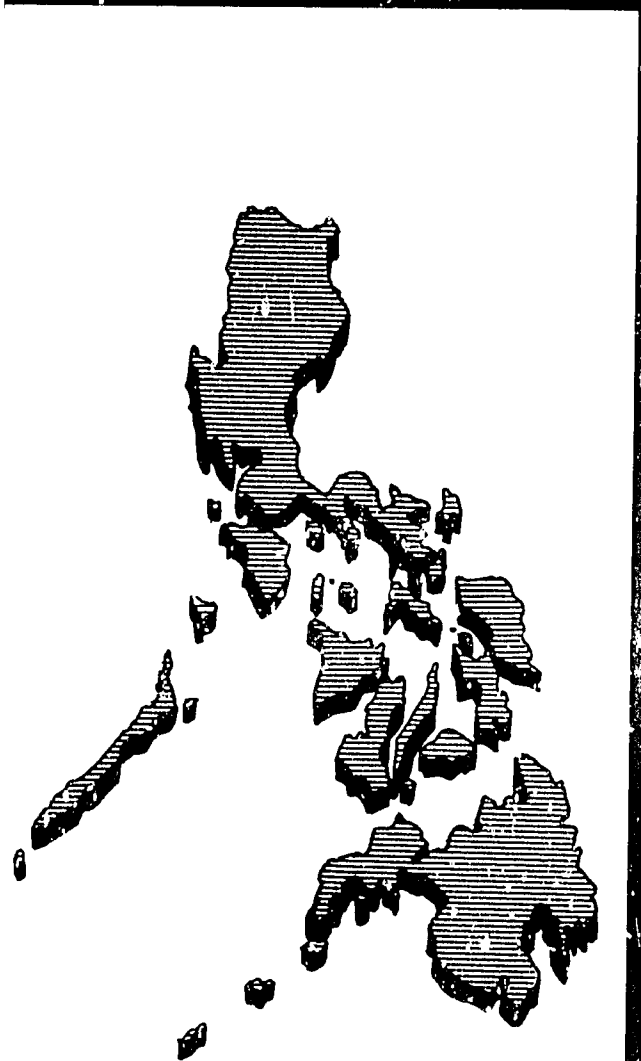

Seed Potato Systems in The Philippines: A Case Study

by

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Los Baños, Philippines

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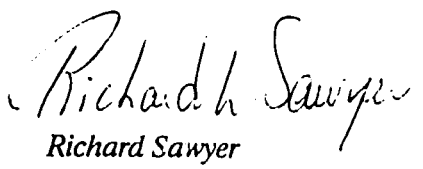
Foreword

Agencies supporting potato improvement in developing countries generally place high priority on potato seed programs. The results of these efforts have been mixed due to the differing philosophies guiding the technologies being introduced and the many physical and socio-economic variables which may affect the performance and achievements of a seed program.

Few comprehensive studies are available which document the structure and functions of seed potato programs. Given the complexity and the key role seed programs play in any country's potato improvement, CIP has initiated a series of case studies of seed programs. In addition to the present study, others will examine the seed potato systems of Ecuador, Canada, The Netherlands, Great Britain, and Kenya. These case studies offer a comprehensive look at the important informal seed sector, the official seed programs, and the interaction among the various elements of the informal system, the official program and farmers.

We expect the conclusions from these studies will help guide CIP activities and that they will also be useful to national institutions concerned with the successful functioning of this vital component of the potato system.



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Numerous individuals both in the Philippines and Lima have read and provided valuable comments and corrections on earlier drafts of the report. Many of these contributions have been incorporated. However, omissions or errors and the views expressed here are the responsibility of the author.

Special thanks go to Lilia Salinas and Mariella Altet who, via their desktop computers, typed, designed and produced this report.

Acronyms

BAEcon	Bureau of Agricultural Economics
BIBAK	Benguet-Ifugao-Bontoc-Apayo-Kalinga Farmer Association
BPI	Bureau of Plant Industry
BSU	Benguet State University, formerly Mountain State Agricultural College
CIADP	Cagayan Integrated Agricultural Development Project
CIP	International Potato Center
DA	Department of Agriculture, formerly Ministry of Agriculture and Food
FCDF	Farmers Community Development Foundation
GTZ	German Technical Assistance Agency
HADP	Highland Agriculture Development Program
IPB	Institute of Plant Breeding
NCT	National Cooperative Testing Program
NPRCRTC	Northern Philippine Root Crops Research and Training Center
PCARRD	Philippine Council for Agriculture, Forestry and Natural Resources Research and Development
PPP	Philippine Potato Program
RMT	Rapid Multiplication Technique
SAPPRAD	Southeast Asian Program for Potato Research and Development
SGA	Seed Grower Association
TPS	True potato seed
UPLB	University of the Philippines at Los Baños

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Abstract

Seeds and seed systems provide a vital link between cropping seasons. While systems of botanical seed reproduction have been extensively studied, the seed systems of vegetatively reproduced crops are relatively undocumented although vegetatively reproduced crops are a major food source in many countries.

This research report, one of a series of case studies of seed potato programs, examines the seed potato system in the Philippines. This system is dominated by the farmer-based informal seed system. There are seven organized seed production programs, three of which are in the public sector. The informal seed system is hampered by insufficient supplies of low quality seed. The cash flow constraints and low capital accumulation of potato farmers are leading causes for the failure of the informal system to link the temporally mismatched seasons of seed potato supply and demand. The activities of the government via the Philippine Potato Program are presented, with special attention to the efforts of the German Agency for Technical Assistance and the Bureau of Plant Industry project to develop a complete system of certified seed potato production. In this and other organized programs there is extensive activity in developing both program and farmer-based rapid multiplication schemes.

The relationships among the public sector institutions are examined. Because it does not account for cash flow constraints and low capital accumulation among potato farmers, the European-style system of utilizing seed grower associations to handle multiplication and distribution of certified seed developed by the government appears unworkable. In the government seed program, problems associated with management and coordination have been more constraining than technical factors in limiting progress toward planned objectives.

Summary

In the Philippines, several seed potato production programs in both the public and private sectors are the focus of numerous research and production activities. The most important public sector program was designed to create a complete system of certified seed production. The project established a variety screening program, a laboratory-supported, in vitro, rapid multiplication scheme, a virus testing laboratory, a series of diffused light potato stores, and a farmer network of certified seed producers. The project operated in a flexible manner and eventually modified its original plans in several ways.

The strongest aspects of the project were those that dealt with training of scientific and technical personnel, crop research and establishing the technical aspects of the seed program. The weakest aspects of the program were monitoring research, establishing the seed farm, management of the seed farmer network, and utilizing marketing or other social science-based studies.

The private sector seed schemes also have established networks of farmer seed producers. These differ from the government sector programs in their studies, use of more closely managed contracts and strict enforcement of contract terms.

Managing and administering the resources for a network of certified seed producers in Philippine conditions will continue to be a problem for any government agency. The problem is based in the cash flow and credit constraints which limit the farmers' crop disposal decisions. Changing these constraints is a costly, slow process beyond the capability or responsibility of the Philippine Potato Program (PPP).

There is extensive activity in developing farm-based rapid multiplication schemes. While still in a learning and therefore experimental stage, these schemes appear to be an appropriate method of improving the quality of planting material reaching farmers.

The screening program has introduced several varieties that have become widely disseminated. The breeding programs have progressed slowly but have varieties that have been or soon will be released. One variety recently released by the screening program has spread rapidly, indicating that for introducing new varieties the informal seed system functions well. The breeding programs view the procedures for release and for volume seed bulking of new varieties as a constraint on the introduction of new varieties.

The viability of selected components of the PPP appears to be positive. The seed program has served as a catalyst for many diverse activities and by the exercise of coordinating these efforts a greater institutional strength has been achieved. The emphasis on training has resulted in improved workers who will continue to contribute so long as they remain employed in potato work.

There have been several technical changes that will have a lasting effect. The promotion of improved storage and improved seed management appear to have resulted in widespread changes in farmer practices.

Finally now that the seed program has started and struggled through difficult learning phases, it now may have the maturity to arrange its technical and managerial affairs. The multi-institutional interdisciplinary concept of the PPP is a significant stabilizing factor, as this forces institutional interaction, removing any sense of "do it alone" isolation. Seeing each element as essential to the whole puts pressure on the individual institution to perform. This network should be able to protect the interests of the Bureau of Plant Industry (BPI) seed program, as it adjusts to the double changes of loss of special project status and change of funding flow as part of the reorganization of the Department of Agriculture.

Specific Conclusions

1. Potato production in the Philippines requires a large volume, rapid-turnover cash flow. Lack of capital accumulation and cash flow constraints prevent most farmers from buying or holding seed and becoming seed grower specialists.
2. The major weakness in the informal seed system is the lack of a market institution to bridge the temporally mismatched periods of seed potato supply and demand.
3. Despite these weakness the informal farmer seed system provides more than 90% of the seed used in the Philippines Lack of supplies limits seed from organized seed programs to approximately 10% of the market.
4. The BPI seed program appears to have solved most technical problems but still faces infrastructure and managerial problems. Based on current PPP objectives the principal infrastructure problem is to obtain a fully functioning seed farm. The principal managerial problem is certified seed production with the Seed Grower Associations (SGA's).
5. Lack of established management policies and a managerial accounting system contributed to the large decline in seed stocks in the RP-German seed project.
6. The European-style system of using SGA's to handle the multiplication and distribution of certified seed appears unworkable due to the cash-flow and market-failure constraints mentioned in points one and two above.
7. It is estimated that the volume of certified seed reaching farmers is very low (32-68 t/year) but use of second and third generation seed multiplied by farmers from the official seed appear to be somewhat more widespread.
8. Lack of capital to construct stores limits the diffusion of improved storage technology among farmers, but in organized seed programs, seed storage does not appear to be a problem.
9. Regionalized seed schemes based on rapid multiplication techniques or use of true potato seed are a more practical defense than quarantine laws against spread of diseases.
10. Imports of seed potatoes have been limited by price not by legislation. High prices remain a restriction for all but a few growers. Domestically produced seed can easily compete in price against imported seed of similar quality. Also there is always a risk of importing disease along with the seed. However BPI quarantine facilities are nearing full operation.
11. The SAPPRAD lowland seed program and private sector seed schemes have benefited both directly and indirectly from BPI technology development and organization of seed potato growers. These programs are competing with BPI for seed growers in northern Luzon. The winners in this competition are the farmers. The competition should have a long run benefit by demonstrating to farmers that specialization in seed production is viable.
12. Market assistance and provision of credit have perhaps been the weakest elements of the PPP. As noted in point one, seed market constraints are probably the single most limiting factor in expanding the potato cultivation area.
13. The institutional structure of the PPP by allocating responsibility and forcing inter-agency contacts is one of the strengths of the BPI seed program helping to ensure its viability and enhancing its perceived value among its users.

1. Introduction

Background

For over ten years now the potato has been designated as a high priority crop by the Philippine government. By allocating both human and financial resources, and by cooperating with foreign technical assistance agencies, the government has embarked on a production expansion program that centers on the development or introduction of better adapted varieties and the provision of healthy seed material. During the period of over ten years numerous agricultural researchers have been trained, the research program has been expanded, its findings extended to farmers and a seed program has been established.

This report examines the system of seed potato production and use. Both the efforts of the government and of the private sector will be discussed. The government efforts have centered on a cooperative project with the German government to establish a seed production scheme in the highlands of northern Luzon. Beginning in 1977, the German Technical Assistance Agency (GTZ) collaborated with the Bureau of Plant Industry (BPI) in a research and seed production program headquartered at the BPI station in Baguio, and they established a seed farm at Buguias, north of Baguio on the Baguio-Bontoc road. This cooperative seed production project terminated in June 30, 1987, but GTZ and BPI continued to cooperate on the introduction and development of fruit trees as an additional source of income for highland farmers.

During the past ten years there have been significant changes in the production and utilization of potato in the Philippines. The continued high prices received for potatoes in the retail market have made potato production profitable and have encouraged increased planting. Highland farmers are almost always commercial vegetable producers, on small farms whose areas it is almost impossible to increase. Therefore they have strong incentives to increase their yields on the limited areas they have available for planting. The farmers correctly recognize the value of seed tubers and aggressively seek out good material. The government is currently supporting a drive to increase potato production in lowland areas (Horton et al., 1987). The growth of demand for potato chips and french fries[1] has been a significant factor in influencing activity in the sector. Major private sector firms are Halsema Incorporated, a potato supplier and seed farm operator contracted by McDonalds; F. Silayan Incorporated, a food machinery manufacturer with a frozen french fry plant and a potato production scheme; and Universal Robina Corporation, a potato chip manufacturer who has also established a potato production plan.

The increased public sector activity in potatoes together with the increased private sector involvement has created an atmosphere of progress and change with rising expectations for all parties involved. Crucial to sustaining this activity and meeting the expectations it has aroused is the development of the seed sector as a means of increasing yields and supplying appropriate varieties. The government is interested in developing a domestic seed industry in order to reduce imports. The interest of the private sector is to have available low cost, reliable quality planting material.

Methodology and Objectives

This report is one of a series of case studies on seed potato systems in selected countries. The main objective of the individual case studies is to identify strengths and weaknesses in organized seed potato programs. To do this effectively, the organized potato program must be examined in the context of its environment. Thus a systems approach is adopted in these studies to categorize and evaluate the role of an organized program within the larger seed system.

1. These terms refer to the American usage and are equivalent to the British terms crisps and chips respectively.

It is widely recognized that poor quality seed, the high cost of good quality seed and physiological age are major limiting factors in potato production. Many seed projects have been conducted in developing countries with the aim of relieving the constraints of poor quality seed to production. The results of these projects have been highly variable. CIP and other organizations have been involved in seed systems work in numerous countries. Foreign assistance to developing countries has taken many forms, including the direct placement of scientists in seed programs, technical backstopping, short-term assignments, financial support, training and provision of supplies, equipment and genetic material. However, records and results of these activities are dispersed throughout the developing world and their current status is largely unknown.

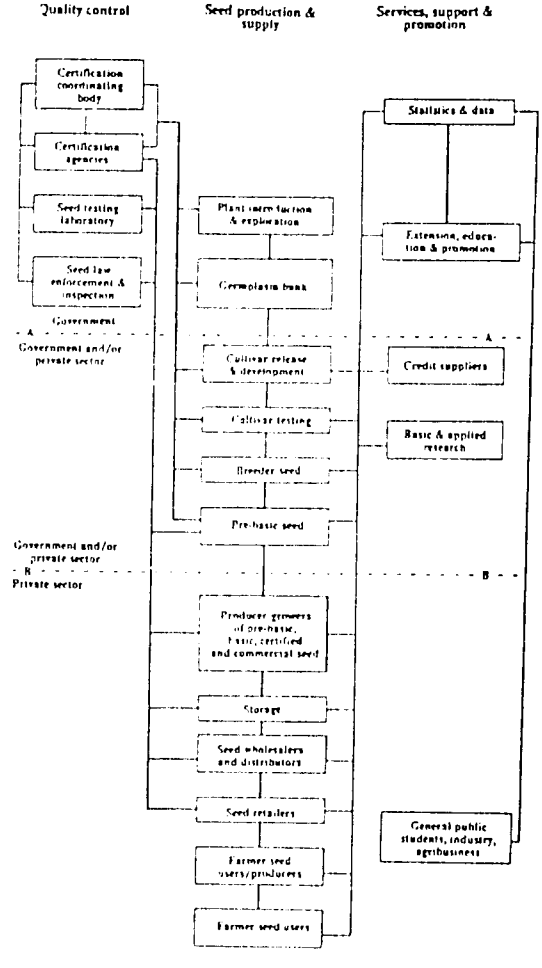
This case study series is designed to record the diversity of formal and informal seed systems and to determine how seed projects can be integrated into those systems. The intent is also to analyze the performance of different technical and institutional schemes in seed potato projects. A final objective is to document the importance of improved formal seed systems, as compared with informal systems, to increased production.

This case study uses a systems framework to assist in identifying the elements of the seed system and their relation to the environment. Analysis of individual elements is based on available information, interviews, publications and direct observation. The field work for this study covered two months in various locations in the Philippines during the first half of 1987. More than 60 interviews were conducted with informants in Manila, Los Baños, Baguio, Buguias and Malaybalay and other locales. Where possible the descriptive analysis is supplemented by quantitative documentation, but this is not often possible. The paucity of documentation and time constraints on field work eliminate the possibility of formal efficiency or impact analysis.

The concept of system used in this study stresses function rather than structure as the basic device by which to classify the system parts. Special attention is paid to linkages between the different agencies which have roles in the organized seed programs and the linkages between these agencies and the informal farmer-based seed system.

A diagram depicting the essential elements of a seed system is presented in Figure 1. This diagram identifies three major categories of seed systems and groups individual elements, defined by functions, within these categories. Linkages among the elements are indicated by the connecting lines. Examination of the figure quickly reveals the complexity of the system and the multitude of institutions and agencies that are part of it.

Figure 1. Essential elements of a potato seed system



Source: modified from Gregg, Delouche and Bunch, 1980.

By not including in the figure other factors such as physical and cultural environment or macro-economic policies such as trade restrictions or pesticide price subsidies, the issue of defining the boundary of a system is raised. The elements included in the figure are directly related to the production and distribution of quality seed or are aspects that can be influenced or managed by participants in the system. These elements are the primary focus of this case study. Other selected factors are described as they relate to this system. The dotted horizontal lines demarcate areas where the government and the private sector may have a comparative advantage in managing the activities found there.

Format

The format of the report will proceed from the general to the specific. First there is a brief discussion of trends in the potato sector and the potato in the Philippine food system in terms of production, consumption and marketing. Next is a presentation of the larger elements which influence the seed system, the physical and socio-economic environment and the government. An overview of the RP German seed potato project is presented in the discussion of government activities.

After this overview the discussion roughly follows the chain of activities found in the Philippine seed system, a sequence of events described for successful seed programs by Douglas (1980). Those steps are: (1) provision of adequate varieties (here is included a discussion of breeding programs), (2) the initial creation of seed supplies, a step crucial for overcoming the slow rate of reproduction while moving from foundation material to sufficient quantities of basic seed, and (3) the building of seed supplies, which includes the organization of farmer cooperators for bulk multiplication but also for quality control. Next is discussed the work of the private sector, the components of crop protection and storage are introduced, and an overview and discussion of results are presented.

A Note on Potato Physiology and Pathology

The functions of a seed potato system are in part governed by certain aspects of potato physiology and pathology. This section, relying on Horton (1987), introduces some of these aspects and how they can be managed.

Physiology

The potato is a member of the plant family *Solanaceae* which also includes tobacco, tomato, eggplant and pepper. The potato tuber is an enlarged portion of an underground stem containing about 80% water. The plant can reproduce sexually through seed from its tomato-like fruits, but the vast majority of the world's potato farmers select tubers to use as "seed." Tuber-based multiplication is slow, averaging 1:10. Thus numerous generations are needed to produce large quantities of seed, an important consideration for seed programs as each generation of this perishable tuber must be properly stored and protected from diseases.

The tuber has dormant buds called "eyes" and passes through several physiological stages that affect the number of eyes that will sprout. Dormant tubers do not sprout; physiologically young tubers sprout only from the apical buds, mature tubers show evenly distributed sprouting and old tubers produce few thin sprouts. Sprouting is important since yield is related to the number of stems produced by sprouts. The rate of physiological aging is controlled by several factors including variety and storage conditions. Storage temperature and exposure to light strongly affect sprouting and subsequent yields. Temperatures higher than about 4°C induce sprout growth and, in dark conditions long thin sprouts develop. If exposed to light sprouts remain short and are more sturdy and vigorous.

Usually smaller whole tubers are preferred as seed. Undamaged tubers have fewer entrances for disease. Per unit of weight, smaller seed produce larger yields than large seed of equal health and physiological condition.

