farmer of each community was encouraged to plant 4-5 crops which include the potato. This is aimed to spread out the risk, input requirements and income over a safer and longer time frame. The plan is to encourage lowland potato farmers to diversify their crops in order to develop progressive self-sustaining and well-balanced lowland potato farms.

Institutional Benefits

The most obvious institutional impact of the Lowland Potato Project has been to stimulate national policy makers, researchers, educators, extension agents, and farmers to consider the potato as a potentially important crop in the lowlands.

A second institutional impact is the strengthening of applied research and extension capabilities. The project's philosophy, strategies, and incentives are motivating individuals from different disciplines to work together in solving practical problems. The project's integrated, client-oriented approach is seen as a useful model for similar work on other commodities and problems.

A third institutional impact is to improve linkages among the various institutions that carry out research, extension, and training in the Philippines. These include: PCARRD, Ministry of Agriculture and Food, Philippine Institute of Plant Breeding, Bureau of Plant Industry, Northern Philippine Root Crop Research and Training Center, CIP, Republic of the Philippines-German Seed Program, local colleges and universities, municipal and provincial governments, private foundations, and area-based development programs.

A fourth institutional impact is the formation of loosly organized association of potato growers communities near population centers. In coordination with local agencies, these groups plan, execute and regulate informal potato research and development programs.

Finally, the lowland potato project is generating useful information for CIP and national programs of other countries, most directly the members of SAPPRAD.

Production Impact

To date, the production impact of the lowland potato project has been small in aggregate terms but quite significant for many of the individual farmers involved. For example, in the 1985-86 season 55 farmers in Northen and Central Luzon produced an average of 450 kg of potatoes having a market value of P 3,125 (US$160). These were produced on small garden plots averaging only 250 m^2. The net returns per unit area and the return on investment are much higher for lowland potatoes than for competing crops.

If the project expands on schedule to include between 6,000 and 10,000 farmers, each cultivating about 1,000 m^2 of potatoes in 1989/90 and achieving average yields of 15 t/ha -- a bit below the current average yield in the on-farm trials -- total lowland potato production would be between 9,000 and 15,000 tons, or more than 25% of current potato production in highland northern Luzon. Assuming a farm-gate price of P 4/kg, the monetary value of lowland potato production would be between P36 M and P60 M (between US$ 1.8 and US$ 3 M). Total net farm income would be increased by perhaps P15 M (US$ 750,000), giving each participating farmer an additional net income of between P 1,500 and P 2,600 (between US$ 75 and US$ 130).

The Challenge Ahead

The technical feasibility and economic viability of growing potatoes in the Philippine lowlands has been demonstrated at the farm and

village level on a pilot scale. However, for lowland farmers to adopt potato production on a large scale, a combination of technical and institutional innovations are still needed in four key areas: seed production and distribution, finance, varietal improvement, and maintenance research and extension. These are now the focus of attention in the Philippines lowland potato project.

CONCLUSION

SAPPRAD coniders research as a tool for development. In this context, the technology transfer project has provided the impetus to accelerate development of viable new approaches for producing and using potatoes. Since the project began (1984) it has kept watch over the promising results of research and has verified and pilot-tested new production methods in specific country situations. An attempt has been made to systematically institutionalize this R&D approach in each of the SAPPRAD member coutries.

It has been demonstrated that research need not always be a long and costly process. Through collaboration among institutions and farmers in planning and conducting R&D, the process can be shortened and research results can benefit the clientele much earlier than usually occurs.

In three years the technology transfer project has successfully piloted lowland potato in the Philippines and Indonesia. In other countries, there is a need to further refine technologies and prepare the institutional base for this approach. For these reasons, extending the Technology Transfer Project would be highly beneficial.

Annexes

ANNEX 1

SAPPRAD FIVE-YEAR REVIEW QUESTIONNAIRE*

Country : _____ Date: _____
Your Name : _____

A. CONSTRAINTS TO POTATO/SWEET POTATO PRODUCTION AND USE

What are the principal constraints to greater potato/sweet potato production and consumption in your country?

Please use the following scale:

0 = not present
1 = of little practical importance
2 = important
3 = very important

PRE-PLANTING PROBLEMS	Your answer:
A. Inadequate varieties?	_____
B. Inadequate supply of planting material?	_____
FIELD PROBLEMS	
C. Bacterial diseases	_____
D. Fungal diseases	_____
E. Virus diseases	_____
F. Insects/mites	_____
G. Nematodes	_____
H. Poor agronomic management	_____
I. Inputs not available	_____
J. Production cost too high	_____
POST HARVEST PROBLEMS	
K. Seed storage problems	_____
L. Problems storing table potatoes	_____
M. Inadequate marketing facilities	_____
N. Demand limited by high price	_____
O. Demand limited because people don't like potatoes/sweet potatoes	_____

* All country representatives, project leaders and a few other knowledgeable individuals were requested to fill out the questionnaire. PNG's country representative was not available.

B. IMPACT OF SAPPRAD

Please use the following scale:

0 = not present
1 = of little practical importance
2 = important
3 = very important

INSTITUTIONAL IMPACT	Your answer:
Has collaboration with SAPPRAD helped your program:	
a. Increase staff?	_____
b. Expand facilities?	_____
c. Expand budget from domestic sources?	_____
d. Expand budget from foreign sources?	_____
e. Improve planning, coordination and management?	_____
f. Improve links with other programs?	_____
g. Improve links with extension?	_____
h. Expand training?	_____
i. Release new varieties?	_____
j. Expand seed production?	_____
k. Had impact at farm level?	_____

PRODUCTION IMPACT:	
Have farmers benefited from:	
a. Better varieties?	_____
b. Better seed supply?	_____
c. Better seed storage?	_____
d. Use of TPS?	_____
e. Better consumer potato storage?	_____
f. Increased potato processing?	_____
g. Improved agronomic management?	_____
h. Improved control of:	
i. Virus diseases?	_____
ii. Bacteria?	_____
iii. Fungi?	_____
iv. Insects?	_____
v. Nematodes?	_____
i. Improved marketing?	_____
j. Increased yields?	_____
k. Reduced production costs?	_____

HAVE CONSUMERS BENEFITED FROM:	
a. Greater availability of potatoes?	_____
b. More even availability throughout the year?	_____
c. Lower potato prices (relative to other foods)?	_____

C. CHANGE IN STAFFING

In 1980 and 1986, approximately how many man-months of professional time (people with university training) did government agencies and universities dedicate to potato research and seed potato program(s) in your country? Please fill in the following table to the best of your ability:

	1980		1986	
	Man-months dedicated to: Potato research	Seed potato programs	Man-months dedicated Potato research	Seed potato programs
Source of funding:				
Local	_____	_____	_____	_____
Foreign	_____	_____	_____	_____
Total man-months	==========	==========	==========	==========
Percent of total research effort in each area:	%		%	
1. Breeding/selection	_____		_____	
2. Agronomy	_____		_____	
3. Pathology	_____		_____	
4. Pest management	_____		_____	
5. Post-harvest technology	_____		_____	
6. Seed technology	_____		_____	
7. Socioeconomic studies	_____		_____	
8. Others (specify)	_____		_____	
Total	100%		100%	

D. YOUR PERSONAL ASSESSMENT

In your opinion what have been the main benefits of SAPPRAD to your country?

1. _____
_____
_____

2. _____
_____
_____

3. _____
_____
_____

And what have been the weakest areas, or problems of SAPPRAD that need improvement?

1. _____
_____
_____

2. _____
_____
_____

3. _____
_____
_____

What are the major future benefits you expect from SAPPRAD?

1. _____
_____
_____

2. _____
_____
_____

3. _____
_____
_____

ANNEX 2

QUESTIONNAIRE RESULTS

Annex 2A. Constraints to potato production and use (from page 1 of questionnaire)

Annex 2B. Benefits of SAPPRAD (from page 2 of questionnaire)

Annex 2C. Changes in staffing in research in seed programs (from page 3 of questionnaire)

Annex 2D. Personal assessments: main benefits of SAPPRAD (a complete listing of responses to question D.1)

Annex 2E. Personal assessments: weakest areas or problems of SAPPRAD (a complete listing of responses to question D.2)

Annex 2. Personal assessments: major future benefits expected from SAPPRAD (a complete listing of responses to question D.3)

Annex 2A. Constraints to potato production and use

	Indonesia						Sri Lanka			Thailand			Papua New Guinea	Philippines					
	highlands			lowlands						A		B		highlands			lowlands		
	A	B	C	A	B	C	A	B	C	highlands	lowlands			A	B	C	A	B	C
Pre-planting problems																			
Varieties	0	1	2	2	2	2	2	0	1	2	2	1	3	1	2	2	2	3	3
Planting material	2	2	2	2	3	2	3	3	2	3	3	3	3	2	1	2	3	3	3
Field problems																			
Bacterial	1	2	2	3	3	3	3	3	3	3	1	1	2	1	1	1	3	3	2
Fungi	1	3	3	2	2	3	2	3	2	3	2	2	1	2	3	2	0	3	2
Viruses	2	2	3	2	2	3	2	3	2	3	2	3	1	3	3	3	3	3	2
Insects	2	1	2	2	1	2	1	1	2	2	2	1	1	1	2	1	2	3	3
Nematodes	1	1	2	0	1	2	1	2	2	2	0	1	1	2	2	3	0	3	1
Poor agronomy	1	1	2	2	1	2	0	0	1	3	2	3	3	0	1	2	2	3	2
Inputs not available	1	1	2	2	2	2	0	0	1	1	1	3	2	1	2	2	2	3	2
High production cost	3	2	2	2	1	3	1	0	2	2	3	2	0	2	3	3	2	3	3
Post-harvest problems																			
Seed storage	2	1	2	2	0	2	2	3	3	3	3	2	1	2	2	1	3	3	0
Table potato storage	3	1	2	1	0	2	0	2	3	2	2	2	2	1	2	1	3	3	3
Marketing facilities	1	0	3	1	0	3	0	0	3	3	3	2	2	1	2	3	1	3	3
High price	0	0	0	[illegible]	0	0	0	0	3	2	3	1	2	3	3	3	3	3	3
Consumer preferences	0	0	3	0	1	3	0	0	0	3	3	1	1	0	0	1	0	0	1

Source: SAPPRAD Five-Year Review Questionnaire

Note: The letters A, B and C denote different respondents.