The environment where seed tubers are grown and stored strongly affect the subsequent crop. All else equal, seed grown and stored

under cool, humid conditions will behave as young seed for a longer period. Young seed tends to be later maturing and thus higher yielding than old seed. Earliness or lateness of maturity is also dependent on variety.

Pathology

Seed tubers can transmit many yield reducing diseases. The most important of these are virus diseases some of which may reduce yields by as much as 50%. One of the principal objectives of certified seed programs is the production of virus free seed. Aphids are the principal vector for virus transmission. Thus seed farms are in cool, rainy and windy areas that inhibit the development and movement of aphid populations. In the tropics this means highland areas.

Bacterial wilt (*Pseudomonas solanacearum*) is a soil-borne disease that can also be transmitted by infected seed. This serious disease is one of the most damaging to potato crops in developing countries. Farmers try to avoid it by purchasing seed from fields that have not been inoculated by the bacterium. Nematodes are an important pest that also reside in the soil.

A fungal disease, late blight (*Phythopthora infestans*), is one of the most important potato diseases. Capable of spreading rapidly and destroying entire fields, this disease accounts for the majority of pesticide costs incurred by many potato farmers as repeated spraying is necessary to control infestation.

There are few varieties with effective resistance to these pests and diseases. Careful management and good controls are thus necessary to produce a good crop. An important part of good management is starting with healthy seed of the correct physiological age.

Implications for Official Seed Programs and Farmers

The intent of official seed programs is to produce true-to-type seed judged free of or with tolerable amounts of diseases or pests. The physiology and pathology of the potato define several basic parameters of these programs. Seed programs need access to fields and water free of disease and pests and location in a zone where crop infection is inhibited both in the field and in storages. There also needs to be access to facilities or institutions capable of handling large volumes of a bulky perishable commodity during several multiplication cycles. The slow multiplication rate places a premium on any technology which can speed the process, and therefore rapid multiplication techniques are valauble.

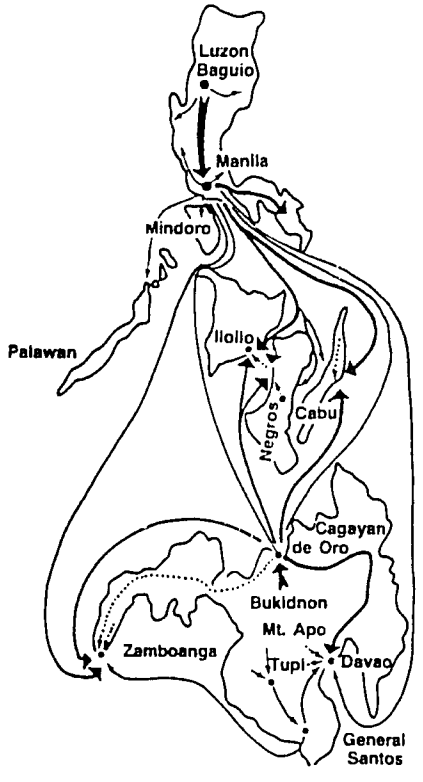
The gradual build up of diseases in seed stocks obliges farmers to replace their seed stock periodically. In the absence of widespread certified seed, the source of the replacement seed requires careful consideration. In developing countries this usually means that seed from higher altitude zones would be preferred. Thus there often exists a distinctive flow of seed from one location to another. Once on the farm the farmer can use various methods to slow the rate of degeneration of the seed. These methods include proper post-harvest handling and storage, field or post-harvest selection, and pre-planting treatment.

2. Potatoes in the Philippines

Area, Production and Yield

Potato production in the Philippines is centered in the high and mid-elevation areas of Benguet and Mountain Provinces in the agricultural region of Ilocos in Northern Luzon. In 1986 approximately 78% of all potato production was in the Ilocos region. This is less than the 86% in 1970, but is due to expansion of production in other areas rather than falling production in Ilocos. National and regional data are reported in Appendix 2 on Tables 1-4. Production zones in the other regions can be seen in the map in Figure 2.

Figure 2. Schematic map of major potato marketing flows in the Philippines



Source: Poats et al., 1981

Note: Tickness of lines indicates greater or lesser annual quantity. Dotted lines indicate irregular or seasonal supply.

The data show a rapid expansion in production during the last ten years at an average annual rate of 8.3%. Most of that growth is explained by expansion in area and the rest is due to changes in yield. A region showing rapid production growth is Northern Mindanao, which consists principally of medium elevation areas around Malaybalay, Bukidnon. In Malaybalay the principal cause of growth in production has been an increase in yields. Portions of the big jump in reported yields in 1982-83 resulted from a seed buying trip to Benguet by a farmers group from Malaybalay. The positive impact of seed renewal on yields is clearly seen.[2]

The PPP has programmed goals for further increases in production over the next five years (Table 1). Further growth is expected in the highlands but with rapidly accelerated growth in the mid- and low-elevations. The potential for accelerated growth in the low elevations appears good and is being tested by a Southeast Asian Program for Potato Research and Development (SAPPRAD) program (Horton et al., 1987).

Table 1. PPP Projections of potato area, Philippines, 1987-92

Year	High elevation (ha)	Low/medium elevation (ha)	Total
1987	4,000	100	4,100
1988	4,200	200	4,400
1989	4,400	500	4,900
1990	4,600	600	5,200
1991	4,800	700	5,500
1992	5,000	800	5,800

Source: PPP/PCARRD mimeo, 1987.

2. Since the Bureau of Agricultural Economics (BAEcon) has used qualitative methods for collection, the interpretation of these data should be treated with caution. Small, irregularly-shaped plots, rough terrain, multiple planting dates and low visitation rates by concerned officials all contribute to creating doubt about the accuracy of reported data. A survey of PPP literature shows wide range of reported production, area and yield for various years. The yield data is discussed in greater detail in Appendix 1.

Consumption

Potatoes are not a regular item in the Filipino diet. Rice is the principal staple appearing at every meal and supplying 38% of daily calories (FAO, 1985). Market prices for a kilogram of potatoes are generally above those for a kilogram of rice, relegating the potato to the status of an expensive luxury vegetable. That status is reflected in its use as an occasional side dish served on special occasions such as Christmas.

Using aggregate national data, annual per capita potato consumption is slightly less than one kilogram, one of the lowest averages in the world (Horton and Fano, 1985). However, this average masks significant variation among regions. Poats et al. (1981) show that potato growers and the wealthy consumers in Manila eat significantly more potatoes than are eaten by other groups. The Manila area is also the principal site of a significant new consumption source --potatoes processed into french fries-- because of the growth of franchise hamburger and fried chicken restaurants. The growth of this sector is expected to continue at its current rapid pace for the next several years. Another significant source of consumption demand in the Manila area is hotels which service foreign tourists.

Acknowledging the current patterns of consumption and recognizing the nutritional benefits of the potato, one of the goals of the PPP is to improve the nutritional status of the population via increased potato production (MAF, 1977). The SAPPRAD lowland potato program is designed to develop production areas near local market cities with the intent of supplying the demand for potatoes in those cities.

Marketing

As might be expected from the above discussion of production and consumption, the major flow of potatoes is from the northern Luzon highlands to Manila. With its transport links, Manila also serves as a distribution point to other regions (Figure 2).

In northern Luzon, potatoes are often picked up by wholesalers directly from the farmers' fields, or are delivered by the farmer in his own or in a contracted truck either to assembly points or to the wholesale market in Baguio. Transport charges correspond to the distance of the farm from the main Baguio-Bontoc road and the subsequent distance from Baguio (Olgado et al., 1979).

Potatoes are frequently retailed by count or weight among other vegetables in mixed-item vegetable stands. They are graded by size, the largest grades being most expensive followed by medium and smaller grades. Medium grade potatoes are the preferred home consumption size and appear most frequently in retail shops. Larger grades are absorbed by buyers for processors. Small grades are often retained by farmers for use as seed. Prices received by farmers show variation by the seasonality of both supplies and consumer demand. Typically, high prices found in November-January reflect both a seasonal low in supplies and high consumer demand for potatoes for holiday dishes.

Farm-level marketing activities depend on the resources of the individual farmer. Almost all farmers perform some in-field grading and packing. The results are red net bags of approximately 28 kg called *bombas* with a shell of larger potatoes and a core of small potatoes. Dealers know this and offer appropriate prices. Though there is some farmer resistance, strict grade enforcement by processors and the associated rejection of non-grade potatoes have begun to have a positive effect on the purity of grading.

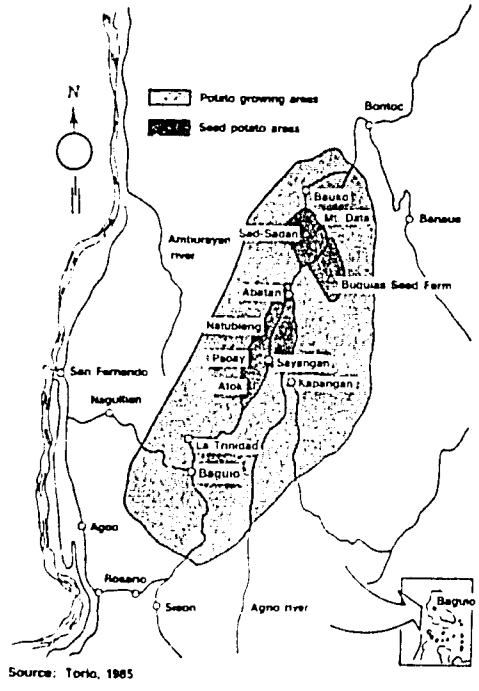
Farmers with sufficient resources deliver their own production to the wholesale market, while those without or with financed crops often rely on the financer/wholesaler to perform all of the field-to-market activities. A survey of seed potato growers showed that 51% of producers had their potatoes picked up in the field while 26% delivered their potatoes to the road, 16% delivered to Baguio and 6% to Manila (Waibel, 1981). Since most fields are distant from a road, hand carrying the *bombas* to the pick-up point constitutes a significant marketing cost. There are few storage facilities for table potatoes at the farm level; thus all production goes into market at harvest time and effects large price fluctuations as seen in Table 24. Harvest dates can be controlled to a limited degree by in ground storage, i.e., not harvesting the crop.

In Mindanao lack of adequate farm-to-market roads was cited second only to bacterial wilt in a frequency rating of production constraints. Reacting to the low seasonal flow of potatoes from Benguet to Manila in December, growers in Mindanao try to time plantings so as to market their production in that time slot (Manto et al., 1979).

Physical Setting for Potato Production

Potato production in the Philippine highlands of northern Luzon is a permanent upland vegetable cultivation system at heights ranging from 1,500 to 2,300 m. Potatoes are grown by approximately 25% of the area's 45,000 farm families (Waibel, 1981). Within the population of potato producers, seed potato producers occupy a narrower ecological zone of the higher altitudes (Figure 3). Within the highland areas are valleys classified as mid-elevation (as low as 1,200 m) that also produce vegetables in rotation with rice.

Figure 3. Potato growing areas in the highlands of Luzon



Source: Torio, 1985

There are two relatively distinct growing seasons. The main season occurs during the warmer wet weather commencing in February-March and ending with harvest in June to early July. Heavy rains and typhoons are major production risks. The smaller, second season occurs during the cooler dry weather starting in September-October for frost-prone higher areas and in October-November for lower irrigated areas. Night frosts at higher elevations can be a production risk. However, most production in the second season occurs in valley bottoms in what formerly were irrigated rice fields. The landscape in the producing areas is mountainous with terraces constructed for crop production (Potts, 1983).

In addition to natural production risks from climate, there are serious pest and disease problems (late blight, potato tuber moth, bacterial wilt) which are usually combated chemically. Because of the profitability of potato production and limited available land, farmers in northern Luzon do not adhere to recommended crop rotations but rather rely on purchased inputs to intensify the potato production system (Potts, 1983).

Since vegetable (especially potato) farming has been profitable, there is increasing pressure on the land base as less suitable area is cultivated and crop rotation cycles shortened. However, some observers question whether a commonly practiced rotation ever existed. There is serious environmental degradation occuring as more and more forest cover is removed exposing the land to erosion. This degradation will continue for the foreseeable future as road construction improves the accessibility to previously remote areas and continued profitability of vegetable farming attracts more migrants. As seen in Table 1 the PPP projects an increase in potato area for the highlands. Whether that increase will come from crop substitution or opening new area is unclear.

The several different mid-elevation (500-1,500 m) regions in Mindanao make that island the second most important producing area. Seed production areas in Mindanao are limited to only higher mountain slopes, the most notable of which is Mt. Kitanglad. South of the typhoon tracks and with fairly reliable seasonal rainfall, large areas in Mindanao have demonstrated

agronomic potential for satisfactory yields of potatoes. The single biggest constraint to production is widespread presence of bacterial wilt -- recent research showed 88% of responding farmers reporting problems with bacterial wilt. The Institute of Plant Breeding (IPB), BPI and CIP have active research programs to develop resistant varieties and to adapt cropping systems to accommodate the presence of bacterial wilt (Kloos et al., 1986).

In the Visayas, production is limited to isolated locations in vegetable growing areas on the slopes of mountains. In one such area in Negros researchers recently reported a production zone with 20 ha at an altitude of approximately 700-1,000 m yielding 6-10 t/ha. Poor quality seed is considered the principal production constraint (Susana and Vander Zaag, 1986). The Cagayan valley in extreme northern Luzon is another potential area for expanded production. Recent farm trials documented moderate yields among cooperators who had not had much previous experience in planting potatoes. Potential yields are higher but those recorded were limited due principally to water management problems (Yabis et al., 1986). Drought is a production risk in Cagayan (CIADP, 1985).

While previously considered unfeasible, lowland potato production has been shown possible, and a large-scale program is rapidly introducing potato production in many areas. Major constraints to lowland potato production are high temperature, water stress, typhoons, heavy soils and lack of seed. Since 1979, farm trials have shown that the physiological constraints can be met by growing potatoes in the cooler dry season from November to February. Other recommendations are to plant where the water supply is assured on previously flooded fields, thus reducing problems of bacterial wilt. There is a seed scheme designed to supply quality planting material to participants in the lowland potato project (Horton et al., 1987; Gayao et al., 1986b). Economic studies have shown that lowland production has lower production costs than highland production and returns to investment are competitive with other vegetable crops (Horton et al., 1987).

Farm Agroeconomic Setting

Agroeconomic Factors

As a result of the land scarcity in northern Luzon most migrants are "squatters" on government land and therefore hold no title. However, they are long-term squatters. Respondents in a recent survey reported operating their present farms for an average of nearly 15 years (Francisco, 1987). Squatters have difficulty obtaining loans from official sources as land titles are required for proof of collateral. Most farms are very small and are divided into several parcels which are on average a kilometer from the nearest road. Table 2 shows a recent profile. Irrigation is difficult and farmers may pipe water for more than two kilometers to supply fields. In the hilly terrain, mechanization is not practical and most crop operations are done by hand. This factor, plus the seasonality of production, results in serious labor shortages during the land preparation, crop establishment and harvest periods.

Table 2. Farm characteristics by farm size. Benguet and Mountain Province, Philippines 1985-86

	Small	Medium	Large	Average
Average farm size (ha)	.38	1.39	3.84	1.26
Average area in potato per season (ha)	.29	.75	1.40	.63
Average number of parcels	1.53	1.97	1.99	1.77
Number in sample	125	114	37	

Source: Francisco IDRC-PCARRD survey, preliminary results, 1987.

In most producing areas on the other islands the farm level agro-economic conditions are similar. An exception is the mid-level area of Mindanao, where the rural structure is comprised of very large commercial establishments which produce plantation crops and livestock. If potato production can be established as agronomically feasible and economically profitable there, potentially large production areas could develop without the typical

economic constraints faced by small farmers elsewhere.

Potato production in the Philippines is a highly profitable activity: potato producers in Benguet are among the wealthier small farmers in the country. Among BPI seed potato cooperators Waibel (1981) found that net returns[3] for seed potato production triple those of table potatoes and are nearly ten times greater than those of cabbage or carrots. Other typical crops in Benguet include cabbage, carrots, chinese cabbage, beans and green onions. Table 3 illustrates the degree of commercial orientation of potato growers. On all sizes of farms more than 80% of production is sold. With an average price of ₱4.50 per kilogram, even potatoes grown by small farmers on only one fourth hectare had sales of almost ₱14,000.[4] However, in addition to being a high revenue crop, the potato is a high cost crop because farmers must make extensive applications of inputs. In addition to the usual high labor demands for land preparation, crop establishment and harvest, the potato requires high levels of maintenance labor in weeding, hilling-up and pesticide applications.

Table 3. Average volume of crop disposal by potato farm size to different sources, Benguet and Mt. Province, Philippines, 1985-86

	Small		Medium		Large	
Outlet	Quantity (kg)	%	Quantity (kg)	%	Quantity (kg)	%
Sold	2,586	84	5,021	84	9,605	83
Kept as seed	236	8	723	12	1,204	11
Home consumption	78	2	100	2	304	3
Given away	40	1	80	1.5	216	2
Other	146	5	41	5	178	1
Total	3,086	100	5,965	100	11,567	100

Source: Francisco IDRC-PCARRD survey, preliminary results, 1987.

The potato producing farmers are entrenched in a rapid and high volume cash flow necessary to sustain operations. Most farmers must borrow heavily, usually from input suppliers who take in-kind loan repayments at harvest. Unofficial credit is readily available because credit suppliers acknowledge the high value of the crop as sufficient collateral to secure a loan. This cash flow requirement has significant implications for the farmers specializing in seed production, a point discussed more fully in the farmer crop disposal model presented below.

There are market risks as well. Prices of potatoes fluctuate widely throughout the year, ranging from high in October-January to low in April-July. Prices are generally lowest during peak main crop harvest periods (Gayao et al. 1986c). Farmers can control harvest and selling dates to a limited extent, but not enough to control the prices they receive. Most farmers use informal production credit from vegetable traders or merchants. The terms of contract allow the creditor to establish the harvest date so as to plan for transport requirements. This makes the farmer subject to the decisions of others, further removing him from control of the crop. Farmers generally rely on middlemen for the small amount of market information they receive.

The Informal Seed System

The farmer-based informal seed system is the most important in the Philippines. Though precise data are difficult to obtain, informal discussion and published data indicate that in 1987 about 10% of seed requirements will come from the seven organized seed schemes. The rest will come from the farmer-based system. The use of different types of seed in northern Luzon is given in Table 4. Note that the category "farmers's seed" might include some seed derived from the BPI program or from its cooperating seed multipliers.

Several observers have described the farmer-based seed system (Potts, 1983; Waibel, 1981). For the wet or first season crop in northern Luzon, farmers typically use seed saved from the crop of the previous season. Seed storage losses are a concern of growers. If no irrigation is available for the dry season crop the storage period is from 5-7 months.

3. Net returns are defined as gross revenues minus all variable costs including family labor valued at market wage rates and interest on borrowed capital.

4. The Philippine peso (₱) has maintained a relatively steady value of about 20 pesos to one US dollar during the last several years.

Table 4. Type of seed potato reported by farmers. Benguet and Mt. Province, Philippines 1985-86

Type of seed	Number	%
Farmer's seed	129	86
Certified seed*	19	12.6
Both types	1	.7
Stem cuttings	1	.7

Source: Francisco IDRC-PCARRD survey, preliminary results, 1987.
Note: Includes imported seed.

Farmers in favorable production areas replace seed every three to five years. In lower areas, where aphid populations increase the spread of disease and temperatures limit storage, farmers tend to buy seed for each cropping. Replacement seed is obtained as gift, purchase or loan and may be in quantities as small as 28 kg. This informal sector interacts with the commercial market as well. When sales of imported seed are allowed, farmers purchase from this source in January or February for wet season planting. Typically, small quantities are purchased, sometimes as few as one or two crates (45-50 kg/crate). The farmer may set aside a seed production area for multiplication of expensive imported seed or domestic seed valued for its particular characteristics. In cases such as these, usually the entire production, regardless of size grade will be kept for further multiplication. Cutting seed tubers is a common practice among table potato growers. More than two thirds of potato farmers reported cutting seed in a recent survey (Francisco, 1987). Cutting is practiced not for agronomic reasons but because of scarcity of seed tubers and the desire to extend this high cost input as far as possible.

The informal seed system is insufficient to meet the needs of growers in terms of both quantity and quality. Farmers often report shortages of seed tubers during planting and sometimes purchase small tubers from the Baguio market. These potatoes are of unknown variety, physiological state and health. Imported seed is beyond the budget of most farmers and is thus not a viable alternative. Table 5 shows reasons farmers gave when asked why they selected their seed. Paralleling the reasons given for choice of variety in Table 13, availability and cost were most important. Only at the third level of priority did farmers list level of health as important. This combined with the similar category of "tested" shows that only 16% of farmers surveyed consider health, a major premise of organized seed production, to be an important consideration when selecting seed. Demonstrating to farmers the benefits of healthy seed should be a high priority activity of any seed program. When farmers appreciate the benefits of healthy seed their interest and cooperation with seed programs is guaranteed to increase.

Table 5. Reasons for choice of type of seed reported by farmers. Benguet and Mt. Province, Philippines 1985-86

Reasons	Number	%
Available	75	47
Lower cost	27	17
Clean seed	22	14
High yielding	14	9
Tested	9	6
Disease resistant	7	4
Imported	3	2
New variety	2	1
Total	159	100

Source: Francisco IDRC-PCARRD survey, preliminary results, 1987.

Northern Luzon traditionally has been the only seed producing area. Other potato producing areas lack the favorable temperatures and protection against aphids provided by altitude to sustain seed multiplication. Interviews with traders and purchasers and BPI records show that seed flows out of the Ilocos region to most of the other regions. The study by Olgado et al. (1979) illustrates a difference in seed strategy between growers in Bukidnon and Benguet. The survey details crop disposal habits and, consistent with the data in Table 3, finds that Benguet farmers save an average of 8% of production. Recognizing a lack of outside supplies and adapting to low yields, farmers in Bukidnon save an average of 19% of production for seed. The activities of the Mindanao group illustrate the generally unsatisfactory conditions for inter-island seed flows. The BIBAK seed buying trip referred to above, involved sending

several members to Baguio to make contacts and purchases, adding that cost into the total seed cost.

Policy Setting - The Philippine Potato Program

The policy environment for potatoes has been and continues to be positive. In mid-1976, organizational meetings led to the formation of a national potato program at the end of 1977. The Philippine Potato Program is a multi-disciplinary, multi-agency program with cooperators from several institutions in the government.

The original objectives of the PPP were to increase production by increasing yields via low cost methods in the high- and medium-elevations, to expand consumption and utilization of the potato and to develop a viable market for the crop. The program goals were yield increases in the highland areas from the current 12 t/ha to 20 t/ha by 1983 with no increase in area and from 6 t/ha to 9.5 t/ha with area increasing from 100 to 500 ha in the low and medium elevation areas.

The 1977 PPP strategy of implementation was to achieve its objectives with the following components:

- improved production technology
- a seed potato multiplication program
- development of post-harvest handling storage and processing technology
- financing
- marketing
- a nutrition program
- extension (MAF, 1977)

The lead institution of the PPP is the National Food and Agricultural Council (NFAC). The various institutions in the PPP and their areas of activity are included in Table 6. Each of the agencies provides its own funds and operates independently. Of the agencies involved in 1977 only NFA is no longer participating.

At the time of the creation of the PPP both CIP and GTZ increased their level of cooperation with the Philippines. CIP established a Southeast Asia and Pacific Regional Office in Los Baños (CIP-Region VII) and later opened its regional germplasm screening and distribution center on Mt. Bahnahaw near Los Baños. Several years after the creation of the PPP the Southeast Asian Program for Potato Research and Development (SAPPRAD), a CIP regional research network was formed. SAPPRAD maintains the office of the coordinator in Los Baños. The Philippines is the lead country in the network for lowland tropical breeding (Page and Horton, 1987). Since the formation of the PPP, CIP has also assigned two agronomists to long-term regional positions which entailed cooperation with BPI in Benguet and Mindanao. In cooperation with BPI, GTZ initiated the RP-German Seed Potato Research and Production Project.

The RP-German White Potato Research, Development and Seed Production Program

It is within this setting that the RP-German seed potato project was started. The program lasted for ten years, ending June 30, 1987. Its purpose was certified seed production with supporting research and extension. The major objective was to be accomplished by the:

- establishment of a foundation seed farm in a high altitude, isolated area in Buguias
- establishment of seed storage system using government or private sector resources
- organization of seed production areas in Benguet with contract seed growers
- supervision of production and initial distribution of seeds by BPI to be passed on to seed grower associations
- certification of seeds by BPI (BPI, 1977)

These steps were based on the motivating assumption that low yields are due to the widespread use of virus-infected seed. Provision of virus-clean seed was considered a major means of increasing yields.

Upon initiation of the program, work started immediately in all areas. Contracts to multiply imported seed were arranged. BPI personnel were assigned to the program and a research agenda was developed. Introductory and organizational meetings were held with farmer groups. For the first several years of the project, the research program dominated other activities

Table 6. Member agencies of the Philippine Potato Program, 1977

Agency	Original activities
Bureau of Plant Industry	Seed production
University of the Philippines at Los Baños & Institute of Plant Breeding	Breeding and post-harvest research
Benguet State University* & Northern Philippine Root Crop Research and Training Center	Table potato research and training
Department of Agriculture*	Policy coordination and extension
National Food Authority	Marketing
Central Bank - Technical Board for Agricultural Credit	Credit and finance
Philippine Council for Agriculture, Forestry and Natural Resources Research & Development	Research and finance
Ex-officio members: International Potato Center funding	Technical support, training and program & GTZ
National Food and Agriculture Council	Program coordination

Note: Benguet State was formerly Mountain State Agricultural College and the Department of Agriculture was the Ministry of Agriculture and Food.

while facilities and infrastructure were developed. Later, seed grower associations were organized and, finally, the seed farm became operational. The development of individual components of the project will be discussed more fully below.

Seed Flows in the RP-German Program

Seed potatoes flow through the program in a complicated manner. This section uses official program data carried in the annual and semi-annual reports or other records to trace a brief history of the program, describe trends and trace the flow of potatoes in and out of the program's control.

For the majority of the program's existence, the first step in the flow of materials through the program has been to receive imported seed and loan it out to contracted farmers for multiplication. The next step is repayment of the loaned seed and supplementation of that seed with procurements of additional seed, usually from the same farmers. That seed is stored, sold, released for research or loaned for further multiplication in the next planting season (Figure 4). The Buguias seed farm later began to produce basic seed and importations were suspended.

The starting point for this analysis is the data presented in Table 7 which show where seed goes and from where it comes. The total stock column gives the volume of material handled by the program during the year. The trend clearly shows the almost explosive growth in material handled and the equally dramatic

Table 7. Source and use of potato seed by the RP-German Seed Program, 1977-87, all figures in tons

Year	Total stock	Seed distribution					Seed sources				
		Sales	Loans	Planted at seed farm	Free dis-bursements	Losses	Imported	Repayment of loans[2]	Procured	Produced at seed farm	Balance
1977	5.0	-	4.0	-	.5	.5	5.0	-	-	-	-
1978	41.1	7.6	21.3	-	-	9.9	14.2	5.4	21.5	-	2.3
1979	34.3	3.1	13.2	-	-	6.3	7.9[1]	-	24.1	-	11.7
1980	81.9	4.5	18.3	-	2.7	7.8	29.5	-	40.7	-	48.6
1981	182.5	27.0	90.6	-	4.7	2.2	29.9	88.8	15.2	-	58.0
1982	181.6	14.2	57.3	-	5.6	1.4	5.0	56.8	61.8	-	103.1
1983	221.8	37.5	98.0	-	5.7	1.9	2.0	75.1	41.6	-	78.7
1984	158.5	46.7	56.3	-	8.2	.9	-	57.4	22.4	-	46.4
1985	107.5	26.3	37.0	9.0	4.1	5.7	-	39.6	10.7	10.8	25.4
1986	60.5	9.9	18.0	9.0	2.8	.8	-	15.6	1.0	18.5	20.0
1987[3]	108.7	4.4	32.1	6.8	2.3	3.8	12.0	22.2	23.9	30.6	59.3

Source: Inventory of Seed Materials, various years.
Notes: 1. Not 14 t as in importation papers due to rotting in route. 2. Includes repayments from 1978 to 1985 outstanding loans. 3. Final 1987 data provided by BPI.

decline in 1986 to the point where the program was handling only slightly more potatoes than in its second year of operation. A closer examination of other columns help to explain how this rise and fall occurred. Not all of the subsequent tables include the complete range of years due to late initiation of record-keeping procedures. The balance column is an accounting device to carry forward the remainder to the next year.

The original source of total stock was imports. The total annual figures are broken down by variety in Table 8. From the beginning of the project until the opening of the seed farm in 1981 the program was essentially a sophisticated import and multiply scheme. The imports continued every year until 1983 with the introduction of two promising new cultivars, Berolina and Granola. After a three-year gap during which stock levels could not be sustained, 1987 saw renewed importation as a quick recovery measure to rebuild the depleted stocks.

For certified seed production, seed loans to farmer cooperators and the subsequent repayment of these loans formed the principal method of expanding the volume of material in the program's control. With only slight deviations, these two columns track the trend of the total stock column. These columns are examined in more detail in Tables 9 and 10.

Figure 4. Diagram of seed flow through the RP-German Seed Potato Program

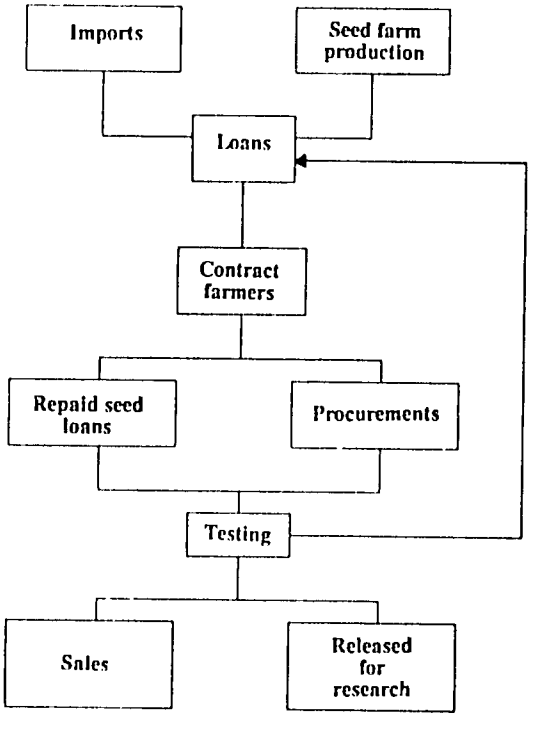


Table 8. Seed potatoes imported by RP-German Seed Potato Program 1977-87

Year	Variety	Quantity (kg)
1977	Red Pontiac	5,000
1978	Cosima	15,000
1979	Isola	4,200
	Fina	4,200
	Red Pontiac	2,000
	Franzi	4,000
1980	Cosima	15,000
	Isola	12,000
	Red Pontiac	2,000
1981	Cosima	20,000
	Isola	10,000
1982	Fina	5,000
1983	Berolina	2,000
	Granola	2,000
1987	Cosima	6,000
	Monza	6,000
Total		114,500

Source: Inventory records RP-German Seed Potato Program

Table 9 shows the repayment rate on the loans on a seasonal basis starting in 1981. The repayment rate ranges from 100 to 68%. Notable, however, are the generally lower levels of repayment since 1982. Major storm damage in 1983 and 1986 accounts for some of the declining trend, but even so collection of seed loans was notably less successful. Starting around this time, the potato processing industry began organizing seed production schemes and the value of good planting material rose. Thus, motivation existed for farmers not to honor contracts for repaying loans of seed, so as to avail themselves of the profitable contractual arrangements offered by the processors.

Table 10 examines more closely the dispersal and performance of the loans. Arranged on a cropping-season basis, the table clearly shows that most of the program's activity occurred on the wet season. The trend in the number of farmers receiving loans does not closely follow the trend in loans, and indicates considerable variation from year to year in the average size of a loan. Also showing considerable variation is the apparent seeding rate, as seen by comparing the quantity of seed loaned and the area planted, though this may reflect inaccurate data reporting more than variable agronomic practices. The "total production" column serves as an ultimate measure of the seed flow out of the program and into the seed system. The actual distribution of this production is uncertain and is discussed below in a decision model of farmer crop disposal.

Table 9. Seed loans and repayments from farmer cooperators of RP-German Seed Potato Program by crop season, 1981-86

Crop season	Loaned (kg)	Repayment (kg)	Percentage recovered
Wet 1981	80,889	79,924	98.8
Dry 1981	17,262	13,659	79.1
Wet 1982	50,549	48,995	96.9
Dry 1982	6,700	6,700	100.0
Wet 1983	96,252	76,368	79.4
Wet 1984	51,900	45,725	88.1
Wet 1985	33,109	30,284	91.5
Dry 1985	3,980	3,480	87.4
Wet 1986	17,936	12,515	69.8*

Source: Monthly Inventory Reports. RP-German Seed Potato Program
Note: Provisional.

The "yield" column in Table 10 indicates that yield performance of the program's basic and certified seed is not meeting the often-expressed goal of 20 t/ha. The total production figure is theoretically provided by the field inspectors who observe the harvests. Farmers may desire to under-report the harvest for a number of reasons so these figures may be erroneous. For whatever reason, the efficiency of production with the loaned seed and the repayments of loans appear to deserve close monitoring.

Returning to Table 7, free releases of seed have grown steadily during the life of the program. These releases are principally for research. The volume of research disbursements is dominated by release for variety trials in BPI and in other institutions. Free releases highlight the service role the program is

performing. Clearly, there is a cost of producing the seed which is disbursed from the production portion of the program to its own and other research programs. The management question is whether production should be allocated for research support or seed multiplication. This point is discussed in the next section. The rate of increase in seed needed for research by the various institutions is in part, due to interagency linkages.

Table 10. Number of cooperators, area planted and total production of seed potatoes loaned-out to farmer-cooperators of RP-German Seed Potato Program 1977-86

Year	Season	No. of farmers	Area (ha)	Quantity seed (t)	Total production (t)	Yield (t/ha)
1977	Dry	10	.5	-*	-	2.4
1978	Dry	32	19.3	-	-	17.2
1979	Wet	28	6.0	13.3	101.8	17.0
	Dry	7	1.7	3.4	26.3	15.5
1980	Wet	28	12.6	25.0	164.1	13.0
	Dry	20	7.1	14.1	124.6	17.5
1981	Wet	72	29.1	74.3	428.3	14.7
	Dry	24	6.5	17.3	74.6	11.5
1982	Wet	49	23.6	50.3	402.5	17.0
	Dry	7	2.5	6.7	45.5	18.2
1983	Wet	76	35.9	96.7	432.0	12.0
1984	Wet	56	21.7	56.9	334.3	15.4
1985	Wet	36	12.3	32.4	135.4	11.0
	Dry	5	1.5	3.9	22.7	15.3
1986	Wet	68	17.93	-	-	

Source: Seed Distribution Reports, RP-German Seed Potato Program.
Note: Not recorded.

Potato losses occur in storage (see Section VII on storage). High levels of loss in the early years resulted from the lack of proper storage facilities in which potatoes are stored in large unventilated heaps.

Table 11 details by year and variety the volume and certification grade of the program's procurements. Because there were imports in addition to the cycle of loans and procurements, the procured seeds of any variety in a given year may represent several different generations of multiplications of the health standards as noted in the table. This precludes the use of this table as a proxy for a degeneration study. The table does illustrate that most procured seed has been C1 and C2 grade, grades worth reloaning for the multiplication/certification cycle. Table 16 in the section on seed certification gives virus laboratory results of tests of procured and loan repayment seed and illustrates a similar distribution of seed grades.

Table 11. Variety and grade of seed procured from farmer-cooperators of RP-German Seed Potato Program by year and variety, 1980-86

Year	Variety	Volume (kg)	% of grade* C1	C2	C3
1980	Cosima	10,219	100		
	Isola	29,672	100		
	Red Pontiac	793		100	
1981	Cosima	5,620		100	
	Isola	9,536		100	
1982	Cosima	15,122		23	77
	Isola	22,060			100
	Conchita	9,660	100		
	Fina	15,900	100		
1983	Cosima	5,660		31	69
	Conchita	9,135			100
	Fina	13,465			100
	Granola	8,000	100		
	Berolina	5,000	100		
	Greta	315			
1984	Cosima	2,595		37	63
	Fina	1,600		100	
	Granola	15,025	100		
	Berolina	3,190	100		
1985	Cosima	825		100	
	Granola	6,060	100		
	Berolina	3,775	100		
1986	Granola	1,000	100		

Source: Seed Procurement Reports, RP-German Seed Potato Program.
Note: See Appendix Table A6 for definitions.

All told, several things began happening during the period 1983 to 1986 which contributed to the decline in stocks. Tables 9 and 10 indicate that loans to farmers performed poorly, reported yields were low and repayment rates did not match previous performance. As listed in Table 7, procurements began dropping by 30, 50 and 90% just as loan repayments began falling. In the face of this situation, sales (Table 7) began declining, but at a one year lag, removing seed potatoes from the program's control. With no imports and negligible production from the seed farm, the inevitable result was the rapid divestiture of program stock without visible means of replacement.

In 1983 and 1984 sale of seed by the seed program earned money for the national treasury.

In a government populated with money-losing enterprises, the performance of the BPI seed unit appeared to be exemplary and earned the program approval from bureaucrats at all levels. This natural tendency calls into question the relative importance of the production (and Income earning potential) versus the research and extension roles of the program. Who buys project seed? DA-Cagayan, DA-Ifugao, SAPPRAD and BSU have all been customers. Most other sales were made to farmers near the seed storage facilities. There have been a few very large sales to corporate entities. Generally, the entire policy of seed sales by the government deserves careful review.

Conspicuously lacking so far from the discussion is the production at the Buguias Seed farm. Not until 1985 were systematic records kept. For much of the period the seed farm either did not exist or was not in condition to be producing significant amounts of basic seeds. In more recent years adverse climatic conditions, incomplete seed farm infrastructure, unresolved technical and management problems and the political instability in the area have limited the effectiveness of the seed farm.

3. Breeding and Variety Selection for Seed Production

The work of every seed program is based on the existence of varieties with characteristics suited to the needs of farmers, processors and consumers. Thus breeding and germplasm maintenance programs are an essential component of a seed production system. The link between breeding programs and seed production programs must allow for the feedback of information regarding characteristics of desired varieties so that breeders can supply useful varieties for seed production. Similarly, the seed program must be aware and take advantage of superior new varieties.