Scale: 0 = not present
1 = of little practical importance
2 = important
3 = very important

Annex 2B. Benefits of SAPPRAD

	Indonesia			Sri Lanka			Thailand	Papua New Guinea	Philippines			
	A	B	C	A	B	C			A	B	C	
											highlands	lowlands
Has collaboration with SAPPRAD helped improve:												
Staffing	1	0	1	0	0	2	3	0	1	3	3	3
Facilities	1	1	1	1	1	2	2	2	1	3	2	3
Domestic budget	1	1	1	1	0	1	3	0	1	3	2	3
Foreign budget	2	2	1	0	2	3	3	1	1	2	2	3
Management	2	2	2	2	1	2	3	2	2	2	3	3
Program linkages	2	2	2	0	1	1	2	2	2	2	3	3
Extension	2	2	2	2	2	2	2	2	2	2	2	3
Training	2	2	2	1	0	3	3	2	2	2	3	3
New varieties	0	1	2	1	2	1	2	0	0	3	3	3
Seed production	2	2	1	1	0	1	2	2	2	2	2	2
Farm-level impact	3	2	1	1	1	1	3	1	3	2	2	3
Have farmers benefited from:												
New varieties	1	2	2	0	2	1	2	0	1	3	3	3
Better seed supply	2	2	2	0	2	1	2	2	0	2	2	2
Seed storage	2	3	2	0	0	2	3	2	0	2	1	0
TPS	0	0	0	1	3	1	1	0	0	0	3	3
Table potato storage	2	1	1	0	0	1	2	0	0	2	2	1
Processing	0	1	1	0	0	0	1	0	0	0	2	2
Agronomy	2	2	2	0	1	1	2	1	2	2	3	3
Control of:												
- Viruses	2	1	2	1	0	1	1	0	0	2	3	2
- Bacteria	1	1	2	1	0	1	1	0	2	2	2	2
- Fungi	0	1	2	0	0	1	2	0	0	2	2	2
- Insects	2	1	2	0	0	1	3	0	0	2	2	2
- Nematodes	0	1	2	0	0	1	1	0	0	1	2	2
Marketing	0	1	1	0	0	0	0	0	0	1	2	3
Higher yields	2	1	2	0	1	1	2	1	1	0	3	3
Lower production cost	2	3	1	2	0	1	2	0	0	1	2	2
Have consumers benefitted from:												
Increased supply	0	1	1	0	1	1	1	2	1	3	2	3
More even supply	0	1	1	0	1	1	1	3	0	0	2	1
Lower prices	0	2	1	1	0	1	1	0	0	1	2	2

Source, note and scale. See Annex 2A.

Annex 2C. Changes in staffing in research and seed programs

	Indonesia				Thailand				Papua New Guinea				Philippines			
	1980		1986		1980		1986		1980		1986		1980		1986	
	Potato res	Seed prog	Potato res	Seed prog	Potato res	Seed prog	Potato res	Seed prog	Potato res	Seed prog	Potato res	Seed prog	Potato res	Seed prog	Potato res	Seed prog
Staffing (man-months):																
Locally funded	96	24	120	48	5	2	28	11	12	12	12	40	120	120	360	120
Foreign funded	4	0	0	24	0	0	0	0	0	0	0	0	36	36	60	36
Total	100	24	120	72	5	2	28	11	12	12	12	40	156	156	420	156
Percent of research by area:																
Breeding/selection	20		10		0		18				60		20		40	
Agronomy	20		30		40		29				5		20		30	
Pathology	10		10		40		14				0		5		15	
Pest management	20		5		20		11				0		5		9	
Post-harvest technology	10		10		0		18				5		10		2	
Seed technology	10		30		0		4				30		30		2	
Socioeconomics	10		5		0		0				0		10		2	
Other	0		0		0		7				0		0		0	
Total	100		100		100		100				100		100		100	

Source: SAPPRAD Five-Year Review Questionnaire. Information not available for Sri Lanka.

Annex 2D. Personal assessments: Main benefits of SAPPRAD

Indonesia

"Exchange of research results on production of potato among country members and CIP is much faster."

"Training for the research staff, extension workers and farmers has been stimulated."

"SAPPRAD has introduced DLS and potato production in the low elevation. New potato varieties and TPS will follow soon."

"SAPPRAD has initiated the regional approach in research and development of potato that improved the communication among research workers in Southeast Asian countries."

"The program developed research and research budget on potato as well as transfer of technology."

"A productive network has been established for exchange of materials, information and research results."

"It stimulates motivation for policy makers, researchers, extension staff and potato farmers to increase production."

"A technology has been developed to guarantee relatively high profit margin in producing potato."

Sri Lanka

"Introduction of an important technology [TPS] which could help the marginal farmers to grow potato and reduce cost of production."

"Financial benefit to carry out certain extension programs related to potato production."

"Reorientation of research priorities in developing technologies for small scale farmers."

"Some degree of finacial and material assistance."

"Exposure to TPS and rapid mutliplication. Meeting and discussing problems of mutual interest on potato with foreign scientists is of significant value."

"Training of relevant personnel in advanced technology pertaining to above and other problems with potato diseases, etc."

"Foreign funding, certainly helps to bridge the gap."

Thailand

"More researchers work in potato field in different areas."

"Some technologies have been transferred to the farmers and extension officials."

"SAPPRAD has increased collaboration among the institutions involved in potato production."

Papua New Guinea

"Seed programme integrated."

"Provision of RMT."

"Internal and overseas training."

Philippines

"Assisted in lowland potato production."

"Assisted in seed potato production."

"Additional funds for potato research and development."

"Utilization of research results in farmers' field."

"It has improved R&D in lowland potato."

"It has enhanced transfer of improved lowland potato technology."

"Improved the breeding program and strengthened the national potato network."

Annex 2E. Personal assessments: Weakest areas or problems of SAPPRAD

Indonesia

"Post harvest technology: not only for seed storage but also for consumption tubers. How long can the farmers keep the tuber while waiting for better price?"

"Processing potato research."

"Most activities of potato growing in low elevations are between April to October in Indonesia. The budget transfer allocation should be more in that period."

"Breeding nurseries need to be identified to produce improved potato varieties, which can adapt to local conditions."

"A newsletter needs to be published for exchange of information in the region."

"More stress needs to be given to research on handling and processing to develop the limited market, followed by socioeconomic studies."

Sri Lanka

"SAPPRAD activities are confined to TPS and RMT. It is necessary to extend to other aspect of potato production such as post-harvest technology."

"Field evaluation of SAPPRAD activities especially TPS with trainees needs to be strengthened and monitored."

"Lack of specialized tours for extension officers engaged in TPS and RM activities."

"There was no clear cut fund allocations for technology transfer."

"Projects in Sri Lanka. The proposals on rapid multiplication and tropical agronomy projects were deleted from the project leaders proposals, but still the project leader was asked to present the results on these activities at the external review meeting."

"Funds from TPS Project were spent for technology transfer training courses and projects."

"Planning of meaningful trials relevant to the country's needs and which subsequently can be of use to other SAPPRAD countries."

"Too many research activities, with insufficient competent personnel for their successful execution."

"So called "trained personnel" under SAPPRAD programmes, not contributing fully to future planning and execution of relevant programs."

Thailand

"Seed production scheme, needs to organize better arrangement among institutes to avoid duplication."

"Utilization of potato needs to be transferred to the people especially in village level."

Papua New Guinea

"More equitable sharing of funds between countries."

Philippines

"Avoid subsidizing inputs to farmers in lowland potato production. Farmers have the impression that they should be subsidized continuously."

"Avoid too much interference with politics."

"Provide funding assistance to local research institutions who are committed to potato production."

"Some countries are less prepared to utilize improved technology. Example: improved clones have been sent from Philippines to other countries but there is little evidence that they are able to follow up initial favorable results."

"Utilization."

"Socio-economics/marketing/benefits to farmers."

Annex 2F. Personal assessments: Major future benefits expected from SAPPRAD

Indonesia

"Adequate supply of good quality seed with reasonable price."

"Wide area of rice-field in Java/lowland and highland outside of Java are planted with potatoes."

"Higher income of not only potato farmers but also rice farmers."

"Successful development of potato production in low elevation of Southeast Asian countries."

"Increase production and consumption of potato with price that people can afford to buy."

"Good quality seed of preferred varieties or TPS that induce the development of potato processing industries."

"National seed production will strongly stimulate extensive cultivation of potato."

"Efficient production technology will enhance the prodution increase."

"The improved potato variety for the mid-lowland will provide opportunity for more farmers to increase their income."

Sri Lanka

"Development of TPS and RMT executed to farmers agro-socioeconomic condition."

"Help to develop a sound seed production programme (TPS)."

"Training of extension officers on technical aspects and some aspects of TPS technology transfer "

"Training of extension workers and inservice trainers."

"Facilities for tissue culture, so as to maintain the TPS germplasm in vitro at the Research Station, Sita Eliya."

"Varietal releases : resistance to bacterial wilt, late blight, viruses etc. Also varieties that can give reasonably good yields with low inputs."

"Heat tolerant cultivars, that can be planted not during normal planting seasons, but during the off seasons, to make potato available during most part of the year."

"TPS and rapid multiplication programmes which can completely eliminate the import of seed potato to Sri Lanka in the not too distant future."

Thailand

"Seed programs."

"Increase of production with low cost."

"Adapted varieties in particular highland and lowland areas."

Papua New Guinea

"Provision of more breeding material for selection work."

"Assist in the development of seed production in the private sector."

"Improve postharvest and storage techniques."

Philippines

"Expansion of potato production in the lowlands."

"Continued support for potato R&D."

"Improved varieties."

"Continued technical assistance."

Annex 3. Statistical Data on SAPPRAD Member Countries

Table A3.1 Basic economic and demographic statistics

	Population			GNP	Growth rates (%)		
	actual		projected	per capita			
	1984 (million)	1984 (% rural)	2000 (million)	1985 (US$)	population a/	GNP per capita b/	agricultural production c/
Indonesia	159	75	212	540	2.3	4.9	3.7
P.N.G.	3	86	5	710	2.6	0.6	2.6
Philippines	53	61	76	660	2.7	2.6	4.0
Sri Lanka	16	79	21	360	1.8	2.9	4.1
Thailand	50	82	66	860	2.2	4.2	3.7

Source: World Development Report 1985. IBRD. Washington, D. C., 1986.

a/ Average annual rate 1973-84. b/ Average annual rate 1965-84. c/ Average annual rate 1973-84.

Table A3.2 Selected food statistcs

	Cereal imports 1984		Daily per capita calorie supply 1983		
	total (000 t)	per capita (kg)	total	% of requirement	% from rice
Indonesia	1,926	12	2,380	110	58
P. N. G.	174	58	2,109	79	n.d.
Philippines	964	18	2,357	104	38
Sri Lanka	658	41	2,348	106	42
Thailand	150	3	2,330	105	64

Source: World Development Report 1985. IBRD. Washington, D. C., 1986. Food Balance Sheets. FAO. Rome, 1985.

n.d. = no data.

Table A3.3. Selected agricultural indications

	Arable land (106 ha)	Population per ha arable land total	Population per ha arable land rural	Fertilizer use 1983 (kg/ha)	Index of food production per capita 1982-84 (1974-76 = 100)
Indonesia	15.5	10.2	7.7	74	120
P.N.G. a/	-	130.8	112.5	18	95
Philippines	7.9	6.7	4.1	32	107
Sri Lanka	1.1	14.5	11.5	74	125
Thailand	17.7	2.8	2.3	24	115

Source: World Development Report. IBRD. Washington, D. C., 1986. FAO Production Yearbook 1985. FAO. Rome, 1986.

a/ In addition to an estimate arable land area of only 26,000 ha, P.N.G. has 350,000 ha of permanent crops. Population per ha arable land has been calculated using the population estimate of 3.4 million.

Table A3.4 FAO estimates of potato and sweet potato production 1985

	area (000 ha)	yield (t/ha)	Production total (000 t)	Production per capita (kg)
Potato				
Indonesia	26	7	190	1
P.N.G.	-	9	1	-
Philippines	4	11	48	1
Sri Lanka	6	12	70	4
Thailand	1	11	8	-
Sweet potato				
Indonesia	211	9	1,876	11
P.N.G.	103	5	469	134
Philippines	214	5	1,005	18
Sri Lanka	16	9	140	9
Thailand	40	9	355	7

Source: CIP Root Crop Data Bank (based on unpublished data provided by FAO Basic Data Unit).

Note: National production estimates, where available, generally exceed the FAO estimates. Total production may not equal area times yield because of rounding.

ANNEX 4

FAO TIME SERIES DATA ON POTATOES AND SWEET POTATOES

Table A4.1 Potato production (t)
Table A4.2 Area in potatoes (ha)
Table A4.3 Average potato yield (t/ha)
Table A4.4 Potato production per capita (kg)
Table A4.5 Sweet potato production (000 t)
Table A4.6 Area in sweet potato (000 ha)
Table A4.7 Average sweet potato yield (t/ha)
Table A4.8 Sweet potato production per capita (kg)

These figures are very rough approximations. It is known that in most cases FAO figures underestimate actual root crop production. The tables are presented to indicate the general orders of magnitude and trends in potato and sweet potato production in the SAPPRAD member countries.

Table A4.1 Potato production (t)

	Papua New Guinea	Indonesia	Sri Lanka	Thailand	Philippines
1961	88	55,000	3,928	519	10,530
1962	95	60,000	1,148	2,500	15,100
1963	109	65,000	7,271	2,300	17,665
1964	52	67,000	4,721	2,000	15,892
1965	35	69,000	2,117	7,700	16,586
1966	35	75,000	7,361	7,000	16,956
1967	167	85,000	11,509	8,000	12,254
1968	17	65,000	18,270	8,000	18,377
1969	2	104,000	26,927	8,000	20,104
1970	40	70,000	31,741	8,000	22,261
1971	56	123,000	30,500	8,000	24,618
1972	243	124,000	31,279	8,000	22,918
1973	448	173,000	26,384	7,000	25,409
1974	244	119,700	26,896	6,000	20,424
1975	34	124,000	21,924	5,000	20,400
1976	20	154,000	27,876	2,872	18,800
1977	44	248,230	29,102	5,548	18,802
1978	43	233,000	29,098	6,000	20,046
1979	146	203,657	37,900	6,500	31,839
1980	401	230,377	51,121	6,500	36,893
1981	407	216,713	66,000	7,000	37,125
1982	164	180,000	76,893	7,000	40,677
1983	171	219,000	89,800	7,500	34,005
1984	200	180,000	68,254	8,000	42,412
1985	550	190,000	70,000	8,000	47,600

Source: FAO Basic Data Unit.

Table A4.2 Area in potatoes (ha)

	Papua New Guinea	Indonesia	Sri Lanka	Thailand	Philippines
1961	13	15,000	806	65	2,230
1962	15	15,000	512	300	2,500
1963	21	17,000	791	300	2,570
1964	14	18,000	792	300	2,510
1965	9	19,000	673	1,400	2,520
1966	9	18,500	848	900	2,560
1967	30	21,500	1,474	1,000	2,520
1968	5	16,200	1,869	1,000	3,020
1969	2	23,000	2,968	1,000	2,980
1970	6	13,000	3,306	1,000	2,940
1971	8	18,000	3,067	1,000	3,640
1972	23	17,000	3,539	1,000	3,300
1973	15	22,000	3,352	980	4,050
1974	30	17,600	3,195	830	3,290
1975	27	17,000	3,122	690	3,300
1976	5	20,000	3,113	400	3,100
1977	10	22,000	3,110	500	3,300
1978	10	26,000	2,860	540	3,170
1979	29	21,538	4,100	590	4,000
1980	59	24,450	4,537	590	4,140
1981	51	30,000	5,320	630	3,830
1982	61	23,000	6,169	630	3,910
1983	35	28,000	6,810	680	4,200
1984	40	25,000	5,959	730	3,920
1985	61	25,700	6,000	730	4,300

Source: FAO Basic Data Unit.

Table A4.3 Average potato yield (t/ha)

	Papua New Guinea	Indonesia	Sri Lanka	Thailand	Philippines
1961	6.8	3.7	4.9	8.0	4.7
1962	6.3	4.0	2.2	8.3	6.0
1963	5.2	3.8	9.2	7.7	6.9
1964	3.7	3.7	6.0	6.7	6.3
1965	3.9	3.6	3.1	5.5	6.6
1966	3.9	4.1	8.7	7.8	6.6
1967	5.6	4.0	7.8	8.0	4.9
1968	3.4	4.0	9.8	8.0	6.1
1969	1.0	4.5	9.1	8.0	6.7
1970	6.7	5.4	9.6	8.0	7.6
1971	7.0	6.8	9.9	8.0	6.8
1972	10.6	7.3	8.8	8.0	6.9
1973	29.9	7.9	7.9	7.1	6.3
1974	8.1	6.8	8.4	7.2	6.2
1975	1.3	7.3	7.0	7.2	6.2
1976	4.0	7.7	9.0	7.2	6.1
1977	4.4	11.3	9.4	11.1	5.7
1978	4.3	9.0	10.2	11.1	6.3
1979	5.0	9.5	9.2	11.0	8.0
1980	6.8	9.4	11.3	11.0	8.9
1981	8.0	7.2	12.4	11.1	9.7
1982	2.7	7.8	12.5	11.1	10.4
1983	4.9	7.8	13.2	11.0	8.1
1984	5.0	7.2	11.5	11.0	10.8
1985	9.0	7.4	11.7	11.0	11.1

Source: FAO Basic Data Unit.