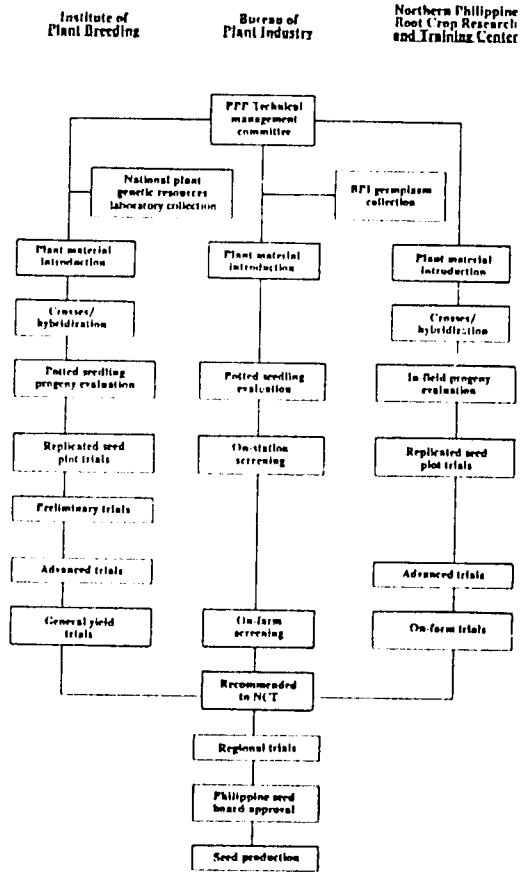
Prior to the late 1970's there was no formal potato breeding program in the country. Varieties used were the Mexican clones Conchita and Greta, introduced in the early 1960's. These well-adapted varieties could be maintained with extant farmer practices. A small-scale screening program using Dutch and German varieties had been in existence for several years at Benguet State University. As late as 1977 a planning document stated that "in the absence of adequate potato breeders... the establishment of a seed farm... is essential" (BPI, 1979). That situation has now been remedied.

Breeding Programs

In the Philippines there are four distinct breeding programs. The programs are at the Institute of Plant Breeding at UPLB, the Northern Philippine Root Crop Research and Training Center at Benguet State University, the CIP-Region VII Station in Los Baños and at the Baguio-Buguias Station of BPI. The activities of the Philippine programs are presented in Figure 5.

Each of these programs has distinctive objectives and methodologies. All of the programs are young and procedures, locations and interrelations are still flexible and adapting t changing situations.

Figure 5. Basic elements of potato breeding programs in the Philippines



The IPB Program

There is a hybridization program at IPB. The IPB program has since 1982 received partial funding from SAPPRAD and participants observe that this funding bolstered the lowland potato breeding program (Page and Horton, 1987). IPB has objectives for developing varieties for the high-, mid- and low-elevations with the corresponding characteristics necessary for these elevations. The main target is resistance to bacterial wilt, nematodes, thrips and heat tolerance (Rasco et al., 1983).

Germplasm is maintained in the field in Buguias and Benguet, and at laboratory facilities in Los Baños. Greenhouse crosses are made at IPB research field at BSU. The main thrust of the crosses is to combine heat tolerance with bacterial wilt resistance and high yield. Testing for heat tolerance is done in pots at UPLB. Tubers selected from this step are planted to an IPB seed plot near the BPI-Buguias seed farm where selection is made for yield, bulking ability, tuber uniformity, and late blight resistance. Tubers selected are passed on to Preliminary, Advanced, and General Yield Trials. These are in three locations; BSU, UPLB and BPI/Lipa near Los Baños for readings at high-, mid- and low-elevations. The yield trial is generally replicated. Promising material is collected along with material from other programs for seed increases --the IPB-BSU program and the BPI Buguias seed farm for the National Cooperative Testing (NCT) network. NCT screens varieties in regional trials at six to eight locations for two wet and two dry seasons before advancing candidates to the seed board (Institute of Plant Breeding, 1985).

Upon commencing activity in 1976, the strategy of the IPB program was first to introduce named varieties as an interim step to the longer process of breeding. In 1982 after several years of screening and setting up the NCT network, the technical working group of the Philippine seed board, recommended six varieties for seed board approval: Red Pontiac, Cosima, Isola, Fina, Conchita, and Arka, all of which were approved. These were all introduced varieties and were viewed only as stopgap varieties until selections from the breeding program become available. The seed program was most interested in Conchita but there were no clean seed available. Conchita clones were sent to Australia for virus "clean up" but for reasons still unclear the returned material did not perform as expected. Plants produced 50-100 very small tubers. Farmers still talk of their bad experience with the seed produced from the returned Conchita.

The Northern Philippine Root Crops Research and Training Center

The program at the Northern Philippine Root Crop Research and Training Center (NPRCRTC) in La Trinidad, Benguet, was started in 1982 as a collaborative arrangement with CIP. It focused on two projects: management of late blight through the development of resistant germplasm and development of TPS progeny for the high-, mid-, and low-elevation areas. The program is not directly linked to the PPP.

The NPRCRTC makes controlled crosses and hybridizations in greenhouse facilities in La Trinidad and the progeny are evaluated for adaptation, tuber uniformity, and quality for true potato seed (TPS) in fields at the station. Selections of clones and tuber families are then passed on to replicated trials at the BSU station in La Trinidad which are located at the lower range of high-elevation sites and at a research farm at Atok, a genuine high-elevation site. In the replicated trials there is testing for late blight, bacterial wilt, and yield in the first and second seasons. Advanced selections are then planted again in non-replicated trials on-station and finally in farmer's fields. Based on these results, nominations for the NCT are made (Nisperos-Ganga, 1985).

Plant materials used in the NPRCRTC are obtained from widespread sources, although most are from CIP-Lima. In 1986, results from eight replicated trials and five on-farm trials indicated that two clones, I-1035 and B71-240.2 were suitable for release in the country. In an effort to hasten the procedure of getting the clones into seed production, the NPRCRTC recommended the clones directly to the seedboard. The clones were accepted and named Montañosa and Dalisay, and were targeted to the highlands and lowlands respectively.

Prior to the seedboard clearance, the NPRCRTC approached the BPI-German program with a quantity of clones and stem cuttings and requested that they be multiplied. The program declined until official approval was forthcoming. With seedboard approval the program has started RMT production of the two varieties.

The release of the two varieties was delayed for one year due to lack of planting material. Thus to supplement the efforts of BPI, the NPRCRTC has entered into planting material production with the aim of making material from these varieties (rooted cuttings) available to farmers to coincide with the publicity surrounding their release. The NPRCRTC has engaged in limited publicity about the release. Publicity sheets describe the variety and announce that stem cuttings are available. The NPRCRTC activity with stem cuttings is discussed in more detail in the section on rapid multiplication below.

The CIP-Region VII Program

The CIP-Region VII breeding program has, by definition, a Southeast Asian regional focus. However, because much of the breeding work is taking place in the Philippines and because the disease problems in the other Southeast Asian countries are the same as those in the Philippines, many varieties being developed are suitable to specific Philippine conditions. The breeding program uses material from numerous sources. Its objectives are bacterial wilt resistance, heat tolerance for lowland varieties and thrips resistance. CIP-Region VII routinely shares material with the IPB program.

The BPI Program

The BPI varietal screening and germplasm maintenance program was included in the overall BPI program from the beginning of the RP-German project. The program has had variety trials every year. Currently trials in two locations on the Baguio-Bontoc road are being replicated four times. The program has more than one hundred accessions in its collection - fifty are maintained in-vitro and others are vegetatively maintained in the greenhouses or fields. All but a few of these are named varieties. The maintenance program is integrated completely with the pre-basic seed production program. The efforts of maintenance are geared towards preservation of a minimum of stock material in very clean condition for eventual seed production.

Variety screening has resulted in several recommendations to the seedboard. Selection of varieties for seed production has shifted over the years from Red Pontiac, Isola, Fina, and Cosima to Granola, Cosima, Monza, and Berolina. This shift marks a responsiveness of the program to the market for varieties with qualities suitable for processing. Demonstration plots in farmers' fields have been a particularly valuable source of information on variety preferences of farmers and have been a significant source of introduction of new varieties to the informal seed system. Over the years the program has imported and multiplied several non-seedboard varieties for research purposes.

Private Sector Screening

Private sector work in variety selection is a separate issue. The leading example is the introduction of the North American variety Lemhi by the Halsema scheme. With a particular need not being met in timely fashion, the private sector appealed to and got permission from the quarantine division of BPI to import germplasm for a short-run screening program. This is an example of the overriding importance of quality in selection. McDonalds hired a consultant to perform some limited screening in the Philippines using a selected list of processing varieties with quality and appearance constraints on length, color, and dry matter. Although the variety is susceptible to late blight, McDonalds continues to use it, and require that it be grown, at least in a limited amount.

Roles and Relations Among Breeding Programs

As illustrated in Figure 5, the Philippine breeding programs are essentially separate

parallel institutions with very similar objectives. Not shown in the figure but still an influential factor, are the connections with international programs and commercial channels as sources of germplasm and technical assistance. All the Philippine programs are in frequent contact with this international system. Differences are in the material in active use and in some of the early screening criteria. The programs share some facilities but are essentially independent from each other. The varieties in production and objectives of the breeding program appear to reflect the farmer and market needs. With the processors forming the largest single demand source, there is a heavy emphasis on processing varieties because farmers seek extra profits from varieties that produce a larger proportion of the semi-oblong extra large tubers.

A relevant question pertains to the continued role of the BPI screening program. The premise for starting the screening activities was the lack of organized breeding in the country. That situation no longer exists. There are several arguments in favor of continuing the BPI program. One argument is that the screening program has already been the source of some outstanding varieties tested by the NCT. Another positive factor is the close contact BPI has with farmers, especially with on-farm experimental plots as a source of feedback regarding preferred varieties. Contacts between farmers and the breeding programs are less frequent.

By engaging in its own screening efforts, BPI maintains a certain independence from the breeders and thus is available as an alternative source of opinion on the selection of germplasm. An unwritten policy of the Philippine Seed Board is to have two tons of basic seed available before releasing a seedboard approved variety. This policy is aimed at satisfying the demand created by the publicity surrounding any release. However the policy of the BPI seed production program is to not multiply varieties until they are approved by the Seed Board. The quandary of the breeding program, therefore, is to determine how much of its resources to devote to seed production.

An issue raised above concerns the role of the BPI seed program as a service agency, illustrated by its release of seed to other institutions. BPI possesses seed maintenance and rapid propagation capabilities and a staff and facility to produce pre-basic and basic seed material. Arguments can made in favor of consolidating the germplasm maintenance and research seed production requirements of all the breeding/screening programs under the supervision and responsibility of BPI. IPB estimates that nearly one half of its budget is spent in these logistical activities and not in the actual breeding (Rasco, personal communication).

Certain economies of scale could be realized by the consolidation of BPI and IPB production activities. Costs of such coordination, however, appear formidable. One such problem is the need for organized on-going planning in order to get production requests from the breeding program to BPI in time for BPI to meet these requests. This would greatly increase the level and frequency of communication between the agencies. Also important is the perception of BPI's reliability in providing sufficient quantities of seed in a timely manner. Given the concerns of the breeding programs surrounding the production of newly released varieties, it appears likely that there would be similar concern about the routine production of program material.

Varieties and Farmer Preferences

Since the initiation of the PPP, farmers have had a large number of varieties from which to choose. The varieties have become available to farmers through imports, official releases and unofficial escapes from farmer field testing. Three studies completed during the life span of the RP-German program illustrate the range of varieties available and their relative popularity (Table 12). Methods used for sample selection and data collection differ, but there is enough similarity to make a valid comparison. The comparison shows some significant shifts in popular varieties.

In 1977-78 four varieties used in roughly balanced proportions accounted for nearly all reported varieties used. The popularity of the "Mexican" varieties Conchita and Greta reflected their good adaptation to local conditions. Red Pontiac was imported the year before by the RP-German Program and its popularity possibly reflected that fact. In 1980 after three years of

RP-German program operation, the most popular varieties grown remained the Mexican clones Greta and Conchita, which were found in over half the fields surveyed by Potts, et al. (1983a). Five years later these varieties accounted for less than a third of that amount. Cosima, a variety promoted by the RP-German Program from the earliest days to the present (see Table 8), was already well-established in 1977-78 and had risen in importance in 1985. Fina and Isola, have traditionally filled special ecological and consumer niches and after an initial decline have since remained in stable use. The most remarkable change between the periods has been the popularity of Granola, a German variety first introduced to the Philippines in selection trials of the RP-German Seed Program in 1982 and officially released in 1984. Granola is popular because it produces a high ratio of extra large grade tubers which earn a premium in the market. Even before official release the variety was being disseminated rapidly in the informal seed system.

Table 12. Percentage distribution of potato varieties found in three surveys. 1977-78, 1980 & 1985[1], Benguet and Mountain Province, Philippines

Variety	1977-78 n=213[2]	1980 n=184	1985 n=210
Granola	-	-	39
Cosima	19	16	29
Fina	18	4	5
Red Pontiac	24	8	5
Isola	9	4	3
Greta	27[3]	14	15[3]
Conchita		42	
Others	3	11	4

Notes:
1. 1977-78 study by Olgado et al. 1980 study by Potts et al. (1983). 1985 preliminary results from Francisco IDRC-PCARRD survey.
2. Number for Potts et al. is field count regardless of farmer number, for others it is the positive farmer response on varieties grown by 150 (Francisco) and 123 farmers (Olgado).
3. Some farmers group these two varieties under the single name "Mexican" and have been listed as that in Francisco and Olgado.

Farmer respondents in the Francisco survey were asked to give reasons for choosing the varieties they planted (Table 13). Significantly the reason given most often was one of availability and not of variety performance.

The data indicate several points. First, despite the fact that farmers view seed availability as a problem, the fact that Granola is widely grown only a few years after its introduction is evidence that the informal seed system functions fairly efficiently in the low volume dissemination of new varieties. Second, the informal seed system does not function well in supplying the quantities of desired seed. Due to the importance of yield and resistance characteristics, there apparently is a very large market for seed from organized seed programs. What is not indicated in the Francisco data is the regional distribution of varieties. As noted by Potts et al. (1983a) there are distinct distribution patterns by variety. The low rate of concern with storage may imply that the storage technologies introduced in the late 1970's have solved pressing problems, or else that no storage differences among available varieties are perceived. The low concern for economic factors shows a recognition that the market offers little differential in price among different varieties.

Table 13. Reasons given for choice of variety by potato farmers. Benguet and Mountain Province, Philippines 1985-86

Reasons	Number[1]	%
Readily available	48	26
High yielding	47	25
Resistance to pests & diseases	31	16
Good local adaptation	26	14
Desire to try new varieties	17	9
Early maturity	9	5
Best variety	5	3
Good selling price	2	1
Cheaper seed tubers	1	.5
Good storability	1	.5
Total	187	100

Source: Franciso IDRC-PCARRD survey preliminary results.

Note: 1. Number gives total responses from 150 farmers.

4. Initial Seed Multiplication

Assuming the supply of adequate varieties is assured via breeding and screening, the next stage in the process of seed production is initial multiplication. There are three distinct phases in this step: maintenance of selected varieties, production of pre-basic seed from the varieties in maintenance, and production of basic seed. During initial multiplication stage the role of the breeder is variable, ranging from complete control of these three phases to participation in just a single phase as a part of a specialized agency. In the Philippines, the structure tends toward the latter, with the BPI seed production facility providing all three services.

Plant breeders tend to have special aspirations for varieties released by their programs and may feel that others do not appreciate the qualities of these particular varieties and do not assign high enough priority to them. Since IPB and BPI are separate agencies with facilities in different locations, coordination of their activities through the PPP should be a special concern. This coordination should provide formal communication and feedback rather than relying on informal contacts through personal relationships.

Maintenance of germplasm in the BPI program is done by the rapid multiplication unit and appears to be a smoothly functioning part of the program. The in-vitro maintenance provides mother plant material for the rapid multiplication techniques used for pre-basic seed production. The rapid multiplication schemes of BPI and others are discussed in the following section.

Rapid Multiplication

There are currently four rapid multiplication technique (RMT) schemes operating in Benguet area and a fifth in Mindanao. The four schemes in Benguet include that of the BPI seed program, a collaborative SAPPRAD-BPI Project, a Root Crops Center project and the Halsema Inc. seed farm. The Mindanao scheme is that of BIBAK in Malaybalay, Bukidnon.

The BPI Program

The largest and most complex RMT work is at BPI. A major component of the seed production program has been developed in accordance with the RP-German Project objectives. RMT work at BPI was developed with training assistance from CIP and technical assistance from German counterparts, and represents a major effort of the project. The establishment of facilities and training was completed as initially planned. A small tissue culture laboratory with a laminar flow cabinet and lighted shelves has provided in-vitro capability since 1983 (Joerdens-Roettger, 1985). RMT work at BPI is based on research, production and extension.

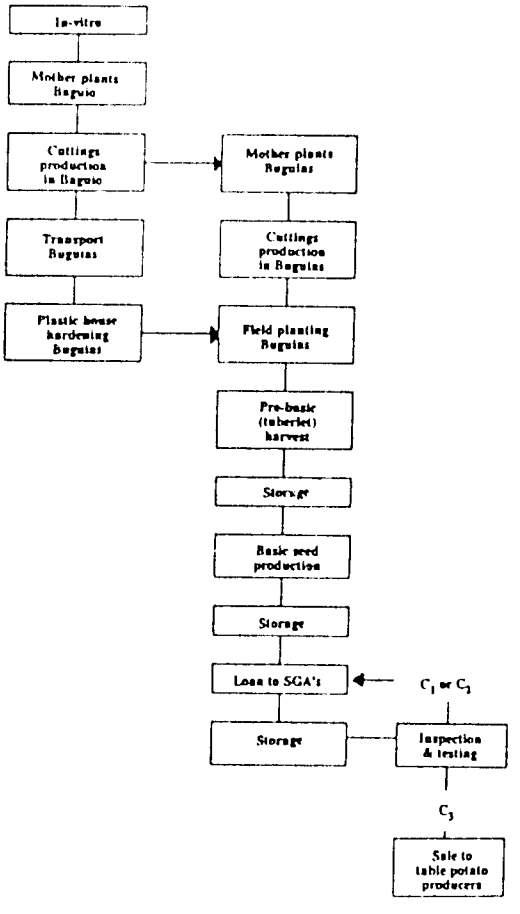
The RMT research program has primarily consisted of verification-type activities to assess local performance of varieties in numerous conditions. Projects to determine optimal planting medium, the number of shoots produced from mother plants, spacing, survival rates, and other agronomic practices have all contributed to increased levels of technical knowledge and competence of RMT in the program (BPI Annual Reports, various years).

RMT section production activities consist of two basic parts: production for the seed farm in Buguias and filling requests for material from agencies such as the NPRCRTC or IPB. Varieties are maintained in-vitro, in the greenhouse and in the field, with the majority of the holdings being in-vitro. In-vitro derived mother plants are currently the source of materials for all types of RMT production.

RMT production for the seed farm follows a multi-step procedure (Figure 6). First mother plants are developed from foundation material and cuttings are produced in the Baguio greenhouse. Being at a lower, warmer altitude, the cuttings of certain varieties perform better in Baguio than in the cooler Buguias plastic houses. In-vitro multiplication of nodal cuttings, top shoot cuttings and multiple stem cuttings are three techniques used to maximize production. Average survival rates of the cuttings during the

rooting process is 92-96%. Survival rate for transplanted shoots is 85% in pots, 80% in greenhouse beds and 70% in the field (Torio, 1985). Cuttings are uprooted and transported to the Buguias farm where they may either be hardened in the plastic houses or planted directly in the field. The hardening process consists of several days in the Buguias greenhouse to diminish transplant shock and increase survival rates. Seedlings are then placed in reuseable pots and transplanted to the field without disturbing the root ball. The field-planted cuttings are harvested and the resulting production of pre-basic seed is turned over by the RMT staff to the seed farm personnel for storage and further multiplication. There are also some mother plants in the seed farm greenhouse.

Figure 6. Schematic diagram of the BPI seed production scheme



Source: Elaborated for this study.
Note: C_1, C_2 and C_3 refer to certification grades.

Currently there are six varieties in RMT production: Granola, Cosima, Monza, Berolina, Montañosa, and Dalisay. A brief history of RMT work shows rapid increase in volume of cuttings using several techniques (Table 14). At the beginning of RMT production work in 1981, Greta and Conchita were produced from tuber-derived mother plants. That work continued in 1982. In 1983, due to clean-up problems with Conchita (see Section 3), production shifted to new varieties including Granola, Cosima, Red Pontiac, and Monza. The first two (Granola and Cosima) proved difficult to multiply during short day conditions.