Table A4.4 Potato production per capita (kg)

	Papua New Guinea	Indonesia	Sri Lanka	Thailand	Philippines
1961	0.04	0.56	0.39	0.02	0.37
1962	0.05	0.60	0.11	0.09	0.51
1963	0.05	0.63	0.68	0.08	0.58
1964	0.02	0.64	0.43	0.07	0.50
1965	0.02	0.64	0.19	0.25	0.51
1966	0.02	0.68	0.64	0.22	0.51
1967	0.07	0.76	0.98	0.24	0.36
1968	0.01	0.57	1.52	0.23	0.52
1969	0.00	0.89	2.20	0.23	0.55
1970	0.02	0.58	2.54	0.22	0.59
1971	0.02	1.00	2.39	0.21	0.64
1972	0.10	0.98	2.41	0.21	0.58
1973	0.17	1.34	2.00	0.18	0.63
1974	0.09	0.90	2.01	0.15	0.49
1975	0.01	0.91	1.61	0.12	0.48
1976	0.01	1.11	2.02	0.07	0.43
1977	0.02	1.75	2.07	0.13	0.42
1978	0.01	1.61	2.04	0.14	0.44
1979	0.05	1.38	2.61	0.14	0.68
1980	0.13	1.53	3.45	0.14	0.76
1981	0.13	1.41	4.37	0.15	0.75
1982	0.05	1.15	5.01	0.14	0.80
1983	0.05	1.37	5.74	0.15	0.65
1984	0.06	1.10	4.29	0.16	0.80
1985	0.16	1.14	4.32	0.16	0.87

Source: FAO Basic Data Unit.

Table A4.5 Sweet potato production (000 t)

	Papua New Guinea	Indonesia	Sri Lanka	Thailand	Philippines
1961	295	2,464	58	165	696
1962	296	3,680	43	190	749
1963	296	3,070	52	208	784
1964	298	3,958	68	180	725
1965	300	2,651	51	196	701
1966	315	2,476	63	230	687
1967	320	2,144	73	247	672
1968	320	2,364	76	250	706
1969	330	2,260	66	265	731
1970	348	2,175	72	280	657
1971	360	2,211	57	295	651
1972	380	2,066	56	305	648
1973	388	2,387	91	319	748
1974	400	2,470	157	340	916
1975	420	2,433	194	385	986
1976	422	2,381	186	326	829
1977	425	2,460	128	324	888
1978	430	2,083	133	330	1,037
1979	436	2,194	149	335	1,123
1980	440	2,079	127	340	1,048
1981	450	2,094	159	348	1,010
1982	455	1,676	153	355	1,038
1983	460	2,213	118	355	813
1984	464	2,338	147	355	777
1985	469	1,876	140	355	1,005

Source: FAO Basic Data Unit.

Table A4.6 Area in sweet potato (000 ha)

	Papua New Guinea	Indonesia	Sri Lanka	Thailand	Philippines
1961	74	366	11	22	135
1962	74	544	10	26	152
1963	74	484	16	28	158
1964	75	620	14	27	146
1965	75	416	14	27	139
1966	75	402	15	34	132
1967	76	360	19	31	132
1968	78	404	20	32	135
1969	80	369	19	32	135
1970	82	358	16	32	128
1971	83	357	15	33	139
1972	85	339	15	34	144
1973	87	379	27	35	160
1974	90	333	41	38	190
1975	93	311	48	41	196
1976	93	301	46	34	209
1977	94	326	28	36	222
1978	95	301	21	36	228
1979	98	287	16	36	238
1980	98	276	14	38	236
1981	99	275	17	39	221
1982	100	220	16	40	209
1983	101	280	14	40	183
1984	102	283	16	40	164
1985	103	211	16	40	214

Source: FAO Basic Data Unit.

Table A4.7 Average sweet potato yield (t/ha)

	Papua New Guinea	Indonesia	Sri Lanka	Thailand	Philippines
1961	4.0	6.7	5.1	7.4	5.1
1962	4.0	6.8	4.4	7.2	4.9
1963	4.0	6.3	3.2	7.4	5.0
1964	4.0	6.4	4.8	6.7	5.0
1965	4.0	6.4	3.7	7.3	5.0
1966	4.2	6.2	4.3	6.8	5.2
1967	4.2	6.0	3.8	8.0	5.1
1968	4.1	5.9	3.8	7.8	5.2
1969	4.1	6.1	3.5	8.3	5.4
1970	4.2	6.1	4.6	8.8	5.1
1971	4.3	6.2	3.9	8.9	4.7
1972	4.5	6.1	3.9	9.0	4.5
1973	4.5	6.3	3.4	9.1	4.7
1974	4.4	7.4	3.8	8.9	4.8
1975	4.5	7.8	4.0	9.4	5.0
1976	4.5	7.9	4.1	9.7	4.0
1977	4.5	7.5	4.6	9.1	4.0
1978	4.5	6.9	6.4	9.2	4.6
1979	4.4	7.6	9.1	9.3	4.7
1980	4.5	7.5	8.9	9.0	4.4
1981	4.5	7.6	9.5	9.0	4.6
1982	4.6	7.6	9.4	9.0	5.0
1983	4.6	7.9	8.2	9.0	4.4
1984	4.5	8.3	9.0	9.0	4.7
1985	4.6	8.9	9.0	9.0	4.7

Source: FAO Basic Data Unit.

Table A4.8 Sweet potato production per capita (kg)

	Papua New Guinea	Indonesia	Sri Lanka	Thailand	Philippines
1961	150.4	25.1	5.8	6.0	24.2
1962	147.6	36.7	4.1	6.7	25.2
1963	144.2	29.9	4.9	7.1	25.6
1964	142.0	37.8	6.2	5.9	23.0
1965	139.7	24.8	4.6	6.3	21.6
1966	143.2	22.6	5.5	7.1	20.5
1967	142.0	19.1	6.3	7.4	19.5
1968	138.6	20.6	6.3	7.3	19.9
1969	139.5	19.2	5.4	7.5	20.1
1970	143.7	18.1	5.8	7.7	17.5
1971	145.5	17.9	4.5	7.9	16.9
1972	150.3	16.4	4.3	8.0	16.4
1973	150.2	18.5	6.9	8.1	18.5
1974	151.6	18.7	11.7	8.4	22.1
1975	155.8	17.9	14.2	9.3	23.2
1976	152.3	17.2	13.5	7.7	19.0
1977	149.3	17.3	9.1	7.5	19.8
1978	147.1	14.4	9.3	7.4	22.6
1979	145.1	14.8	10.2	7.4	23.8
1980	142.6	13.8	8.6	7.3	21.7
1981	142.1	13.6	10.5	7.3	20.4
1982	140.0	10.7	9.9	7.3	20.5
1983	138.0	13.8	7.5	7.2	15.7
1984	135.6	14.3	9.2	7.0	14.6
1985	133.6	11.3	8.6	6.9	18.4

Source: FAO Basic Data Unit.

ANNEX 5

SAPPRAD PROJECTS, LEADERS, PERSONNEL AND COOPERATORS

A. SAPPRAD Projects and Leaders

Project Title	Date	Project Leader	Country
1. Breeding for lowland potatoes	1982	Dr. Eufemio T. Rasco Jr.	Philippines
2. Tropical agronomy	1982	Ir. Surachmat Kusumo	Indonesia
3. True potato seed	1982 1985	Dr. S.P.R. Weerasinghe Ms. Sita Abeytunge	Sri Lanka
4. Storage and utilization	1982	Mr. Manoch Thongjiem	Thailand
5. Practical seed production	1982 1983 1984 1985	Mr. Muhuju Bubia Mr. Mr. Regan Roy Mr. Emmanuel Titimur Mr. George Gorogo	Papua New Guinea
6. Technology transfer	1984	Dr. P. A. Batugal	Coordinator's Office

B. Major Project Personnel and Country Cooperators

1. Breeding for lowland potatoes (Philippines)

Philippines

1.	Dr. Eufemio T. Rasco Jr.	Breeder, project leader, Institute of Plant Breeding (IPB)
2.	Dr. Rodrigo Valdez	Pathologist (IPB)
3.	Dr. Alfinetta B. Zamora	Physiologist, tissue culture (IPB)
4.	Mr. Efren Altoveros	Breeder (IPB)
5.	Mr. Eduardo Fernandez	Breeder, Entomologist (IPB)
6.	Mr. Wilfredo Sibal	Rapid multiplication specialist (IPB)
7.	Ms. Helen Taja	Agronomist (varietal trials), Cagayan Integrated Agricultural Development Project (CIADP)
8.	Prof. Velma Mangaser	Agronomist (varietal trial), Don Mariano Marcos State Memorial University
9.	Mr. F. Aromin	Agronomist (varietal trial), Mariano Marcos State University

Indonesia

10.	Mr. Sudjoko Sahat	Breeder, Lembang Horticultural Research Institute (LEHRI), Lembang, West Java
11.	Ms. Asih Kartasih	Physiologist, LEHRI

Thailand

12.	Mr. Mannoch Thongjiem	Agronomist, Department of Agriculture, Bangkok
13.	Mr. Wiwat Panouampai	Agronomist, Fang Horticultural Research Station Chiangmai
14.	Mr. Surasak Intrakamhaeng	Agronomist, " " " "
15.	Ms. Siriporn Laotherpong	Physiologist, Maejo Institute of Agriculture and Technology

Sri Lanka

16.	Mr. MLLB Dissanayake	Agronomist, Bandarawela Agric. Research Station

1. Tropical Agronomy (Indonesia)

Indonesia

1.	Ir. Surachmat Kusumo	Agronomist, Agency for Agricultural Research and Development (AARD)
2.	Ir. D. W. Dasi	Agronomist, Malang Hort. Research Garden
3.	Mr. Aliudin	Agronomist, Batu Hort. Research Station
4.	Dr. Toto Sutater	Agronomist, Lembang Hort. Res. Inst. for Food Crops
5.	Dr. Machmud	Pathologist, Bogor
6.	Mr. Supriadi	Agronomist, Lembang Hort. Res. Inst. for Food Crops
7.	Ir. Witono Ms.	Economist, Lembang Hort. Res. Inst. for Food Crops
8.	Dr. Anggoro Hadi	Breeder, " " " " "
9.	Ms. Asih Kartasih	Physiologist, Lembang Hort. Res. Inst. for Food Crops

Philippines

10.	Ms. Jocelyn Eusebio	Sr. Res. Specialist, Philippine Council for Agriculture and Resources Research and Development (PCARRD)
11.	Mr. Faustino Aromin	Agronomist, Mariano Marcos State University
12.	Prof. Velma Mangaser	Agronomist, Don Mariano Marcos Memorial State University
13.	Mr. Jeremias Rodriguez	Agronomist, Tarlac College of Agriculture
14.	Mr. Avelino de la Cruz	Agronomist, SAPPRAD - Philippines
15.	Ms. Rosabelle Belen	Agronomist, Philippine Tobacco Research and Training Center
16.	Mr. Alex Parucha	Agronomist, Nueva Vizcaya Institute of Technology
17.	Ms. Jovita Agrito	Agronomist, Dept. of Agriculture and Fisheries, Camarines Sur
18.	Mr. Eduardo Villanueva	Agronomist, Dept. of Agriculture and Fisheries, Negros Occidental
19.	Mr. Rustico Morales	Agronomist, University of the Philippines La Granja, Negros Occidental

Thailand

20.	Mr. Surasak Intrakamhaeng	Agronomist, Fang Horticultural Expt. Station
21.	Mr. Wiwat Panouampai	Agronomist, " " " "
22.	Mr. Pongsakorn	Agronomist, " " " "

23.	Mr. Samsern	Agronomist, Department of Agriculture, Bangkok
24.	Mr. Dolkich Prationg	Agronomist, Chuchangsao Rubber Research Center

Sri Lanka

25.	Mr. Stanley Kurapuracchi	Agronomist, Kalpitya Research Station

3. True Potato Seed (Sri Lanka)

Sri Lanka

1.	Ms. Sita Abeytunge	Breeder, Sita Eliya Research Station
2.	Mr. K. G. W. Abeytunge	Agronomist," " " "
3.	Mr. L. S. Silva	Agronomist," " " "
4.	Mr. N. Ranatunge	In-service Training Institute, Bindunuwena
5.	Mr. G. N. L. Dayawansa	" " " "
6.	Mr. W. M. A. B. Wijekoon	" " " "
7.	Mr. S. M. Somaratne	Asst. Director, Agric. Extension Division
8.	Mr. M. Boghawatta	Extension Specialist, " "
9.	Mr. Wilbert Perera	Extension Specialist, " "
10.	Mr. Nandasiri	" " " " "

Philippines

11.	Ms. Angelina Khwaja	Breeder, Farmers Community Development Foundation
12.	Ms. Marilou Castaneda	Agronomist, Bureau of Plant Industry, Baguio
13.	Prof. Velma Mangaser	Agronomist, Don Mariano Marcos Memorial State University
14.	Mr. Avelino de la Cruz	Agronomist, SAPPRAD - Philippines

Indonesia

15.	Dr. Angoro	Breeder, Lembang Hort. Res. Institute
16.	Mr. Sjarifudin	Agronomist, " " " "
17.	Dr Azis Azirin Asandhi	Agronomist, " " " "

Thailand

18.	Dr. Bantoon Warrit	Physiologist, Chiangmai University
19.	Mr. Pritana Pradepasen	Agronomist, " "
20.	Mr. Wiwat Panouampai	Agronomist, Fang Hort. Station

4. Storage and Utilization (Thailand)

Thailand

1.	Mr. Manoch Thongjiem	Agronomist, Dept. of Agriculture, Bangkok
2.	Ms. Pissamai Chouvalitwongporn	Entomologist, Dept. of Agriculture, Bangkok
3.	Mr. Chatchai Soontornsawat	Agronomist, Fang Hort. Station
4.	Mr. Pongsakorn Poungsaijai	Agronomist, " " "

5.	Mr. Wiwat Pamouampai	Agronomist, " " "
6.	Ms. Kunyanee Tantidham	Food Technologist, Dept. of Agric., Bangkok
7.	Ms. Poonsri Jirathana	Food Technologist, Dept. of Agric., Bangkok
8.	Ms. Chulaporn Lerthorwornwong	Food Technologist, Dept. of Agric., Bangkok
9.	Ms. Pacharee Boonyodom	" " " " " "
10.	Dr. Tongchai	Director of Extension, Maejo Institute of Agric. Technology

Philippines

11.	Mr. Amado de los Santos	Agronomist, Dept. of Agriculture, Benguet
12.	Ms. Emma Ruth Bayogan	Res. Specialist, Benguet State University
13.	Ms. Victoria Silvestre	Asst. Prof., Don Mariano Marcos Memorial State University (DMMMSU)
14.	Ms. Linda Lucero	Instructor, DMMMSU

Sri Lanka

15.	Mr. W D. Albert	Dept. of Agriculture

Indonesia

16.	Mr. Sihombing	Agronomist, Lembang Hort. Research Institute
17.	Mr. D. W. Dasi	Agronomist, Malang Hort. Research Institute

5. Practical Seed Production (Papua New Guinea)

Papua New Guinea

1.	Mr. George D. Gorogo	Chief Horticulturist, Project Leader Department of Agriculture and Livestock (DAL)
2.	Mr. Tony Pitt	Horticulturist, Kuk Expt. Station
3.	Mr. Michael Hughes	Horticulturist, Tambul Expt. Station
4.	Mr. Faustino Dadpaas	Extension Officer, DAL Hagen, W. H. P.
5.	Mr. Andrew Hayton	Agronomist, Toluma, Enga Province
6.	Mr. Emmanuel Cena	Nutrition Officer, DAL Goroka, E. H. P.
7.	Mr. Steven Preston	Agronomist, DAL, Enga Province

Philippines

7.	Ms. Marilou Castaneda	Agronomist, Bureau of Plant Industry, Baguio
8.	Mr. Amado de los Santos	Agronomist, Dept. of Agriculture, Benguet
9.	Mr. Avelino de la Cruz	Agronomist, SAPPRAD - Philippines

Indonesia

10.	Dr. Azis Azirin Asandhi	Director, Lembang Hort. Res. Institute
11.	Ms. Asih Kartasih	Physiologist, " " " "

Thailand

12.	Mr. Wiwat Panouempai	Agronomist, Fang Hort. Res. Institute
13.	Mr. Chatchai	Agronomist, " " " "
14.	Mr. Pongsakorn	Agronomist, " " " "
15.	Ms. Siriporn Laothertong	Breeder, Maejo Inst. of Agric. and Technology

Sri Lanka

16.	Mr. Dissanayake	Sita Eliya Seed Farm
17.	Mr. Viswanathan	Ceylon Tobacco Company
18.	Dr. Cedric de Vaz	Department of Agriculture

6. Technology Transfer (Coordinating Office)

Philippines

1.	Dr. P. A. Batugal	Project Leader, SAPPRAD
2.	Ms. A. M. Khwaja	President, Farmers Community Development Foundation
3.	Mr. Faustino Aromin	Agronomist, Mariano Marcos State University
4.	Prof. Velma Mangaser	Asst. Prof. Don Mariano Marcos Memorial State University
5.	Mr. Jeremias Rodriguez	Asst. Prof., Tarlac College of Agriculture
6.	Ms. Jean Pinera	Crop Specialist, Dept. of Agriculture, Cagayan
7.	Ms. Rosabelle Belen	Res. Specialist, Philippine Tobacco Research and Training Center
8.	Mr. Alex Parucha	Instructor, Nueva Vizcaya Institute of Science and Technology
9.	Ms. Jocelyn Eusebio	Sr. Research Specialist, PCARRD
10.	Ms. Jovita Agrito	Crops Specialist, Dept. of Agriculture & Fisheries Camarines Sur
11.	Mr. Rustico Morales	Crop Specialist, UP-La Granja, Negros Occidental

Indonesia

12.	Dr. Azis Azirin Asandhi	Director, Lembang Hort. Res. Institute

Thailand

13.	Mr. Manoch Thongjiem	Head, Vegetable Crops Program, Dept. of Agric.
14.	Dr. Tongchai	Director, Maejo Inst. of Agric. & Technology

Sri Lanka

15.	Dr. Cedric de Vaz	Dept. of Agriculture, Peradeniya
16.	Mr. Stanley Karuppuracchi	Kalpitya Research Station

Papua New Guinea

17.	Mr. Tony Pitt	Agronomist, Kuk Experiment Station
18.	Mr. Faustino Dadpaas	Agronomist, DAL Hagen, W. H. P.
19.	Mr. Michael Hughes	Agronomist, Tambul Expt. Station, W. H. P.

ANNEX 6

LIST OF PAPERS PUBLISHED OR PRESENTED IN SEMINARS, WORKSHOPS AND MEETINGS BY SAPPRAD PARTICIPANTS*

Indonesia

1. Kusumo, Surachmat. 1983. New approaches to potato production in Indonesia. Indonesian Agric. Res. & Dev. J. 5(1): 1-7.