Table 14. RMT material produced in the Baguio laboratory and greenhouse

Year	In-vitro	In-vivo		Total
		Top shoot	Multiple stem	
1983	17,000	-	9,949	26,949
1984	173,300	34,770	12,270	220,220
1985	82,545	227,052	32,294	341,891
1986	32,151	104,593	26,336	163,060

Source: RMT section records, RP-German Seed Program.

In late 1983 a serious virus infection occurred in the BPI greenhouse and a large quantity of the cuttings, especially Granola, had to be discarded. The RMT lab was also established in 1983, giving the project the capability of handling in-vitro material.

In 1983-84 the mother plants were replaced with in-vitro derived material and the lab and greenhouse became the centers of production while relatively less work was being done in Buguias. In late 1985, a nursery for rapid multiplication was established at the Buguias seed farm for propagation of cuttings to be used on site. The years 1983-84 saw full production and introduction of several new cultivars. However, by late 1985, bacterial wilt was found in the greenhouse, with the incidence peaking in March-April 1986 due to bacterial wilt-infected materials and improper sterilization. This infection caused a major disruption in material flow, as all plant material and media had to be removed from both the Baguio and Buguias houses. In early 1987 the infection was

completely wiped out, and production was no longer affected by it.

These two contamination problems have had disruptive effects on the smooth flow of materials through the seed production program. Given the difficulties in enforcing sanitation regulations in the greenhouse, it appears inevitable that there will be future infection and corresponding disruption in material flows. Major efforts must be made to educate greenhouse staff and visitors about the need for strict sanitary controls on personnel and materials.

The extension work of the RMT section involves assisting the establishment of farm-based nurseries in seed deficit areas. The cost advantages of producing a seed potato crop using stem cuttings are considerable, and result in the ability of the farmer to accept much lower prices for his production and still earn a profit. (see Appendix Table A6 for details of a cost schedule which compares the cost of production using rooted cuttings or seed tubers). Currently there are nine farmer cooperators, mostly women, who receive in-vitro derived mother plants and training and technical backstopping from Baguio. A nursery typically consists of a screenhouse with plant beds where the farmer maintains mother plants, makes the cuttings and establishes the rooted cutting. Farmers are taught sanitary techniques, how to use a rooting hormone dip, and how to take stem and top shoot cuttings. There have been problems in maintaining consistent performance from mother plants and in management of the cuttings both in the greenhouse and in the field. The intent of the scheme is to develop an alternative plant material flow to these areas as the farm-based nurseries expand beyond provision of the farmer's own seed needs to provision of material to paying customers. The first activities of this kind started in 1984 in Atok where many farms are infected with cyst-nematodes. Nematode-resistant varieties like Monza and Granola are used. Starting in 1987, an experienced local nursery operator has cooperated jointly with BPI-CIP in RMT activities. She has been selling rooted cuttings to her neighbors for five years. The target of the scheme is to obtain the cooperation of 15 nurseries.

The BPI-SAPPRAD Program

A second RMT-based seed scheme is the BPI-SAPPRAD project. This scheme has many similarities to the BPI extension scheme but has different objectives. The program started in 1985 with a special assignment MAF municipal agricultural officer providing field supervision. Its objectives are to supply basic tubers for the lowland farmers. Planting materials are distributed from the SAPPRAD greenhouse on the Baguio station to cooperators both for direct planting and for mother plant development. Seven cooperators with a single nursery have increased to 16 cooperators with three nurseries. The goal is 50 cooperators and 10 nurseries. To date, the largest plot planted with cuttings was 300 m^2, using 4-5,000 cuttings and producing approximately eight tubers per cutting-enough pre-basic seed to plant half a hectare. The SAPPRAD Baguio greenhouse will serve as a supply of mother plants.

The NPRCRTC Program

The oldest RMT scheme is at the NPRCRTC. There, RMT work began in 1979, but ceased with the division of labor between the NPRCRTC and BPI for table potato and seed potato research respectively. Work was reinitiated in 1983 with RMT trials and studies on the cost of producing cuttings and the profitability of production using cuttings (Gayao et al. 1986a). Encouraged by research results, an agri-business type project was initiated. With a capital fund endowment, business people established a fairly large-scale cuttings production farm which sold cuttings to all interested farmers (NPRCRTC, 1986). This project coincides with the introduction of Montañosa and Dalisay, and was designed to speed their dissemination. In the interim period of the corporate start-up, the NPRCRTC is producing cuttings. The cost of rooted stem cuttings is calculated at ₱0.08 each, which, when applied to the material needed per hectare, reduces planting material costs 75% as compared to the cost of tubers.

The Halsema Inc. Program

Halsema Inc. has established RMT facilities on a farm near Baguio. The motivation for establishing the greenhouse arises from the restrictions on acceptable varieties placed on Halsema by McDonalds and the economics of producing seedlings versus importing seed tubers. McDonalds requires a white-fleshed potato for its french fries. A consultant paid by McDonalds conducted screening trials in the Philippines and selected the North American variety Lemhi as suitable. Lemhi is adapted to Philippine conditions but is susceptible to late blight. Obtaining special permission to import a limited amount of seed during the period of import restrictions, Halsema initiated production of Lemhi in 1984. Halsema is thus the only source of Lemhi seed The greenhouse is managed by a former BPI employee from the RMT section who has established a rapid multiplication scheme, using field-planted rooted stem cuttings for tuberlet production. Because the farm is located on the hotter slopes below Baguio, temperature and disease problems restrict production to the cooler seasons of the year. Halsema is actively searching for a more suitable seed farm location at a higher elevation.

The BIBAK Program

The BIBAK Growers Association, a cooperative, is made up of a group of migrants from the mountain provinces of northern Luzon whose members farm small plots of newly opened areas on the slopes of Mt. Kitanglad in Mindanao. In cooperation with CIP and BPI in Mindanao, the group invested in two screenhouses and had a co-op member trained in rapid multiplication techniques. With technical backstopping from CIP-BPI, the co-op has tried using rooted stem cuttings and true potato seed (TPS) seedlings. Neither type of planting material was successful --the stem cuttings were difficult to manage due to water and labor constraints, and the TPS seedlings were not stable second generation producers (Fernandez et al., 1986). The group is now switching its greenhouse over to tuberlet production from stem cuttings produced from in-vitro derived mother plants. Bacterial wilt infection is the most serious constraint to production in Bukidnon and the objective is to get clean fields and clean material in order to avoid the costly process of continually opening new areas.

It is apparent that there is widespread production-level activity using RMT in the Philippines. Though the official mandate is research, the RMT facility at IPB can also perform production-level work to supply in-vitro material to various non-Luzon production schemes (Zamora, 1985). In addition to the centrally managed schemes, the three extension-type activities of farmer-based RMT work provide an excellent opportunity to ascertain the adaptability of RMT to local farm conditions. This process deserves close monitoring for the rapid identification of physical or socioeconomic constraints. The diffusion of RMT to farmer level production represents a significant departure from the earlier model of centralized government-managed production of pre-basic seed, and extends more technology options to farmers.

On-farm evaluation trials of RMT in Benguet showed that farmers had difficulty in establishing and maintaining nurseries. Time and labor constraints were cited as major limiting factors (Caringal and Vander Zaag, 1986). In northern Luzon increased labor hours in a nursery for seedling production coincided with land preparation activities, and created a significant labor constraint. Given the option, many farmers would rather buy the material than produce it. It is also apparent that considerable training is necessary to learn RMT production. Extensive technical education and extension contact is, therefore, necessary.

True Potato Seed

The use of TPS as a source of farm-level planting material is being actively explored in the Visayas and Mindanao, two areas cut off from easily accessible seed sources in Luzon. In Negros the level of use is strictly experimental and consists of growing TPS into potted seedlings for direct transplanting to the field. CIP-BPI farm trials have shown promising results, but with familiar complaints from farmers about labor shortages in the extra nursery activities (Susana and Vander Zaag, 1986).

In Mindanao TPS research and applications are further advanced (Fernandez et al., 1986). The BIBAK cooperative has committed capital to establishing a screenhouse nursery and has a trained technician. Unfortunately, the varieties adapted to the area have not proved to be stable parents of seed. After experiencing unsatisfactory field results from second generation tubers, the co-op is considering a switch to tuberlet production from stem cuttings.

Basic Seed Production

By definition, the rapid multiplication schemes discussed above have a basic seed production step. Basic seed is produced from the tubers (pre-basic seed) produced by the rooted cuttings. There are two distinct models. Except in the BPI scheme, all the pre-basic material is distributed directly to farmers for either direct control by the farmers or for contract farming under varying degrees of supervision. The BIBAK cooperative distributes material directly to its members and leaves the disposal of that material up to the individual members. The farmer-based nursery schemes of BPI, SAPPRAD, and the NPRCRTC follow similar patterns. These schemes rely on farmer-to-farmer movement of seed to achieve widespread distribution. Halsema Inc. uses a system of contract farmers to multiply the pre-basic seed and supervises the management of the crop relatively closely. Halsema controls all the production of these contract growers. In the BPI scheme, basic seed production is centralized at the Buguias seed farm and is under the control of BPI technicians.

Basic Seed Production in the Buguias Seed Farm

The Buguias seed farm occupies a central link in the sequence of seed production. The only substitute for its activities is importation. It receives output from the greenhouses and bulks it up to the volume of basic seed sufficient for delivery to the network in charge of producing certified seed. The role of the seedfarm in this process is illustrated in Figure 6.

The importance of the rapid development of the seed farm has been stressed in most planning and evaluation documents (BPI, 1977; Zeddies and Weiler, 1979; MAF, 1977; Warmbier and Weiler, 1982). The development and performance of the seed farm has been a continual source of concern. In a 1979 evaluation report, the status of the seed farm was described as "... the most delayed activity" of the project (Zeddies and Weiler, 1979).

The seedfarm was located in Calagan, Buguias, Benguet, in order to have a sufficient altitude (2,000 m) and isolation for health conditions for basic seed production, and, in addition, proximity to the centers of production. Isolation was soon lost as casual observation might have predicted. The Philippines has a long history of pioneers moving into newly accessible areas (Potts, 1983), and an equally long history of a lack of will or ability to evict squatters from restricted or protected areas. Next to the perimeter of the seed farm, squatters have cleared fields thus losing-isolation. A trip to the farm entails a five to six hours drive from Baguio, where most of the technical staff at the farm have homes and families. During the rainy season the road is frequently closed due to land slides. The remote location of the farm places it beyond electrical services. A generator supplies electricity for several hours each evening.

Higher altitude means that water must be lifted a long distance to assure supply. In 1987, several years after an unsuccessful attempt to drill for water, a functioning well which supplies potable water for the staff was established at the seed farm. Because of the difficult location no technical or field staff live permanently at the farm. Instead they choose to travel at regular intervals between Baguio and the farm.

The road into the seedfarm was opened in 1981, and construction of the facilities and clearing of the fields began that same year. Stem cuttings from Conchita produced in Baguio were planted in that first season. In 1982 more Conchita cuttings were planted, along with 1.2 ha of Greta and Conchita tubers. Production of the 1982 plantings was only 14 tons because of drought. Presumably, the tubers produced from the cuttings retained a basic seed rating, and were planted the next season or else loaned to farmer cooperators. However no records were

found indicating the disposition of the production.

In 1983 there was more construction. An irrigation system was installed, a boundary fence completed and several buildings (including storage) were constructed. Installation of a water system was begun. There is no record of 1983 wet season production. In the 1983 dry season (October-December) a total of 2.45 ha was planted with Conchita which was being bulked up. Partial harvest figures showed a yield of 11.4 t/ha.

In 1984 there was considerable political instability in the region. Production reports mention an area of 1,500 m^2 planted to cuttings. There is no record of tuber production in 1984.

In 1985 recorded production activities expanded considerably. Five varieties of pre-basic seed -- Granola, Cosima, Sangema, Monza, and Red Pontiac -- were produced from rooted cuttings and tuber planting: a total of .6 ha was devoted to that production. Certified seed production was also in progress with 1.3 ha of Granola planted. Two serious typhoons produced adverse effects on production in the wet season. In the dry season, 1.75 ha of Granola seedlings were planted. Nearly one hectare of pre-basic seed was planted with cuttings and tubers. More complete seed farm records were kept starting in the 1985 cropping season (Table 15).

Table 15. Seed production and inventory report of seed potato, Buguias seed farm.

Year and variety	Area planted (ha)	Quantity planted (kg)	Prod[1] (kg)	Loaned out (kg)	Sold (kg)	RIV[2] (kg)	Condemned (kg)	Planted (kg)
1985								
Red Pontiac	0.4	1,000	3,000		2,075			925
Granola	1.6	4,121	7,800		875	855		5,905
Sub-total	2.0	5,121	10,800		2,850	855		6,830
1986								
Red Pontiac	0.4	925	1,580		929	180	471	0
Granola	2.3	5,905	14,111	1,500	2,531	760		3,475
Berolina	0.25	650	2,800	-	-	500		2,110
Sub-total	2.95	7,480	18,491	1,500	3,560	1,440	471	5,585
Grand total	4.95	12,601	29,291	1,500	6,510	2,295	471	12,415

Source: Seed Farm Records
Notes: 1. Removes 10% for shrinkage. 2. Requisitioned for research and demo purposes.

Production at the seed farm is possible on a year round basis except during July-September. The main production season starts with plantings from February to March, with harvest in June and July. As these are wet months, late blight is a problem, due to high humidity and fewer bright sunshine hours. During harvest, frequent heavy rains delay the work. Curing is possible in the racks in the diffused light store house. For stem cuttings, the heavy rains pose a threat of wash-out. Wet season production may be replanted or loaned during the dry season. Depending on the varieties and dormancy period the tubers may be stored until the following February.

In the second season (October-November) the principal concern is damage from frost during the night. October planting is not affected by frosts. The driest months are January and February during which insufficient irrigation water may be a problem.

For several reasons, production at the seed farm has seldom reached expectations. There have been several disasters in the form of typhoons, droughts, frost and other meteorological problems. Management problems result from the remoteness and hardship associated with staying at the farm. There are numerous reasons for staff to delay a departure from Baguio and to hasten a departure from Buguias. A result is that crops in the field sometimes do not get needed attention at the proper time.

Communication among station and seed farm staff is a source of concern. An example is the conflicting opinion as to when the RMT staff relinquishes responsibility of the cuttings production and when the farm production staff takes over. The resulting confusion has caused loss of some pre-basic seed.

Finally, there are problems of coordination. With divided policy guidelines and changing staff positions, systematic record keeping has been virtually non-existent. Lack of record keeping allows individuals to avoid responsibility, especially when it is not clear who should be responsible. Lack of records also has implications for planning. When there is no history of past performance or activities then planning relies on memory or impressionistic judgement.

In the complicated work of planting, treatment, harvest, storage, and reuse of different varieties of potatoes on numerous, scattered fields in order to produce a timely supply of the final product, planning and monitoring become activities of paramount importance. These activities appear to be done on an *ad hoc* basis at the seed

farm. The result is production either too late to use, or production which because it is too early results in physiologically old tubers. Skipping applications of water or chemicals, or under applying them also result from poor planning.

In summary, the seed farm has suffered from a long series of mishaps and delays. Construction of facilities was difficult and slow. Staff were attempting new techniques in an uncomfortable environment. Added to that were the complications of natural disasters and political disturbances.

The remedies are obvious and many are already being implemented. The improved Baguio-Bontoc road will reduce remoteness by shortening the drive by two to three hours. The provision of potable water has removed some of the hardships of staying at the farm. Management changes at the termination of official GTZ involvement have reportedly led to changes in management at the seed farm. The new manager is reported to have clearly delineated goals, purposes, outputs and activities expected of staff, and has established a new system of activities, monitoring, and evaluation.

5. Building Seed Supplies

Once BPI has produced the basic seed there are several possibilities for its use. One method of handling distribution is to sell or turn over small quantities of seed to large numbers of farmers and then rely on farmer-to-farmer movement of seed to achieve widespread use. This low cost method of distribution relies on farmers' existing seed distribution flows and their ability to understand the benefits of using the basic seed. For this approach to be effective, detailed knowledge of informal seed flows for the location of the best distribution points in the system is needed. This system relies on unsupervised and thus, in the formal sense, uncertified production of improved seed.

A second possibility for distribution is to produce certified seed on government farms. This alternative is impractical for BPI because it has no large areas of land available for such production, nor the budget to do so.

A third, intermediate option is to supply the basic seed to those selected seed growers or seed enterprises which multiply and market under some supervision and are covered by certification procedures. This final model of multiplying basic material into certified seed potatoes is based on "... a process which developed over decades in central Europe and... led to good results (t)here." (BPI, 1977). With the preferences of the RP-German program for a system model so clearly stated, the facilities and procedures for producing certified seed have become a central part of program development.

Certified Seed Production in BPI

The certified seed production process involves two distinct parts --the actual multiplication of the basic seed, and the quality control measures designed to guarantee the output. The RP-German project established certification procedures and facilities available for use by anyone. Up until the present, there has been only limited non-BPI use of the soil and crop testing facilities. Other programs are not using the certification process but are producing *de facto* certified seed as a means of protecting their investments in seed production. There is significant variation in the multiplication schemes of the various seed programs. This section will examine the system of organizing the farmer multipliers and the quality control measures employed by the BPI system. Other organized programs will be discussed in the next section.

Seed Grower Associations

The BPI model for certified seed production uses seed producer groups to handle the multiplication and marketing of seed. Implementation of this model has passed through various stages as the program has developed. In the first phase, contract growers were used as SGA's were formed. The second phase consisted of development of the SGA's through a system of seed loans. The final phase is the complete control of certified seed production by SGA's while BPI specializes in basic seed production and testing (Schultz et al., 1977).

To facilitate this plan farmer groups need to be formed or, as stated in one planning document, farmer groups must be "convinced" to form cooperatives (Schultz et al., 1977). The idea of "convincing" farmers to form cooperatives highlights one of the basic difficulties of rural development projects, and betrays an orientation to design and implement projects called "top-down" or "paternalistic." This top-down approach attempts to do social engineering by creating rural organizations based on recommendations of a planning group which has developed a project with a timetable for implementation. Typical timetables include steps that are dependent on the successful completion of activities by the rural organizations (Moris, cited in Blase, 1986).

In this approach it is expected that the relatively passive recipients of assistance will be transformed, over time, into active and responsible citizens and hence will develop a favorable view of the changes intended by a project. A model opposite to "paternalism" is "populism." In this model the assumption is that rural people can change their lives autonomously. This neglects the presence of entrenched local interests that can dominate rural organizations at the community level (Uphoff and Esman cited in Blase, 1986). The difficulty is to find a balance between centralized versus local decision making. Uphoff and Esman conclude that leadership is considered the most critical variable for establishing and maintaining local organizations. Good leaders help protect the organization from political conflict, especially in the distribution of assets and income.

BPI created rural organizations with the intention that they would assume major responsibility in the smooth functioning of a seed certification system which relies on public perception of the benefits of the system and voluntary compliance with its regulations. For that to happen the SGA's need to pass what literature on rural development refers to as "tests of institutionality." These tests involve a process that occurs over time. One of the tests is the ability of the organization to survive and grow. Another test of institutionality is whether the organization is viewed by the people around it as having an intrinsic value. Intrinsic value is judged by several criteria, among which are autonomy and influence. Autonomy refers to the ability of the SGA to control its destiny and thus establish its own rules and procedures. Influence relates to the ability of the SGA to acquire and use resources and protect itself from encroachment. Another test is whether the organization receives support from other organizations. A final test of institutionalization is whether its innovative norms are accepted by others around it, another indication of how others value the organization. Organizations which possess or induce these characteristics are said to be institutionalized into the environment (Blase, 1986). The ability of the SGA's to qualify for this status is doubtful, as will be seen in the next section.