2. Kusumo, Surachmat. 1983. Effects of mulch, rows and depth of planting on potatoes. Bul. Penel. Hort. X(1): 16-20.

3. Kusumo, Surachmat. 1983. Varietal testing in potatoes. Bul. Penel. Hort X(2): 1-6.

4. Kusumo, Surachmat. 1983. New approaches to potato production in Indonesia. Jour. AARD 5(1 & 2): 1-7.

5. Kusumo, Surachmat. 1983. Medium elevation potato growing. Warta Litbang 7(2): 1-7.

6. Azis, Azirin Asandhi. 1987. Report on technology transfer of potato production technology. Paper presented at SAPPRAD Research Seminar in Lembang, January 15, 1987.

7. Petunjuk Technis, Bercocok Tanam Kentang Dataran Medium (Potato Technoguide for Farmers in Medium Elevation of Indonesia). 1985.

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9. Kusumo, Surachmat and Dasi, D. W. 1987. Effect of intercropping of potato and shallots on yield at medium elevation. Paper presented at SAPPRAD Seminar in Lembang, January 15, 1987.

10. A. Permadi, Hadi Angoro, W. Adiyoga, S. Sahat, and A. Srie Duriat. 1987. Strengthening potato seed production in Central Java. Paper presented at SAPPRAD Seminar in Lembang, January 15, 1987.

11. Subardi. 1987. Development of mid-elevation potato in Kabupaten Magelang. Paper presented at SAPPRAD Seminar in Lembang, January 15, 1987.

12. A. K. Karjadi and R. Kuswindarti. 1987. Effect of two concentrations of murashige and skoog media in the in-vitro of three potato cultivars. Paper presented at SAPPRAD Seminar in Lembang, January 15, 1987.

* This list does not include presentations for the Five-Year Review.

13. Azis, Azirin Asandhi. 1987. Yield performance of five varieties of potato at different altitude. Paper presented at SAPPRAD Seminar in Lembang, January 15, 1987.

14. Sudjoko Sahat. 1987. Evaluation of several potato clones against late blight and bacterial wilt. Paper presented at SAPPRAD Seminar in Lembang, January 15, 1987.

15. Ati Srie Duriat. 1987. Heat treatment as a means of eliminating potato blight and bacterial wilt. Paper presented at SAPPRAD Seminar in Lembang, January 15, 1987.

16. O. Setiani Gunawan. 1987. Survival of P. solanacearum E. F. Smith in the rhizosphere and non rhizosphere of weeds and economic plant species. Paper presented at SAPPRAD Seminar in Lembang, January 15, 1987.

17. Satjadipura, S. 1987. Potato hybridization for TPS production. Paper presented at SAPPRAD Seminar in Lembang, January 15, 1987.

18. Sihombing, P. 1987. Tuber seed storage in diffuse light on seed quality and potato yield. Paper prpesented at SAPPRAD Seminar in Lembang, January 15, 1987.

19. Sinung Basuki, R. 1987. Potential of lowland potato production in Java: A case study in Desa Merdikorejo - Sleman and Desa Dukun Magelang. Paper presented at SAPPRAD Seminar in Lembang, January 15, 1987.

20. Kusumo, S. and Subijanto. 1987. Multilocation trial of potato varieties for medium elevations. Paper presented at SAPPRAD Seminar in Lembang, January 15, 1987.

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1. Abeytunge, S. 1985. Problems and prospects of TPS technology transfer in Sri Lanka. Paper presented at the Regional Workshop (South Asia) on true potato seed production at Kathmandu, Nepal, Sept. 21-25, 1985.

2. Abeytunge, S. 1985. Research finding on true seed agronomy. Paper presented at the Regional Workshop, Kathmandu, Nepal, Sept. 21-25, 1985.

3. Abeytunge, S. 1985. Scientific and technological problems in the implementation of national seed production programme for potato in Sri Lanka. Paper presented at the Regional Workshop, Kathmandu, Nepal. Sept. 21-25, 1985.

4. Abeytunge, S. 1986. Selection of genotypes for true seed production under Nuwara Eliya conditions. Paper read in Seminar, Inservice Training Institute, Galpalama, May 16, 1986.

5. Abeytunge, S. 1986. Seedling tuber production practices for seed tuber production in potato. Paper read at the Seminar, Inservice Training Institute, Galpalama, May 16, 1986.

6. Abeytunge, S. 1986. Rapid multiplication methods for seed production in potato. Paper read at the Seminar, Inservice Training Institute, Galpalama, May 16, 1986.

7. Abeytunge, S. 1986. Certain observations made in implementing true seed technology. Paper read at the Seminar, Inservice Training Institute, Galpalama, May 16, 1986.

Thailand

1. Thongjiem, M. and P. Chouvalitwongporn. 1985. The quest for improved varieties and seed storage in Thailand. CIP Circular Vol. 13 No. 3, September 1985.

2. Chouvalitwongporn, P. and N. Thongjiem. 1985. Potato Tuber Moth in Thailand. Entomology and Zoology. Jour. Dept. of Agric. (April-June issue).

3. Chouvalitwongporn, P. and M. Thongjiem. 1985. Potato storage and the use of diffused light seed store. Horticulture Journal, Horticulture Research Instiute, Dept. of Agric., Thailand (Sept.issue).

4. Chouvalitwongporn, P. and A. Vattanatangum. 1985. Potato tuber moth control in Thailand. Working Paper #85-14 The Potato in Southeast Asia and the Pacific region.

5. Thongjiem, M., W. Panouampai and P. Puangsaijin. 1986. Potato Research in Thailand. Paper #86-13.

Philippines

1. Fernandez, E C., G. S. Rodulfo, E. C. Altoveros and E. T. Rasco Jr. 1984. Breeding potatoes for lowland tropics: Results of the 1984-1985 trials at UPLB. 1985 Lowland Potato Conference, PCARRD, Los Banos, Laguna, April 21, 1985.

2. Altoveros, E. C. and E. T. Rasco Jr. 1984. UPLB potato breeding program: Highlights of 1984-85 results in highland trials. Lowland Potato Conference, Los Banos, Laguna, April 21, 1984.

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4. Rasco Jr., E. T., R. G. Maghirang, E. C. Fernandez and E. C. Altoveros. 1984. Breeding for pest resistance in highland crops. Lowland Potato Conference. April 21, 1984.

5. Zamora, A. B. and C. N. Paet. 1984. Work on rapid multiplication of white potato at the Institute of Plant Breeding. Lowland potato conference, April 21, 1984.

6. Zamora, A. B., Ma. Inez Gonzales and R. C. Barba. 1984. Tissue culture and multiplication of white potato. Lowland Potato Conference. April 21, 1984.

Technology Transfer

1. Acasio, R. F., A. M. Khwaja, P. A. Batugal, V. Mangaser, J. Eusebio and A. de la Cruz. 1984. Performance of selected processing and table potato cultivars in warm tropical environments of the Philippines.

2. Eusebio, J. E., R. F. Acasio and P. A. Batugal. 1984. The effects of mulching and date of planting on the agronomic performance of potatoes under Canlubang conditions. Lowland Potato Conference, April 21, 1984.

3. Balaki, E. T., A. Basalong and J. Dati. 1984. Tropical agronomy studies on white potato under Tubao, La Union conditions. Lowland Potato Conference, April 21, 1984.

4 Aromin, R. B., H. L. Layaoen and S. R. Obien. 1984. Adaptability test of white potatoes under Ilocos Norte conditions. Lowland Potato Conference, April 21, 1984.

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7. Castaneda, M. 1985. Report on potato seed production using rapid multiplication. Highland Potato Conference, Aug. 14, 1985.

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14. Khwaja, A. M., P. A. Batugal, M. M. Castaneda, J. P. Valdez and A. A. de la Cruz. 1986. Breeding strategies for achieving uniform, hig yielding true potato seed families. Selected as one of the best papers presented at the 17th Annual scientific meeting of the Crop Science Society of the Philippines, BSU, La Trinidad, Benguet, Philippines, April 30 - May 2, 1986.

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19. Belen, R. G., P. A. Batugal, H. L. Layaoen, S. R. Obien. 1986. Verification trial of lowland potato in Jones, Isabela. Paper presented during the 17th annual scientific meeting of the Federation of Crop Science Society of the Philippines, BSU, La Trinidad, Benguet, April 30 - May 2, 1987.

20, Pinera, J. I., A. A. de la Cruz, P. A. Batugal, E. Calano. 1986. Piloting potato production in Sto. Nino, Cagayan on farm trial. Paper presented at the 17th annual meeting of the Federation of Crop Science Society of the Philippines, BSU, La Trinidad, Benguet, April 30 - May 2, 1987.

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23. de la Cruz, A. A., P. A. Batugal, R. F. Acasio, and A. M. Khwaja. 1986. Comparative yield and agronomic performance of highland and lowland seed potatoes kept under cold and cheaper storage systems. Paper presented during the 17th annual meeting of the Federation of the Crop Science Society of the Philippines, BSU, La Trinidad, Benguet, April 30 - May 2, 1986.

24. Aromin, R. B., S. A. Madamba, S. R. Obien, H. L. Layaoen and P. A. Batugal. 1986. Influence of seed source and storage practices on the agronomic characteristics and yield of white potato under Ilocos Norte conditions. Paper presented during the 17th annual scientific meeting of the Federation of Crop Science Society of the Philippines, BSU, La Trinidad, Benguet, April 30 - May 2, 1986.