Description and History

An initial step in certified seed production was the organization of seed production areas. The original temporary scheme was to create a north-to-south, high-to-low seed flow by supplying registered seed to farmers in Buguias who in turn supplied Certified 1 seed to growers in Atok who also in turn supplied Certified 2 or 3 to growers in La Trinidad. This was to be done on contract basis with selected farmers. All participants would be bound by a Seed Certification Act (MAF, 1977). The next step was to organize these farmers into seed grower associations. The seed grower associations were to be the rural organizations that applied the European certification model as BPI gradually removed itself from the multiplication of certified seed.

Organizing farmers into SGA's is not specifically discussed in initial planning documents (BPI, 1977), but seed marketing cooperatives are mentioned. In later documents (BPI, 1979) seed grower associations are expressly called for. Within a few years SGA's were formed and registered with the proper government agencies. Several cooperative members selected by BPI staff received training in cooperative management both in the Philippines and abroad. Original documents called for a full time marketing specialist to provide technical and economic advice to the SGA's (BPI, 1979). The position was never filled.

Four SGA's have been organized. Attempts to stimulate farmers' interest in organizing were based on the use of seed multiplication contracts coupled with technical advice and free seed loans. The formula worked and cooperatives were rapidly formed and officially recognized with minimal delay.

The SGA's are legal entities, recognized by the Philippine government as cooperatives and thus entitled to receive assistance from the Bureau of Cooperatives in the Department of Agriculture. As members of a registered cooperative, the farmers can officially participate in government programs. The SGA's have an executive council (the board of governors) and elected officers: a president, vice-president and secretary treasurer all of whom serve voluntarily. One SGA has a salaried manager. The SGA's hold regular meetings discuss member's

problems and programs of technical interest. As exclusively recognized recipient groups of BPI, the stated objectives of the cooperative are to provide services to its members by allocating free seed loans, and to disseminate technical advice to improve the profitability of seed production for its members. Two of the SGA's own their own seed storages and one has an input supply store. These facilities provide services to members and generate capital for the SGA. BPI staff act as extension contacts and advisors to the SGA's. These same BPI seed production unit personnel are the principal loan processors although BPI-Baguio management must act on all loan applications.

In order of south to north, the four SGA's are Atok in Atok Municipality, Natubleng and Abatan in Buguias Municipality (all in Benguet Province), and Mt. Data in Bauko Municipality, Mountain Province. Mt. Data SGA members have farms on the slopes and crest of Mt. Data, one of the highest and most favorable seed production areas in the region.

The history of the SGA's is generally one of ineffectiveness and mismanagement. The Atok SGA is dormant due to the declassification of the zone as a seed production area because of nematode infestation (Mentz and Balaoing, 1985). The Natubleng SGA has experienced shrinking membership due to alleged abuse of privilege by its officers. The Abatan SGA was recently reactivated after six years of inactivity due to a disinterested president who was not replaced. The Mt. Data SGA is the largest and most successful of the SGA's. This is the only SGA which has a small core of influential members who appear to think and act cooperatively.

In an effort to strengthen the marketing activities of the SGA's the RP-German program has promoted the construction of self-help seed stores. Two of the SGA's, Natubleng (in 1983) and Mt. Data (in 1984) constructed 30 tons diffused light stores. The SGA supplied the land and labor, GTZ the capital and BPI a grant of 15 tons of basic seed.

However, the cooperatives have received few benefits from the stores. In the Mt. Data SGA the store is essentially a private entity used by a select group of members who live nearby and use the facility without payment. There is little store management and storage losses reportedly are high. The Natubleng store is also dominated by a few members who live nearby, but there are payments to the SGA for the use of the store.

The BPI seed grant was given on the condition that cooperatives administer and manage the grant so that members receiving a loan of SGA-controlled seed be required to repay the interest-bearing loan in kind, thus contributing to a growth of seed stocks in the store. BPI made an initial grant of five tons to be followed by more at a later date. Neither of the receiving SGA's have been able to increase the size of the initial loan. Members of the SGA's receiving loans treat them as interest free; thus the size of the initial grant has not grown. BPI has withheld the remaining portion of the grant pending better performance. This action has created tensions between the SGA's and BPI.

Currently the cohesiveness of all SGA's is from other seed schemes. Other being threatened by schemes recruit members on an individual basis involving them in non-SGA activities and reducing their reliance on and interest in the SGA's. In Atok, where the seed program has been suspended due to nematode infestation, the NPRCRTC stem-cutting program, without working through the SGA, offers planting material to cooperators. BPI supports the activities of several individuals who have farm-based RMT nurseries and SGA members are attracted since they can no longer receive seed loans. In the other three SGA's there are problems because private schemes and SAPPRAD offer seed or table potato contracts to individuals recruited from the SGA's. With outside contracting the individualistic nature of relationships is reinforced. There is a suspicion that production from BPI seed loans is sometimes diverted to these private groups which fail to repay BPI or use the material as seed.

In the rural development literature it has been noted that the institutions needed to implement a technology often lag behind the development of the technology itself (Blase, 1986). This lag in development acts as a brake on the benefits of the technology. This appears to be the case in the RP-German program. The importance of the SGA's was clearly recognized, but the methods to induce their initiation, growth, and stability were inappropriate. Outside pressures such as those from competing

seed schemes have also hindered the institutional development of the SGA's.

An initial inhibiting factor to the development of the cooperatives was the top-down mandate to express a need they had not yet felt. In effect, the SGA's were told they needed to organize instead of being allowed to recognize the need for organization themselves. This is a basic conflict in a project with a timetable plan having the objective of sustainable impact. On one side, the wish is that the project be sustainable and for participants to recognize the benefits, but on the other side, the timetable restricts the ability to wait. The method of stimulating formation of cooperatives with the lure of interest-free seed loans places individual members in competition with each other for scarce contracts and loans. Although there was rhetoric about the equitable distribution of benefits among cooperative members, in practice only a small core --usually the officers-- were able to monopolize seed loans or contracts.

Administration of loans entailed an initial contact between individual members of the cooperative and BPI. BPI officials would then decide who was to receive the loans. Recognizing the disruptive effect this policy had on the strength of the SGA's, BPI changed their loan policy in 1985. To strengthen the role of the SGA, all loan applications must now be made through SGA officials instead of through BPI officials. SGA officials then decide who will receive loans.

In summary, the SGA's can be characterized as a collection of individuals unified by their desire to receive a free seed loan. There is little perception of other possible benefits. Farmers with surplus seed sell to anyone with no special preference given to fellow SGA members.

Farmer Participant Profile

While discussing the SGA's as a group it is useful to briefly examine the types of farmers who participate in the SGA's. Potato farmers in the region generally produce on fairly small fields and may be involved in numerous other enterprises. Some of the growers are relatively wealthy, owning small dry goods stores, vehicles and livestock in addition to their cropping operations. Others may depend entirely on their farming operations. Social interactions being what they are, the wealthier farmers are usually more dominant in local social settings and consequently are selected for leadership positions in the SGA's.

In a survey completed in 1981 Waibel provides some interesting insights into the motivations and intentions of SGA members.

As a member of an SGA, the farmer is eligible for a free seed loan from the program. In light of that fact, 91% of the farmers responded that renewing their own seed stock was the principal reason for cooperating with the program. Only 9% considered the sale of seed as the principal reason for cooperation.

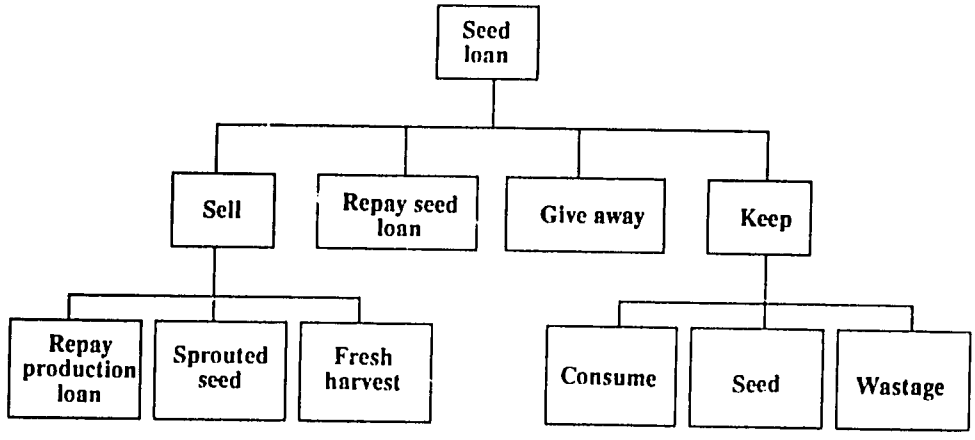
When asked what advantages they perceived in growing seed potatoes, consistent with the response to the earlier question only 23% of farmers listed seed sales. Higher yield and possession of their own seed accounted for 73% of the sample responses. The Waibel survey took place just as the SGA's were being organized. The responses indicate farmer motivations for participation (obtaining a loan to renew their personal seed stock) are counter to project objectives of establishing cooperatives specializing in seed production.

A Model of Seed Crop Disposal

A typical farmer faces numerous choices in the disposal of his potato crop. The choices a farmer who has received a seed loan faces in disposing of his crop are illustrated in Figure 7.

Recent estimates of production costs for a hectare of seed potatoes show purchased inputs as ₱51,941 (see Appendix Table A6). The typical farmer needs to borrow money to finance this high-cost production. The most common arrangement is to secure a loan with a farm inputs dealer or vegetable trader for fertilizer and pesticide purchases. At harvest the loan is payable in kind with the financier marketing the potatoes, returning to the producer any remaining earnings. Approximately 75% of potatoes entering the market are via agents or financier-wholesalers. Often long standing personal relationships exist between the farmer and the financier-wholesalers. Interest rates are typically high -- ranging up to 60% (Waibel, 1981).

Figure 7. A model of potato crop disposal for a BPI seed potato farmer



Farmers are faced with choices which are recorded in the boxes of Figure 7. At least 50% of production is usually required to repay the kind of production loan described above. Among the currently produced varieties, the large and extra large grades make up approximately 40% of production, requiring 10% of the seed size potatoes for the financiers. Thus half the crop production is destined for a single box. Assuming a multiplication rate of 10:1, 10% of production is needed to repay the seed loan and another 10% would be needed for the farmer to maintain his seed stocks, leaving 30% of production for optional disposal decisions. However most farmers receive loans of a ton or less and want to save more than just replacement seed, and thus they double or triple the amount saved.

Poats et al. (1981) report that potato farmers do consume some of their production, though the consumption is highly seasonal around harvest time and often consists of small or damaged tubers that would get a minimal market price. Results from the Francisco (1987) survey show that home consumption by potato growers is two to three percent of total production. Farmers rarely store for consumption.

There is obviously a broadly interpreted scale of what is wastage. The general estimate is four to five percent of production is unusable. Some of that may be consumed or fed to animals while other portions may rot or are missed at harvest.

Up to this point, the farmer has not yet sold any of his crop for cash. Supposing that the farmer has a large family and thus immediate cash requirements, he needs to sell a relatively large percentage of the 50% of his remaining crop after his private loan is repaid. The evidence suggests that this is the most common scenario: the information in Table 3 shows 84% of the total crop is sold.

Storing their product to sell as sprouted seed is an investment option that many farmers are aware of, but few can or are willing to do so. In the language of economics, the harvested crop is only an intermediate good to which the farmer adds value by temporal and physical means. Farmers can transform the tuber into a sprouted seed tuber by proper storage, and handling and by holding the tubers until planting season. Farmers clearly recognize the higher prices they would be paid for sprouted seed during planting season, but for most farmers cash flow restrictions preclude such an investment.

Waibel (1981) also asked farmers if they consider marketing seed potatoes a problem. Since there was an expectation of marketing

assistance from BPI, most farmers did not consider that marketing would be a problem. However, as noted above, marketing assistance has proved to be one of the weakest components of the PPP. Among farmers who felt that marketing might be a problem, most cited lack of cash, irregular purchases of seed by table potato farmers, and the practice of using unmarketable tubers for seed as problematic.

Because there is insufficient seed it is not possible to allocate the quantities needed to satisfy the requirements indicated in each of the boxes in the diagram; the question is, therefore, what gets priority? Given the above scenario, repayment to the private financier and sales for cash receive top priority. It depends on the relative pressures from the two claimants, which one is favored over the other. What next? Moral obligation to fulfill contracts with the government is clearly variable depending on the individual and the consequences of not fulfilling the obligation. Maintaining the possibility of producing aga next season is also important but the pressures of restricted cash flow may make the money worth more today than having or selling seed tomorrow.

Certification Testing

The BPI system of certifying potatoes involves field inspection and laboratory testing. The certification field requirements and field and laboratory standards are given in Appendix Table A7. The requirements reflect an adaptation to local conditions for altitude and planting distance and modified standards of disease tolerance adjusted from European and North American norms. A farmer requiring certification of his crop needs three field visits during the growing season plus a visit at harvest by a BPI inspector. After successful completion of field testing, approximately 200 tubers per field are taken for laboratory testing. Results are usually returned in 4 to 6 weeks in the form of an official BPI letter to the farmer.

These procedures are a significant departure from the originally proposed scheme. In the original scheme, field-passed seed was to be delivered to stores and storekeepers were to notify seed inspectors when the seed would be ready to sell. Inspectors could then assess packing crates and seed. In addition, results of lab tests were to be issued and the certificates seals and labels for seed grade were to be delivered and affixed at this time (Schultz et al., 1977). Because of production and organizational problems this plan was never put into action. The seed certification scheme began with eight project-trained field inspectors. Field inspection in local conditions is difficult. In 1986, single inspection trips to field check 6.8 ha of seed multiplication crops took three people an average of one week per trip covering four to five fields a day.

Field inspection is problematic because it is labor intensive and because it is difficult to keep trained inspectors on the job. The RP-German program experienced problems with the Department of Agriculture when it without consultation pulled the field inspection staff out of those jobs in 1983. Since that time no replacements have been hired. Instead these positions have been filled by BPI research staff. But while reaching the short run certification goals of 30 ha would pose no problems for the laboratory it would require extensive staff readjustment to adequately carry out the field inspections.

In the BPI laboratory, conditions for testing are more amenable. The laboratory is furnished with modern equipment and appears to be efficiently run. It has employed a variety of virus testing methods including latex, micro precipitation and Elisa. Today all virus testing is done with Elisa, which was first used in 1981. The laboratory can also test for nematodes.

The staff of the virus laboratory perform various tasks. The majority of their time is spent in research and only 40% of their time is spent in routine testing work. Testing is done for research support in the station, and as part of pre-basic seed production. Certification is provided free to other institutions and involves a fee for provision of services to other entities that want material tested. The laboratory does virus testing on other material in addition to the potato. Testing is done on mother plants at regular intervals as greenhouse checks on pre-basic seed production. With a positive check plants are immediately discarded. Table 16 shows the recent trend in virus testing. The levels of work declined reflecting the diminished volume of seed loans.

Based on the ability of farmers to produce certifiable seed, certification standards appear to be appropriate for local needs. By adjusting the European/North American norms downward the BPI has exhibited pragmatism in what it expects from the certification process. Local requirements for seed material are such that excessively strict standards would be unrealistic.

Table 16. Post-harvest certification by BPI virus laboratory, 1981-86

Year[1]	No. of farmer cooperator	No. of plant sample submitted	(ha)[2]	Percent of test results by class of seed C_1	C_2	C_3	Rejected[3]
1981	64	64	32.35	77	16	4	4
1982	43	43	20.21	39	31	17	13
1983	77	42	25.87	2	17	69	12
1984	25	25	20.76	32	24	44	
1985	16	16	6.49	79	25		
1986	19	17	6.86	82	18		

Source: Virus laboratory records.
Notes:1. All testing done in March-July crop season. 2. All area planted is field inspected. 3. Rejection due to high virus incidence.

Official Versus Unofficial Seed Certification

A fundamental question is the value farmers place on certified seed. A basic assumption of the certification program is that the "... farmers association will have to buy the crop right out of the field and store it until the quality has been tested." (BPI 1977). As discussed above this reflected an assumption that marketing assistance would be forthcoming from another agency in the PPP, and also a basic ignorance of farmer crop disposal practices. With prices guaranteed by BPI, farmers receive a higher price from the program depending on the grade their crop receives. In 1987 the price was ₱6.50, ₱5.00 and ₱4.50 per kilo for C_1, C_2 and C_3 respectively. The certification test usually takes three to four weeks to complete. The complicating factor is that usually the farmer sells the seed without waiting for the grade, indicating that he does not consider that the customer finds official BPI certification an important factor in the decision which seed to buy. To qualify for a seed loan the farmer has to agree to certification. The charges for certification are ₱100 for field inspections up to 1 ha and ₱500 per seed lot for laboratory testing. The farmer considers this additional cost a worthwhile investment when compared with the higher yields expected from the program seed.

The usual informal "farmer certification" schemes consists of the farmer interested in buying seed visiting the field in order to see the vegetative health of the crop and visiting again at harvest to get an idea about yield. That process, when combined with previous experience in the area or with the seed grower, is usually sufficient evidence for "farmer certification." Farmers who are too far away to go for personal inspection use the established reputation of the grower as the net best criteria. If farmers are known to be producing with BPI seed, that information is sufficient for most seed-buying customers who do not require the extra qualification of an official "C" grade.

Suggestions by PPP staff on the future direction of the certification testing scheme range from one extreme to the other. One position is to disband any certification testing work except for BPI needs, essentially pulling BPI out of the certified seed production business and concentrating on the production of basic seed. The other extreme is to get an effective seed laws passed. The intent of such a law would not be to make BPI a monopoly seed producer but to require anyone who wants to produce seed to be a registered seed grower and by order of law submit their production for inspection. Given local conditions in the Philippines, practical enforcement of such a seed law would be difficult. Enforcement would be especially difficult in the context of the traditional farmer system of seed distribution where lots as small as 30 kg are sold, loaned or given away.

Analysis of the Volume of BPI Seed Reaching Farmers

The procurements and seed loan repayments noted in Table 7 and the information on production in Table 10 are virtually the only available systematic indicators of seed material injected into the northern Luzon farmer seed system by the RP-German program. Using this information and applying the crop disposal model developed above, further information can be derived about the effectiveness of current policy and methods for multiplying seed of

certifiable quality. The results are enumerated in Table 17. Table 10 shows that seed loans to farmers from 1979 to 1985 have resulted in an average annual total production of 327 tons. The crop disposal model showed that loan repayments and consumption and waste were 55% of production, leaving 147 tons, which is the possible maximum amount of seed left in circulation. Deduct the amounts returning to BPI control and the seed remaining in the hands of farmers emerges. From the perspective of the farmers' crop decision model, there are two lines in Table 17 which provide cash income to the farmer, "BPI procurements" and "remainder sold or recirculated."

The analysis shows that from 1979 to 1985 an average of 112 to 147 tons of seed were circulating as a result of BPI supervised multiplication. The ultimate measures of seed injected into the system are the two categories "farmer saved as seed" and "remainder..." giving a total of 33 to 68 tons of seed in farmer control. At recommended seeding rates this was enough material to plant an average of 16 to 34 ha per year. Given the cash requirements of farmers the estimates could be in the lower end of the ranges.

Like all models this one suffers from the over-simplification necessary to create it and the assumptions necessary to make it function. Criticisms of simplification can be directed at the concept of a "hypothetical" farmer. As noted above, the SGA members most likely to obtain loans are its leaders who are some of the wealthier individuals in the community. Therefore, the average loan recipient may not utilize private loan sources to the extent assumed. Another loss of simplification may be the exclusion of categories from the crop disposal chart. The practice of giving, lending or selling very small quantities of seed to neighbors is omitted. That this is an important practice is shown by the evidence on the rapid diffusion of the variety Granola.