25. Mangaser, V. T., J. P. Valdez and M. C. Menguita. 1986. Effects of storage practices on the agronomic characteristic and yield of potato (Var. Cosima) under Bacnotan, La Union conditions. Paper presenting during the 17th annual scientific meeting of the Federation of Crop Science Society of the Philippines, BSU, La Trinidad, Benguet, April 30 - May 2, 1986.

Annex 7. Summary of SAPPRAD funding 1982-86 (000US$)

	Approved ADAB 1/	Expenditures ADAB	Member countries	CIP 6/	Total
Breeding for tropical potatoes (Philippines)					
1982	21.2	19.8	34.7	-	54.5
1983	27.0	30.7	34.0	-	64.7
1984	36.0	34.9	27.3	-	62.2
1985	34.0	34.2	33.0	-	67.2
1986	22.0	21.2	33.0	-	54.2
Sub-total	140.2	140.8	162.0	-	302.8
Tropical agronomy (Indonesia)					
1982	20.8	16.8	30.0	-	46.8
1983	26.0	14.8	26.0	-	40.8
1984	36.0	35.9	30.0	-	65.9
1985	36.0	35.7	30.0	-	65.7
1986	30.0	26.6	41.0	-	67.6
Sub-total	148.8	129.8	157.0	-	286.8
True potato seed (Sri Lanka)					
1982	16.7	11.2	14.6	-	25.8
1983	22.0	12.2	19.0	-	31.2
1984	32.0	15.6	25.0	-	40.6
1985	45.9	25.8	35.5	-	61.3
1986	25.0	30.3	38.0	-	68.3
Sub-total	141.6	95.1	132.1	-	227.2
Practical seed production (PNG)					
1982	10.2	5.0	30.0	-	35.0
1983	14.0	6.9	30.0	-	36.9
1984	23.8	15.0	30.0	-	45.0
1985	14.5	12.8	25.0	-	37.8
1986	8.0	3.7	98.5	-	102.2
Sub-total	70.5	43.4	213.5	-	256.9
Storage and utilization (Thailand)					
1982	13.2	2.7	12.0	-	14.7
1983	16.1	19.7	16.0	-	35.7
1984	26.6	23.7	20.0	-	43.7
1985	29.5	21.8	32.0	-	53.8
1986	20.0	24.3	32.5	-	56.8
Sub-total	105.4	92.2	112.5	-	204.7
Technology transfer (Coordinating Office)					
1982	-	-	-	-	-
1983	-	-	-	-	-
1984	20.5	19.1	10.0	-	29.1
1985	110.6	50.7	50.0	-	100.7
1986	70.0	110.4	100.0	-	210.4
Sub-total	201.1	180.2	160.0	-	340.2
Coordination, management/training and overhead					
1982	98.1	65.0	-	33.1 2/	98.1
1983	151.2	131.6	-	12.0 3/	143.6
1984	143.8	136.4	-	-	136.4
1985	150.9	140.3	-	3.0 4/	143.3
1986	135.0	116.1	-	60.0 5/	176.1
Sub-total	679.0	589.4	-	108.1	697.5
Total budget					
1982	180.2	120.5	121.3	33.1	274.9
1983	256.3	215.9	125.0	12.0	352.9
1984	318.7	280.6	142.3	-	422.9
1985	421.4	321.3	205.5	3.0	529.8
1986	310.0	332.6	343.0	60.0	735.6
Grand total	1486.6	1270.9	937.1	108.1	2316.1

1/ Budget approved by SAPPRAD Coordinating Committee.
2/ One-half of Coordinator's salary.
3/ One-half of CIP senior staff travel expenses to CIP-SAPPRAD regional courses: tropical agronomy (Indonesia), TPS (Sri Lanka), germplasm management (Philippines), storage (Thailand).
4/ Ditto for Advanced Germplasm Course (Philippines).
5/ Salary and perquisites of SAPPRAD Coordinator.
6/ Does not include value of germplasm and other contributions in kind.

ANNEX 8

DETAILED SAPPRAD REVIEW ITINERARY

Philippines

March

17	Tuesday	Arrival of Dr. Douglas Horton in Los Banos, Philippines
18	Wednesday	Arrival of Dr. Orville Page in Los Banos, Philippines
19	Thursday	Arrival at Soekarno Hatta Airport PR959 at 1720 Overnight at Sajid Jaya Hotel

Indonesia

20	Friday	
	7:30 a.m.	Fly to Lembang
	9:00 -12:30 a.m.	PROJECT PRESENTATION - Seminar (Program attached)
	1:00 - 3:00 p.m.	Visit of research activities/facilities
	3:00 - 6:00 p.m.	Travel by car to Jakarta Overnight at Sajid Jaya Hotel
21	Saturday	
	8:00 - 9:00 a.m.	Fly to Yogyakarta
	9:30 -10:00 a.m.	Meet with Bank of Indonesia officers
	10:00 -11:30 a.m.	Travel by car to Magelang (Techology transfer project)
	12:00 - 1:00 p.m.	LUNCH BREAK
	1:00 - 3:30 p.m.	Travel by car to Wonosobo (Technology transfer project)
	5:00 - 8:30 p.m.	Drive to Yogyakarta Overnight at Amburukmo Hotel
22	Sunday	
	8:10 a.m.	Fly to Jakarta
	10:00 a.m.	Meeting with Dr. Azis Azirin Azandi (Technology Transfer Coordinator) and Ir. Surachmat Kusumo (Project Leader)
23	Monday	
	9.00 a.m.	Meet with Dr. Subijanto (Country representative) Ir. Surachmat and Dr. Azis Asirin
	5:00 p.m.	Fly to Singapore SQ207
	11:00 p.m.	Fly to Colombo SQ032

Sri Lanka

23	Monday	Arrive Colombo International Airport SQ032 1:00 a.m. March 24 Overnight at Intercontinental Hotel

March

24	Tuesday	
	7:00 - 9:00 a.m.	Travel by car to Peradeniya
	9:00 -10:00 a.m.	Courtesy call to Dr. Eddie Herath (Country Representative)
	10:00 -12:30 p.m.	Travel by car to Nuwara Eliya
	2:00 - 6:00 p.m.	Visit to research projects seed farm and farmers fields at Nuwara Eliya Overnight at Grand Hotel
25	Wednesday	
	6:00 - 9:00 a.m.	Travel by car to Bandarawela
	9:00 - 1:00 p.m.	PROJECT PRESENTATION (Program attached)
	2:00 - 5:00 p.m.	Visit to project activities and farmers fields
	5:00 - 7:00 p.m.	Travel by car to Nuwara Eliya Overnight at Grand Hotel
26	Thursday	
	10:00 - 1:00 p.m.	Travel by car to Peradeniya
	2:00 - 3:00 p.m.	Meeting with Deputy Director of Research (Dept. of Agriculture) and Senior Staff
	4:30 - 7:00 p.m.	Travel by car to Colombo Overnight at Intercontinental Hotel
27	Friday	Fly to Bangkok TG308 at 1325

Thailand

March

27	Friday	Arrive Don Muang International Airport TG308 at 1810 Overnight at Hyatt Central Plaza
28	Saturday	
	8:30 -12:30 p.m.	PROJECT PRESENTATION (Program attached)
	3:00 - 4:00 p.m.	Fly to Chiangmai Overnight in Chiangmai
29	Sunday	
	7:00 -10:00 a.m.	Travel to Fang Horticulture Station
	10:00 -12:00 p.m.	Continuation of research and technology transfer project discussion LUNCH BREAK
	1:00 - 4:00 p.m.	Visit to research projects/facilities Visit to local potato processor

	4:00 - 6:30 p.m.	Travel by car to Chiangmai Overnight in Chiangmai
30	Monday	
	8:00 - 9:00 a.m.	Visit to Chiangmai University (CU) Presentation of TPS project
	9:00 -12:00 p.m.	Visit farmers diffused light stores at Sansei, Chiangmai
	1:00 - 2:00 p.m.	Visit Maejo Institute of Agriculture and Technology (Tissue culture laboratory and rooted cuttings activities)
	3:00 - 4:00 p.m.	Fly to Bangkok Overnight in Bangkok
31	Tuesday	
	9:00 a.m.	Meet with Dr. Ampol Senanarong and Mr. Manoch Thongjiem
	3:00 p.m.	Fly to Manila LH748 at 1425

Philippines

March		
31	Tuesday	Arrive Manila LH748 at 1830 Overnight in Manila Hotel
April		
1		Courtesy call on Dr. Ramon Valmayor, PCARRD Executive Director; write draft report
1-3		Write draft report for Indonesia, Sri Lanka and Thailand
4	Saturday	Fly to Port Moresby PX011 at 0700
4-8		(Team visit to Papua New Guinea)
9	Thursday	Arrival in Manila SQ082 at 1415 Overnight in Manila
10	Friday	Write draft report for Papua New Guinea
11	Saturday	
	9:00 - 3:00 p.m.	PROJECT PRESENTATION (Program attached)
12	Sunday	Rest Day
13	Monday	Lowland Potato Conference (Technology Transfer Project)
14	Tuesday	Lowland Potato Conference (Technology Transfer Project)
15	Wednesday	Draft report preparation
16	Thursday	Draft report preparation
17	Friday	Depart