Criticisms of functional assumptions can be directed at the percentage allocation assumptions among the disposal categories and the data used for the calculations. The percentage distribution estimates are based on the research of Waibel (1981), Poats et al. (1981), Francisco (1987), and personal communication from informed observers. The total production from seed loans, as reported in Table 10, are believed by some observers to be under-reported by the farmers as a means of avoiding creditors or taxation, nevertheless they are official BPI records.

Table 17. Estimated BPI seed tubers remaining in the northern Luzon seed system, 1979-85 average annual production in metric tons

Crop disposal category	Percent of production	Production (tons)[1]
Total production	100	327
Less: repay private production loans	50	164
consumption & wastage	5	16
Remaining seed size production		147
Repay BPI loan	16	52
BPI procurements	8	27
Farmer saved as seed	10	33
Remainder (sold to ware or recirculated as seed)	11	35
Total seed in circulation[2]		112-147
Total seed in farmer control		33-68

Notes: 1. Figures are rounded to whole numbers. 2. Range is due to remainder which could be disposed of in non- seed or seed sectors.

The decision of the RP-German program to establish a European-type system of seed certification and multiplication rested on an unstated assumption that Filipino potato farmers could accommodate the drastic restructuring of cash flow necessary to make the transition from being table potato to seed potato growers. Though marketing assistance and provision of credit was mentioned in planning documents, these elements are acknowledged to be the weakest parts of both the PPP and the RP-German seed program.

The failure of the program to appreciate the severity of the constraints faced by farmers has resulted in a seed certification model of limited effectiveness. Representative of that is the current condition of the SGA's.

Failure to understand and analyze pressures on the farmers' crop disposal decisions led the program to assumptions about how the SGA's would develop a "cooperative spirit." Encouragement of farmers by extension staff to circulate seed among themselves and to set aside some portion of their product (thus foregoing potential personal income for a future collective good) indicates a failure to understand farmers'

priorities in crop disposal decisions. Without some external influence or method of relieving the existing pressures to allocate production, it is apparent that the SGA's will continue along their present paths.

There is a growing awareness by the seed program management of the constraints which limit the effectiveness of the SGA's. Policies to limit the size of the cooperative and to make SGA leadership responsible for administering loans are steps which demonstrate management concern for the successful integration of the SGA's into the certification process.

6. Other Organized Potato Production Schemes

In addition to the BPI seed production program there are six other organized seed and/or table potato production schemes in the Philippines. These are F. Silayan Agri-Products, Halsema Incorporated, Universal Robina Corporation, the NPRCRTC, SAPPRAD and the BIBAK Growers Cooperative. Each of these schemes has started since the RP-German program began and while they all have the same objectives -- dependable supplies of quality planting material -- their methods are quite distinct. Major aspects of these schemes are discussed below.

The Silayan Inc. Scheme

Silayan Inc. is a manufacturer of food processing machinery and also has a french-fry processing plant. It is the supplier of ready-made french fries to Jollibee, a major Filipino-based hamburger franchise chain.

Silayan entered the seed business in reaction to the high costs associated with the variability in the processing qualities of purchased table potatoes and the high cost of imported seed material. The objective was to obtain a dependable supply of fewer varieties of potatoes that would be more suitable for processing. The company began organizing contract table potato growers in 1984 and seed growers shortly there after. The area under contract has expanded very rapidly and company officials predict rapid future growth as well.

Silayan operates in close cooperation with the BPI program by contracting key BPI personnel to assist in the organizing and monitoring of contract compliance. The traditional Silayan scheme has been to contract with table potato growers for their extra-large grade potatoes at guaranteed prices. Most contract growers are cooperators in the SGA's. Silayan has not been supplying seed but has provided loans sufficient to cover recommended purchased inputs. The contracts specify input and management requirements. The loans are payable at harvest with extra large (XL) grade potatoes. Farmers sometimes do not have sufficient quantities of XL grade and have to make purchases from their neighbors. The contract farmers agree to planting dates ranging from early February to late April, which results in a steady supply of potatoes from April through December. Contracts for seed growers differ only in that the company agrees to purchase all their production although in some cases, only the XL grades are bought.

The smooth functioning of the Silayan system is based on education, strict enforcement of contract terms, and close supervision by the contracted BPI personnel. Farmers are arranged in producer groups of five to ten with a group leader. The leader has the authority to check contract compliance and he acts as an information dissemination/feedback contact for higher management. All farmers are interviewed before contracts are signed and must show potato growing expertise and the capability of obtaining sufficient good quality seed. Silayan management has arranged educational/motivational trips for its contract farmers. An example was an all cost-paid trip to Manila to tour the french-fry processing plant and a party at the home of one of the executives. The trip served the purpose of educating the farmers on the need for strict enforcement of quality control. It also served to introduce them to the company and established a network of personal contacts, perhaps thereby giving the farmers more reason to honor the terms of their contract.

The Silayan seed scheme is based on periodic importation and multiplication. Seed growers are carefully selected for their favorably located fields and crop management is carefully monitored. By making use of local practice and cumulated technical knowledge, Silayan protects its investment in expensive imported seed by making its own informal certification. Silayan has requested the BPI program to include its seed growers in the BPI certification scheme.

Imports are planned for every three to four years to renew stocks. Yellow fleshed varieties are used, taking advantage of the wide distribution of Monza, a variety screened and introduced by the RP-German seed program. In 1987 Silayan imported three tons each of Baraka and Famosa for seed multiplication. Silayan uses rented stores for its storage needs. Due to the high cost of imported seed, they are considering establishing rapid multiplication facilities.

The Halsema Inc. Scheme

Halsema Inc. is a contract supplier of processing potatoes to McDonalds. As discussed in the section on non-BPI RMT schemes, Halsema has established tuberlet production on its seed farm. The tuberlets are then supplied to contract growers by a loan with reasonable interest, payable in kind in all grades of production. The seed farmers also agree to sell all their produce to Halsema at a guaranteed price. Halsema operates its own seed store near Atok. A similar contractual arrangement holds for the commercial growers. In a very different loan arrangement to that of Silayan, contract farmers get a seed loan but no support for purchasing other inputs. The philosophy of this policy is that by also investing in the crop and thus sharing the risk, the contract growers will manage the crop more closely. After deducting for the seed loan, all production is purchased at guaranteed prices. As in the Silayan scheme planting dates are set in the contract to assure an extended dependable supply. Halsema has made use of the BPI virus testing laboratory and will probably continue to do so in the future.

The Universal Robina Corporation Scheme

Universal Robina Corporation is a Philippine-based multinational food processing company. In the Philippines it uses potatoes for chips and consequently is concerned with a different quality potato than Silayan or Halsema. Robina is pursuing an import-and-multiply scheme similar to that of Silayan's. Also like Silayan, Robina offers a credit line to its contract farmers, but in addition to making the loan available for the purchase of inputs, it also offers seeds. The contract calls for the loan to be payable in kind with an all-grades purchase at the prevailing market price but with a minimum price guarantee. The Robina scheme is in its first year, it has imported several tons of seed tubers and has contracted growers.

The SAPPRAD Scheme

Another scheme in its first year is that of SAPPRAD. The scheme has activities ranging from producing foundation seed all the way to delivery of commercial seed to growers. In order to have a consistent supply of good seed for its lowland potato grower association, SAPPRAD has linked with the Farmers Community Development Foundation (FCDF) to establish a complete seed production and delivery system which is one of the most extensive in the country. FCDF is a non-stock, non-profit foundation which handles the seed scheme activities of the SAPPRAD project. In the initial stage, seed production will rely on multiplication of imports while a RMT nursery system is being developed. The BPI-SAPPRAD RMT system is discussed in the RMT section above.

In the-import-and multiply system, growers are contracted to produce seed. Some SAPPRAD growers are using the imported seed while others are providing their own certified seed. Most seed growers have been recruited individually from the seed grower associations with the assistance of BPI staff. The contracts stipulate that seed (for those using imported seed) and inputs are to be provided on loan by FCDF, valued at cost, and payable in kind at zero percent interest. If there is a short fall in the volume of production FCDF has first option on purchase of large-size tubers.

FCDF is constructing a store to receive the seed tubers. All plots will be field inspected and post-harvest tests will be done by BPI. Seed retaining high certification grades will be recirculated to seed growers. Seed will be stored until November for delivery to lowland farmers. The delivery will be handled by FCDF. There will be an announced price for seed sold by FCDF to lowland farmers. The seed will be

provided in interest free loans payable in cash. The lowland growers are coordinated by local committees which usually have representatives of the local agriculture university, the provincial governors office, the Department of Agriculture and the municipality. Applications for loans are made through the local growers association and the oversight committee.

The BIBAK Scheme

The BIBAK scheme was introduced in the RMT section. The BIBAK scheme is currently the best model available to demonstrate the capability of decentralized seed production in a mid-elevation area. Briefly, the object of the BIBAK growers is to minimize problems of bacterial wilt infestation in fields by providing clean planting material. Selected members with uninfected high elevations fields will multiply the tuberlets produced from the Malaybalay greenhouse.

By cooperating closely with BPI and CIP, BIBAK has experimented with a variety of techniques for producing planting material. The association is determined to continue exploring ways to secure healthy affordable seed. The lessons learned there are valuable for applications in other medium elevation sites in the country.

7. Crop Protection and Storage

Crop protection is one of the prominent objectives of the RP-German program. Over the years the crop protection research program has examined numerous diseases and pests that affect the potato. Research on crop protection has included yield degeneration studies and monitoring of aphid populations. There have been numerous field evaluations of new pesticide releases where BPI independently verifies manufacturers claims. Many of the research results have been incorporated into BPI technology bulletins and recommendations (BPI, 1986; Versola, 1986; Technopak, 1985). All diseases and pests ultimately affect seed potatoes but three pests in the Philippines are of more direct concern to seed production, they are the cyst nematode, the potato tuber moth and aphids. Of these, the work on nematodes has had the farthest reaching consequences.

Nematode Survey

In the identification of nematode infected areas, crop protection research has made an important and timely contribution to the viability and credibility of the seed potato program. A continuing survey started in 1980 has evolved into an important epidemiological check on the control and the spread of the nematode (Khayad and Ferrer, 1987). As can be seen in Table 18 the activity in this area has steadily increased. The survey work has now also been incorporated into all farmer contracts; as noted in the certification requirements in Appendix Table A7, uninfected fields are a prerequisite for qualifying for a seed loan.

One result of this survey work is the removal of Atok as a seed production zone. The survey work identified a significant number of infected fields in the area and in 1985 in a general meeting with all seed grower associations the program announced the decision to remove Atok from the seed certification program (Mentz and Balaoing, 1985). Coupled with the exclusion of Atok as a seed production area was a publicity campaign designed to inform customers of Atok seed growers of the dangers of purchasing seed from the area. Though not one hundred percent effective, farmers in the area do report a decline in outside customers especially from areas further north along the Baguio-Bontoc road. At present the only practical control is prevention. Research on crop rotation as a means of pest control in nematode-infected fields points to economically unacceptable long rotation cycles.

Table 18. Survey of potato cyst nematode in the growing areas of Benguet and Mt. Province, Philippines, 1980-87

Year	Number of Farms	Atok	Natubleng	Abatan	Mountain province	La Trinidad	Total
1980	Surveyed	5	4	2	3	-	14
	Infested	5	3	2	-	-	10
1981	Surveyed	20	15	11	75	-	121
	Infested	2	1	-	-	-	3
1982	Surveyed	25	27	40	18	5	115
	Infested	5	-	-	-	-	5
1983	Surveyed	30	46	80	52	10	218
	Infested	-	-	-	2	1	3
1984	Surveyed	40	46	15	40	-	141
	Infested	2	-	-	3	-	5
1985	Surveyed	46	96	35	15	17	214
	Infested	5	-	-	1	-	5
1986	Surveyed	85	141	25	25	4	282
	Infested	-	-	-	-	-	0
1987	Surveyed	98	143	10	14	-	265
	Infested	8	1	-	-	-	9

Source: Khayad and Ferrar, 1987.

Internal Quarantine

Prompted in part by the documentation of the spread of nematodes, BPI has proposed an administrative act for an internal quarantine system to regulate the domestic flow of seed potatoes. As yet there is not a clear plan for implementing this policy. Given the informal nature of the seed potato market any form of

imposed inspection and regulation is not financially or administratively possible at present. Setting up monitoring posts at critical points in seed flow paths as check points for a clearance certificate, would be ineffective for several reasons. First, physically there are many paths along which seed can flow and second, the description of potatoes of seed size can change at many points along the market chain. Farmers may sell their production as table potatoes while a transporter may deliver them to the market as table potatoes, where the retailer may sell them as table potatoes and the farmer who bought them may use them as seed. The seed or table designation may also change with any one of the other actors as well. Finally, the staff and equipment needed to inspect, test, and certify the seed in a comprehensive manner are beyond the capacity of any agency.

Obtaining voluntary compliance is an alternative method by which the quarantine policy may be effective. A massive educational campaign, coupled with the current survey-type monitoring strategy and testing and certification of nematode-free fields upon the request of farmers who wish to satisfy the concerns of potential customers might be effective. For example a farmer in Atok may in fact have a field uninfected by nematodes and wish to sell seed potatoes. That farmer may have an incentive to request soil testing and to obtain a certificate attesting to the health of the field so that he can promote his seed as clean of nematodes.

A final quarantine strategy is to slow the inter-island movement of seed potatoes by decentralizing seed production. By providing locally produced seed to compete against seed from other areas, the differential in transportation costs should reduce the flow of seed between areas.

Storage

Storage and seed storage are synonymous terms in the Philippines: there is no significant amount of table potato storage. As a component of quality control in seed production, improved storage was highlighted as an essential element in a successful system. Early planning documents identified "storage as the key to the success of the.... program." Estimates of losses of stock during storage ranged up to 40% (BPI 1977). Activities in the area of improved storage have been in two distinct areas, provision of storage capacity for the BPI program and the extension to farmers of improved farm-level storage technology.

Government Storage Facilities

Original plans for the development of storage called for the construction of three 100-ton controlled environment seed store houses in each of the targeted seed producing areas -- Buguias, Atok, and La Trinidad. Initially the store houses were to be government owned and controlled. As marketing cooperatives were founded, control would be handed over to them on a contract basis. Finally, the store houses would stimulate the formation of independent privately owned post-harvest storage and handling facilities. In all three phases there would be direct links to government assisted marketing (Schultz et al., 1977).

In 1978 a German post-harvest expert was invited to further analyze the RP-German post-harvest and handling needs. He recommended the construction of additional smaller stores using the diffused light technology promoted in earlier CIP-BPI research. These recommendations resulted in the construction of five 50-ton diffused light stores. There is much to be said for the change in plans. The diffused light stores were much cheaper to build and maintain and additional stores meant more convenient locations for farmers. The promotional effect of the government program adopting a technology that is also appropriate for farmers should be considered a benefit of the change in plans. Several of the stores were built along the Baguio-Bontoc road and, as it is virtually the only farm-to-market road, nearly every farmer who travels to Baguio is made aware of the stores and their technology.

The five seed store houses in producing areas were constructed over the period from 1979 to 1981. Four are centrally located in each of the SGA zones: in Paoay for the Atok SGA, Abatan for Abatan, Sinto for Natubleng and Sadsadan for Mt. Data. The fifth is on the seed farm. In addition to these facilities the program

has a 40-ton cold store in BPI-Baguio for storing genetic and basic seed materials.

The following three tables document the utilization of the seed store houses built by the project to handle the storage and serve as points for the collection and disbursement of seed loans and procurements.

Table 19 charts the monthly percentage utilization of storage capacity and clearly indicates the seasonal aspects of seed storage flow. As might be expected there is little storage during the main cropping season from March to July, but then accessions rise rapidly during wet season harvest to a peak in September that remains stable for the next several months, until disbursements increase as farmers take receipt of the sprouted tubers.

Table 19. Monthly percentage utilization of storage capacity, RP-German Seed Program Stores

Month*	Received (kg)	Distribution (kg)	Balance (kg)	Percentage utilized
April	333	962	11,069	7.4
May	914	3,725	6,938	4.6
June	1,180	23	8,655	5.8
July	24,937	457	27,700	18.5
August	35,935	2,045	61,672	41.1
September	25,207	2,036	90,176	60.1
October	8,413	14,451	84,439	56.3
November	1,502	5,435	80,885	53.9
December	250	4,727	76,408	50.9
January	2,82[illegible]	392	72,799	48.5
February	3[illegible]	12,213	60,926	40.6
March	4,402	56,232	9,200	6.1

Source: Seed Storage Records. RP-German Seed Potato Project.
Note: Three year monthly averages from 1982-83 to 1984-85.

Tables 20 and 21 provide further details on storage utilization, showing annual peak utilization during the program with the highest storage month in any one year. As can be seen this capacity is sufficient to absorb a considerable increase in activity. Table 21 breaks this down into individual store utilization showing the seed-farm store as the most efficiently utilized. The Atok, Sinto, Sadsadan and seed farm store houses are managed by BPI personnel with assistance from local farmer cooperators. The Paoay store uses a locally hired manager. In addition to seed officially entered into project store houses, local farmers often make use of available space. The project does not charge storage fees.

Table 20. Annual peak storage utilization, RP-German Seed Program Stores, 1979-86

Year	Month	Volume (tons)	% of capacity
1979	September	21.3	14.0
1980	October	59.6	39.7
1981	September	84.8	33.9
1982	September	118.2	47.3
1983	September	93.9	37.5
1984	September	58.4	23.4
1985	September	40.9	16.4
1986	October	28.1	11.2

Source: Seed storage records. RP-German Seed Potato Project.
Note: Storage capacity of five mountain trail stores capacity was 150 tons in 1979-80, 250 tons afterward.

Table 19 can also serve as a useful indicator for timing the need for procurement funds and staff time to handle the increased activity of seed flowing into and out of the program's control.

Table 21. Annual peak storage by storehouse, RP-German Seed Program Stores, 1983-86[1]

Year	Month	Paoay	Abatan	Sinto	Seed-farm	Sadsadan
				tons		
1983	November[2]	10.6	26.6	18.3	19.2	12.9
1984	September	11.0	10.4	6.5	22.3	8.2
1985	September	1.4	6.2	7.4	15.3	6.5
1986	October	n.a.	4.6	2.2	16.1	5.2

Source: Seed storage records. RP-German Seed Potato Project.
Notes: 1. Capacity of all stores is 50 tons. 2. Records for separate stores start in November 1983.

Losses such as those reported in Table 7 have sometimes been significant. In the years until 1980 there were no stores available for seed so the garage space in the Baguio station was used. In the bulk storage, darkness, lack of ventilation, and high temperatures combined to cause losses as high as 25%. As an interim step in late 1979 and early 1980, two temporary store houses with a capacity of 40 tons were developed from converted mushroom houses.

Specific problems such as individual store houses have induced losses. As an example, in

1981 the Sinto store house was equipped to store tubers in the red bags used for marketing. Rotting and hardening of the tubers in the center of the bag resulted. The store was consequently refitted with the standard chitting racks. In 1985 a large stock of Conchita was condemned, due to overlong storage and subsequent rottens. This resulted from lack of farmer demand for Conchita because of the change in varietal characteristics mentioned above. In 1986 there were storage losses in the seed farm store house as a result of planning error. Plantings of Granola were scheduled that resulted in a late January harvest such that the seed produced were still dormant for the March to July planting. By the time the October planting date arrived the seed were physiologically old and not suitable for loaning. In February 1987, 1,400 kg were condemned.

Aphids and tuber moths are the principal pests found in store houses. Tuber moths are sometimes found in lower elevation stores while aphids are frequently observed in most store houses even though the managers maintain a regular schedule of spraying against these pests. High levels of aphid infestations have been reported in both privately managed and project store houses. Increased virus infections result. There do not appear to be seasonal storage problems nor are there individual problematic store houses.