Papua New Guinea

April

4	Saturday	Arrive Port Moresby PX011 at 1400 Overnight at Travelodge
5	Sunday	Fly to Mt. Hagen
	10:00 -12:00 p.m.	Travel by car to Tambul Research Station
	1:00 - 2:00 p.m.	Visit research projects
	2:00 - 3:30 p.m.	Visit farmers fields
	3:30 - 5:30 p.m.	Return to Hagen by car Overnight at Plumes & Arrows Hotel
6	Monday (continued)	
	9:00 -12:00 P.M.	PROJECT PRESENTATION (Program attached)
	1:00 - 3:00 p.m.	Visit to DPI rapid multiplication projects and seed farms in Hagen
	3:00 - 5:00 p.m.	Discussion session with potato processors and traders Overnight at Highlander Hotel
7	Tuesday	
	8:00 - 9:00 a.m.	Visit varietal trial experiment
	9:00 -10:00	Meeting with sweet potato researchers at Kuk station
	11:00 a.m.	Fly to Port Moresby
	2:00 p.m.	Visit to Pacific Products (Potato Processing)
8	Wednesday	
	11:00 p.m.	Meeting with G. Gorogo (Project Leader)
	3:00 p.m.	Fly to Singapore PX052 at 1530 Overnight in Singapore Holiday Inn
9	Thursday	
	11:00 a.m.	Fly to Manila SQ082 at 1100

ANNEX 9

PROGRAM PRESENTATION AND FIELD VISITS

INDONESIA

Project Presentations

Lembang Horticulture Research Institute

9:00 - 9:15	Welcome remarks - Dr. Azis Azirin Azandhi
9:15 - 9:30	Remarks - Dr. P.A. Batugal, SAPPRAD Coordinator
9:30 -10:00	Five years of SAPPRAD in Indonesia - Ir. Surachmat Kusumo (Project Leader)
10:00 -10:20	Potato breeding research for bacterial wilt resistance. Ir. Sudjoko Sahat
10:20 -10:40	Rapid multiplication techniques for tuberlet production Asih K. Karjadi
10:40 -11:00	Potato production from true potato seed Sjarifudin Satjadipura
11:00 -11:20	Seed production storage in diffused light and dark storage P. Sihombing
11:20 -11:40	Technology transfer in Indonesia Dr. Azis Azirin Azandhi
11:40 -12:30	Discussion
12:30 -12:40	Closing remarks - Dr. Azis Azandhi

Field Visits

- Tissue culture laboratory, Lembang
- TPS trials, Lembang
- SAPPRAD clonal trials, Lembang
- Magelang Extension Service, Central Java
- Farmers' seed farm, Wonsosobo, Central Java

SRI LANKA

Project Presentation

Bindunuwewa In-service Training Institute

9:00 - 9:10	Welcome remarks - Dr. Sarath Amarasiri
9:10 - 9:20	Remarks - Dr. P.A. Batugal
9:20 - 9:50	Overview of the TPS project in the last 5 years Mrs. Sita Abeytunge
9:50 -10:10	Breeding studies on TPS Mrs. Sita Abaytunge
10:10 -10:30	Agronomic studies on TPS Mr. M.L.B.B. Dissanayake
10:30 -11:00	Tea Break
11:00 -11:15	Training of extension officers and farmers on TPS technology Mr. N. Ranatunga (ADA Training)
11:15 -11:30	Extension work in Badulla District Mr. D.M.W. Dasanayake (ADA Extension)
11:30 -11:45	Extension work in Nwara Eliya District Mr. S.M. Somaratne
11:45 -12:00	Pilot TPS seed production scheme in government farms (Nwara Eliya) Agricultural Officer for Seeds (Nwara Eliya)
12:00 -12:15	SAPPRAD Clonal trials in Sri Lanka Mr. M.L.B.B. Dissanayake
12:15 -12:30	Rooted cuttings studies at RARS Bandarawela
12:30 -12:45	Rooted cuttings studies in government farms
12:45 - 1:00	Closing remarks - Dr. Amarisiri

Field Visits

- In-service Training Institute Demonstration plots
- Farmers fields in Diyatalawa and Kahagolla
- Bandarawela Agric. Res. Station

THAILAND

Project Presentation

Horticulture Research Institute

9:30 - 9:45	Welcome remarks - Mr. Banchong Sikkamondhol
9:45 -10:00	Remarks - P.A. Batugal
10:00 -10:30	Storage and utilization project: 5-year summary Mr. Manoch Thongjiem (Project Leader)
10:30 -11:00	Studies on potato tuber moth in Thailand Ms. Pisamai Chouvalitwongporn
11:00 -11:30	Potato processing at village and households levels Ms. Poonsri Jirathana
11:30 -11:45	Closing remarks - Mr. Banchong Sikkamandol

Field Visits

- Fang horticulture station
- Chiangmai Univerasity
  - Tissue culture laboratory
  - TPS field trials
- Maejo Institute of Agricultural Technology
  - Tissue culture laboratory
  - Rooted cuttings project
- Sansei village farmers' diffused light stores

PAPUA NEW GUINEA

Project Presentation

Hagen Agricultural College

9:00 - 9:10	Welcome remarks - Mr. George Gorogo
9:10 - 9:20	Remarks - Dr. P.A. Batugal
9:20 -10:00	Overview of The Seed Potato program Mr. George Gorogo (Project Leader)
10:30 -10:50	Seed production in Western Highlands Province Mr. Faustino Dadpaas
10:50 -11:10	Seed production in Eastern Highlands Province Mr. Emmanuel Cena
11:10 -11:30	Seed production in Enga Province Mr. Andrew Hayton
11:30 -11:50	Research and Seed Production in Tambul Station Mr. Michael Hughes
11:50 -12:10	Varietal multi-location trials Mr. Tony Pitt
3:00 - 5:30	Project Direction - Commercial seed potato scheme Mr. M. Hugles - Potato industry trends Mr. T. Pitt - Constraints to the potato industry Invited industry personnel - Direction of SAPPRAD involvement
5:30	Closing remarks - Mr. Michael Hugles

Field Visits

- Tambul Research station
- Hagen rapid multiplication and rooted cutting trials
- Variety trial harvest at Kuk Res. Station

PHILIPPINES

Project Presentation

PCARRD Headquarters, Los Baños

9:00 - 9:10	Welcome remarks - Dr. D.P. Gapasin (Country representative)
9:10 - 9:20	Remarks - Dr. P.A. Batugal
9:20 - 9:40	Overview of the lowland potato breeding project Dr. E.T. Rasco, Jr. (Project leader)
9:40 -10:10	Germplasm evaluation; highland and regional trials Mr. Efren Altoveros
10:10 -10:25	Heat tolerance test and low elevation trials Mr. Eduardo Fernandez
10:25 -10:40	Rapid multiplication, virus evaluation and In-vitro maintenance Mr. Altinetta Zamora
10:40 -11:00	Testing/screening for disease resistance Dr. Rodrigo Valdez
11:00 -11:15	Testing/screening for insect resistance Mr. Eduardo Fernandez
11:15 -11:30	Postharvest evaluation and utilization
1:00 - 3:00	Discussion
3:00 - 3:15	Closing remarks - Dr. D.P. Gapasin

TECHNOLOGY TRANSFER

Project Presentation

- Dr. P.A. Batugal (Project Leader) submitted a written report on the technology transfer project (1984-1986)

- Project leader briefed the team on technology transfer project activities in the various countries

- The team attended the two-day Philippine National Lowland Potato Conference-Workshop held at PCARRD Headquarters, Los Baños, Philippines

Field Visits

- Lowland Potato after-rice trial
- Incorporation of potatoes into the farming systems trials

Annex 10. Comments of CIP Regional Scientists on SAPPRAD

1. What have been the main benefits of SAPPRAD to countries in your region?

"Not only national scientists but also many extensionists and farmers have been trained. This has been very cost effective with CIP primarily providing the regional training and national scientists training extensionists and farmers."

"Although the quality of research may not be excellent, the quantity of research on potatoes has increased at a geometric rate over the past 5 years. Many factors enhanced this but the additional flow of money and training through SAPPRAD has been a big factor."

"Through SAPPRAD's support and by having senior management people on the Executive Committee, potato programs have improved, and received more government support and visibility nationally. Thailand is the most outstanding case of this, but also it is true in the Philippines and Indonesia."

"Career improvement through training courses and seminar/symposium participation, facility building and technology transfer."

2. What have been the main weakness or problems of SAPPRAD

"The flow of technology from the project leaders (i.e., in TPS) to other countries has not been very effective. In some cases the technology developed in the lead country is not appropriate or it is behind the other countries."

"Planning and analysis of research are in most cases not very scientific. However this is improving as more qualified people are handling the work. Thailand and the Technology Transfer Project (Philippines) have made the most dramatic improvements in research quality."

"Project leaders are often too busy to do justice to the potato research activity. This has no solution, but is something we have to live with and involve as many people as possible working with them."

3. What are the principal aspects of SAPPRAD that you think should be improved?

"I feel there should be a shift of emphasis away from research projects toward development and technology transfer to farmers. Research should be reduced with the exception of breeding, although that also has little chance of short run payoff. CIP can provide most of the technology needed to prepare technology for farm use."

"Need more effective communication and exchange of information between SAPPRAD and CIP regional efforts."

4. What are principal areas for meaningful collaboration between CIP Regional Office and SAPPRAD and the responsibilities of each?

"CIP and SAPPRAD are really one although CIP has focused on research and regional training while SAPPRAD has focused on development and in-country training. We have developed a harmonious working relation by dividing the responsibilities in this way. I feel that as time goes on, it will become more difficult to distinguish CIP from SAPPRAD and it should be that way, since meaningful collaboration means working as a team for a common goal."

"Research, technology development and backup should be CIP'S regional effort; technological testing and transfer at the farmer level should be SAPPRAD's main responsibility."