Farmer Store Houses

The RP-German program has also assisted farmer-level storage development. The construction of SGA-controlled store houses is an example. (See the section on SGA's above for a discussion of work in this area.)

While the RP-German program was deciding which storage technologies to use in its program, BPI and CIP were also engaged in storage research. Based on recommendations from a 1977 visit of a CIP expert, the BPI-CIP efforts concentrated on the re-introduction of diffused light stores.

Traditional farmer storage practices were to simply pile potatoes on floors in either available or purpose-built space. Excessive sprouting and rotting were problems and became worse as newer varieties with less well-adapted storage qualities were introduced. In an application of the farmer-back-to-farmer model with farmer cooperators, demonstration store houses were established (Rhoades et al., 1983). The results of this and the simultaneous work of the RP-German program stimulated rapid adoption of this technology by the area farmers (Acasio et al., 1986; Potts et al., 1983b).

Projections and Needs

Storage capacity continues to expand in northern Luzon. BPI appears to have sufficient storage space available for the forseeable future. Several private stores have been built to serve the needs of some of the non-BPI seed schemes. There does not appear to be significant demand by farmers for storage space in large private or communal stores. Most farmers prefer to store on the farm for reasons of convenience and security. With the simple techniques and materials needed for construction, the major limitation to further expansion of on-farm stores is lack of capital to buy the materials.

8. Issues

In this section some of the factors important to the smooth functioning of the seed system are discussed. The first section is a description of supply and demand of seed potatoes and the seed potato market. Also included are suggestions for alleviating some of the constraints in this market. Concluding comments on the role of the PPP in the seed system follow with special attention paid to the activities of BPI. Finally areas of the seed system that have not been adequately treated in this study are briefly discussed, and suggestions for further research are proposed.

Seed Potato Demand, Supply and Market

Demand

Common phraseology should be clearly defined when discussing the seed potato market. First is "seed requirements," a phrase frequently used by policy makers. This is simply the seed needed to plant the total potato area. Calculating seed requirement is a matter of multiplying the seeding rate per hectare by the number of hectares. The next definition is "seed demand." This is the quantity of seed potatoes that seed users wish to secure from the "market." Given that farmers save their own seed, this figure is much smaller than seed requirements. Estimating seed demand involves knowing the rate at which farmers replace their seed stock, seeding rate and the area to be planted. A final definition is "effective seed demand." This important distinction in demand highlights the economic constraints on seed users. Effective demand emphasizes the difference between the desire to purchase seed potatoes and the ability to do it. In the Philippines effective demand changes during the year. The lack of synchronization of effective demand with supply is a major limitation of the informal seed sector.

Based on information presented in other sections, a rudimentary calculation of demand can be made as in Table 22. Using data developed by others, it is possible to calculate the size of the seed market for 1987. Assuming that farmer seed market habits will remain constant from the previous year, the results show that farmers will utilize imports and organized seed programs for approximately 660 tons of seed. This does not indicate that farmers wait until seed supplies from farmers are exhausted before purchasing imported, marketed or organized program seed. In fact the opposite may be true. In the organized sector of the seed potato market, supplies appear to be the constraining factor. In the informal sector the opposite side of the market (demand) may be the constraining factor.

Table 22. Estimating 1987 potato seed demand in the Philippines

Total area planted[1]	4,300 ha
Total seed requirements (2mt/ha)[2]	8,600 mt
Total highland area (1500-2500m.a.s.l.)	3,000 ha
Average seed renewal rate (divide)[3]	4 years
Highland area needing new seed	750 ha/year
Total low and mid-elevation area	1,600 ha
Total area needing new seed	2,350 ha/year
Total seed demand	4,700 mt/year
Less seed demand met by other farmers (86%)[4]	4,042
Remaining seed demand	658 mt/year

Sources: 1. Perez, personal communication. 2. Technopack, 1985. 3. Potts, 1983. 4. Francisco, 1987.

Supply

As noted above the vast majority of seed potatoes needed for planting each year are supplied by the farmers themselves. When the farmers wish to purchase new seed they typically buy, borrow, or receive it as a gift from other farmers. In a recent survey Francisco (1987) reports that farmer seed, self-supplied or purchased from other farmers, accounted for 86% of seed potatoes used. The remaining 14% comes from imports or the various organized seed programs.

Table 23. Imports of seed potatoes, Philippines. 1968-85

Year	Quantity (mt)	Value[1] (000 US$)	Percent of seed needs[2]
1968	299	33	6
1969	186	21	3
1970	84	20	1
1971	171	20	3
1972	234	34	3
1973	397	66	6
1974	n.a.[3]	n.a.	-
1975	218	43	3
1976	75	14	1
1977	58	22	1
1978	125	29	2
1979	67	17	1
1980	125	46	2
1981	136	57	2
1982	85	29	1
1983	-[4]	-	0
1984	-	-	0
1985	1	-	0

Source: Foreign Trade Statistics, NEDA.
Notes: 1. Value in CIF. 2. Calculated at a seeding rate of 2 t/ha from areas given in Appendix Table A2. 3. Records not available. 4. No imports.

The PPP was organized as a response to the high cost of imported seed. Table 23 shows volume and percent of seed requirement met by imports. Starting in 1970 legislation was enacted to limit imports to 15% of seed requirements in order to conserve foreign exchange. Although it is often stated that imports of hundreds of tons costing millions of pesos accounted for 15% of the seed supply each year, the data indicate a much more modest role for imported seed potatoes. As can be seen this regulation was never a binding constraint on the limit of imports. A more likely limiting factor was a lack of effective demand due to the high price of imported seed.

In 1982, with the support of the PPP, a total ban was imposed on the importation of commercial seed potatoes. However, each importer was still allowed a maximum of two tons of seed that could be used for multiplication. That ban was lifted in 1987 with the import liberalization policies of the new government. Official records do not show any imports, though exceptions were made for limited quantities for the government program and other special applicants (Technopak, 1985). During the time of the import ban, import quarantine facilities were established in Los Baños for receiving and disease testing of imported material.

The establishment of quarantine facilities is a result of concern regarding the importation of non-native diseases and pests. The existence of several diseases and pests including black-leg, root-knot, cyst nematode tuber moth, and several major viruses are attributed to imported potatoes (Balaoing, personal communication).

A third concern with imported potatoes is the time of their arrival and the logistics of their delivery. Orders are usually placed in November for January/February delivery and March/April planting. Most imports are from Europe and North America and, depending on variety, may or may not be in proper physiological state for wet season planting.

The Market

A major complaint of farmers is lack of seed and, as noted in Tables 5 and 13, availability is the single most important consideration during variety and seed selection. High costs and undependable quality are other complaints. These are market problems which are related to concepts of location and time.

The usual notion of a market as a central place where buyers and sellers meet, exchange information and make purchase and sale decisions is irrelevant in the seed potato market. The prevalent practice of purchasing seed through informal (neighbor) contacts provides the buyer with few options and limited

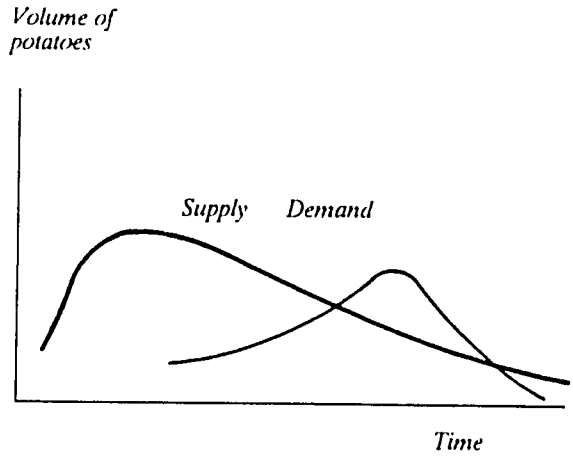
information about supply. For buyers distant from seed producing areas the high cost of market information results in purchases made with minimal selection or choice.

Problems of time appear to be even more severe. Periods of peak effective demand do not coincide with periods of peak supply. Aside from the fact that they have the usual temporal problems of agricultural commodities, seed potatoes can fill the dual role of seed or table potatoes. As described above, the average potato farmer faces severe cash flow constraints that govern when purchases can be made. Some farmers finance their crop with private sector production loans that come due at harvest. So at harvest time, when the supply of seed potatoes is at its peak, farmers are constrained from making purchases from growers by having previous demands on their cash. For both buyers and sellers of seed potatoes, lack of cash combines with low levels of capital accumulation to discourage investment in seed potatoes during the months between harvest and planting.

This is schematically represented in Figure 8. In the figure are curves depicting hypothetical supply and demand of seed potatoes at different times. The supply curve is at its peak during harvest. Because not many farmers want to use storage, the supply is sold to the table potato market. Growers have little available cash at harvest and are not inclined to buy seed tubers and store them until planting. Thus as planting season approaches, farmers begin competing among themselves for supplies that become increasingly scarce as the planting season progresses. In the end many farmers are left without sufficient seed and do not plant.

The failure of the seed market is due to the absence of perceived opportunity for individuals or institutions to profit by bridging this temporally mismatched supply and effective demand. To date the only attempts to fill this role have been by the organized seed schemes, and only to the extent of matching up their own supplies with demands. An example of such a seed marketing agency is FCDF in the SAPPRAD program. The FCDF seed scheme operates in an environment of nearly perfect information about its supplies, demand, and prices but its functions are similar to any independent entity. The objectives of a marketing agency are to buy freshly harvested seed sized tubers from farmers and change them qualitatively and temporally into sprouted seed tubers for planting. Without the full information enjoyed by FCDF, the biggest risk for a marketing agency is in estimating demand.

Figure 8. A representation of the supply and demand of seed potatoes during a cropping season in the Philippines



The original BPI model of seed marketing called for farmer associations to market the seed. Technical assistance was to be provided to the farmer associations principally in the form of market information. The assumption was that the marketing process would last only until seed quality had been verified, at which time farmers buyers would be waiting to make their purchases (BPI, 1979). To the present, the SGA's have not been able or willing to hold seed and no farmers were willing to buy while the seed was available. In numerous documents the RP-German program called for a full time marketing expert to supply technical assistance and timely information. The marketing expert has never been posted.

In a related area the Highland Agricultural Development Program (HADP) has various objectives which will assist table potato marketing in northern Luzon and may have positive effects on seed marketing. One objective is to provide for the construction of subregional market buildings to facilitate trading between farmers and assembler/wholesalers in a

setting more favorable to the farmers. With proper stimulation these could also become seed potato markets. With better market information generated from what may become more centralized trading, individuals with access to capital may see business opportunities in becoming seed retailers with locally based purchase, storage and sales operations.

A short term response to the situation is simply to increase the procurement budget of BPI and to increase the volume of sales of C_3 seed. This expansion of an activity already in place calls for increased managerial control and injects BPI further into the seed market. Since it is a governmental agency, this is not a role it is well suited to perform.

Prices

One of the principal problems faced by a government entity attempting to interact in any market is prices. Government agencies are required to plan and forecast budgetary needs and naturally they use fixed prices. Flexible prices found in the market move above or below the fixed government prices.

The cycle of prices in the Baguio market shows fairly predictable seasonal peaks and valleys, as can be seen in Table 24. During the history of the RP-German program, prices have been fixed by a committee of PPP officials. Sale prices have changed three times: from 1977 to 1981 the price was ₱4; from 1982 to 1985, ₱6, and ₱9 from then to the present. These prices are based on approximately average break-even prices plus a reasonable margin. Examples of break-even price calculations can be seen in Appendix Table A5. Prices offered by the PPP to seed growers are guaranteed in contracts and vary according to the certification grade received. The 1987 prices are ₱6, ₱5, and ₱4.50 for C_1, C_2 and C_3 respectively. If prices are above market price at harvest then BPI has no problem obtaining seed. If they are below, the farmers are reportedly less likely to honor the deliveries stipulated in the contract.

The pricing arrangements found in the contracts of the various seed schemes may provide valuable information on contract compliance and price establishment by the market. Examination of the behavior of the purchasers of imported seed can also be instructive. Since it can be argued that price rather than legislation limited imports, those farmers who did buy the seed presumably felt the investment was worth the cost. Typical reported practice is for the imported seed to be multiplied several times before any of the production is sold.

Table 24. Mean wholesale prices of potatoes in Baguio City, 1982-84 (₱/kg)

Months	1982	1983	1984
January	6.57	1.86	4.57
February	3.50	1.73	4.54
March	2.51	1.86	4.35
April	2.29	2.13	3.83
May	2.34	3.49	2.70
June	1.98	3.48	2.64
July	1.96	2.77	2.68
August	2.27	2.50	3.61
September	2.50	2.73	5.09
October	2.09	3.67	5.54
November	1.80	3.79	6.69
December	2.16	4.42	6.01

Source: BAEcon, Baguio City, April, 1985.

These activities establish that a market for quality seed exists and some farmers choose to enter it even when prices are high. The question faced by the BPI seed scheme is the extent of the market at lower prices. On the opposite end of the price range is the current BPI price of ₱9, which is slightly less than market price for common sprouted seed. BPI has established that demand exceeds supply and that farmers tend not to conserve the production for seed at this price.

One alternative method of determining a price within these ranges that would induce the market to absorb available supplies and cause farmers to value their production as seed, is to employ a variation of the scheme proposed by Robina Corporation. The scheme would use continually updated information in selected markets to establish a base price to which a certain percentage would be added depending upon the grade of seed. Assuming that supply of BPI seed is not strongly limiting, interest and activity in buying and selling of program seed would provide substantial information on

farmers' perceptions about the quality of program seed and the size of the market. If this information were to be made public, other market actors might find information costs reduced sufficiently to allow their participation as seed market agents.

At present it is doubtful that SGA's could fill this role. Lack of capital is the frequent complaint of the SGA's, but given the present state of institutional development, it appears unlikely that the marketing skills or the incentive would arise. Rigidities inherent in the management of government agencies probably preclude their chances for successful operation. However, by subsidizing entry costs with market information it may be plausible for traders to see market opportunities.

PPP and the Seed Potato System

As introduced above, Figure 1 contains elements of a hypothetical potato seed system divided into general categories of quality control, seed production and supply and support services and promotion. The PPP has worked to establish many of these elements. The center of these efforts has been the RP-German seed program. Now terminated, after a period of ten years, this program built an infrastructure and trained the personnel. As seen above, some portions of the systems have been established better than others. This section reviews the activities of the PPP and the RP-German seed program within the structure depicted in Figure 1.

Quality Control

In seed quality control, the certification control body appears to have established realistic quality control standards, and the seed testing lab can execute the necessary testing. However, the transferring of field inspectors to other jobs illustrates a problem of coordination. There is no seed law but all in all, at the present time, the absence of this law does not appear crucial.

Services, Support and Promotion

In the services, support and promotion column, PPP statistics, data collection and dissemination are weak. Lack of systematic record keeping has denied BPI a valuable management tool. Like all government agencies, BPI has adequate systems for financial accounting but needs improved management accounting. Lack of adequate and timely data regarding the status of production activities may have contributed to the disastrous stock depletion of the last few years.

Extension, education and promotion are activities shared by several PPP agencies. BPI has responsibility for extension and education activities as related to its seed production and certification activities. There were relatively more BPI education activities in the earlier years of the program when training on improved seed crop management and storage was high priority. The principal mandate for training has been with the NPRCRTC, and BPI continues to offer programs on table potato production. The Department of Agriculture (DA) has the mandate for extension but has performed poorly in respect to support of certification. As a result, BPI staff were given additional extension assignments. This situation is analogous to requiring entomologists to start a breeding program. BPI research staff have neither the training nor motivation to be extension agents.

The technoguide provides detailed information on sources of and requirements for official credit. However, few farmers appear to use it. Reasons cited include disqualification due to uncertainty of land titles, and bureaucratic difficulties in the application procedures. As a result, nearly all credit is supplied by the private sector.

The PPP's research program is one of its strongest points. There is and has been substantial good quality research conducted in many potato growing environments. Many beneficial research results have been transferred to farmers. Research has been conducted by numerous agencies focused on particular areas of mandate. There has been substantial backstopping by CIP and GTZ.

Within the generally positive picture of biological research at BPI the contribution of social science work has been minimal. During the ten years of the special potato project, there

have been two social science-led research projects, both of which were conducted on-station to measure costs of production. There has been some research by others (e.g., Waibel, 1981; Potts, 1983) that has provided socio-economic information about the farmer seed system that BPI was trying to change. However, lacking detailed, focused socio-economic information on the functioning of the farmers' seed system left the program with fewer policy options for dealing with the lack of progress in the development of viable SGA's.

The neglect of social science research has also been reflected in the lack of monitoring. There are no data to indicate or justify claims of progress. As illustrated by the example of farmer crop disposal, no one in the program has a realistic idea of the amount of seed that remains in circulation after harvest. This implies inability to devise effective remedial intervention. Such basic information as dispersal of introduced varieties is known only by anecdotal evidence.

The private sector also has active research programs as exemplified by the screening and variety introduction by McDonalds and the constant testing and screening of processing varieties by the other programs. Examples of cooperation in research between the public and private sector are the greenhouse experimentation undertaken by BIBAK in cooperation with BPI and the part-time funding of a tissue culturalist in IPB by McDonalds. Among the unofficial contacts and consultancies between the public and private sector, the benefits of the contact tend to flow from the government to the private sector. A significant portion of this activity is in the organization of and communication with seed growers. Open, sanctioned co-operation between the government and the private sector in these areas could direct the flow of benefits from these contacts to the public sector as a whole rather than to particular consultants.

Involving the general public, industry and agribusiness in its program has not been a strong point of PPP. As noted above, there are some areas of cooperation, such as the research and consultancy contacts with agribusiness. An [illegible] worth noting is the network of support [illegible] organized by FCDF that reinforce and suppo[illegible] activities of the lowland potato grower associations. FCDF has created public enthusiasm through field days and inter-agency linkages through regional and national meetings that strengthen the individual producer groups.

Seed Production and Supply

Activities in this central column have received the majority of PPP attention. The activities surrounding germplasm introduction and storage, the breeding programs and the NCT system for releasing varieties appear to be well-established and to have a potential for serving the needs of growers. The principal breeding program at IPB relies on external financial support, but that appears to be assured for the next several years as the IPB program received a good rating for its activities as part of the SAPPRAD network (Page and Horton, 1987).

The next set of activities are within the responsibility of the BPI and reflect the heritage of the RP-German seed program. BPI has the capability of receiving and handling in vitro material and can thus maintain breeder seed. The extensive experience with various RMT schemes has enabled BPI to produce planting material for pre-basic seed production. Recent work with transplanting potted cuttings has increased the reliability of tuberlet production from the cuttings.

BPI has an established seed farm for producing basic seed, though it has yet to demonstrate that it can be a reliable supplier of large volumes of basic seed. There are indications that management charges will improve reliability of basic seed production. Storage is not a constraint for organized seed production and appropriate facilities are in place.

BPI has also experienced problems in the management of the certified seed production network. Currently the SGA's created by BPI do not appear to be viable institutions.

As mentioned a weakness of the informal seed system is lack of farmer seed marketers. This is one of the most crucial failures in the entire seed system since the farmer or informal sector handles the majority of seed, and shortage of seed marketers is the limiting factor in that sector.

Limitations of this Study and Areas for Future Research

There are several limitations to this study. Principal among them is the lack of financial analysis of the project funding.

The PPP has internal funding from numerous sources and external funding from several sources as well. Within the RP-German project the general guidelines for financial support were clearly defined. The Philippine government provided funds for all continuing operations while GTZ funded capital expenditures and technical assistance counterparts. That formula is usually adhered to except when Philippine government funds are not released in time. The disposition of funds within the RP-German project has been between research, production, and extension. No records of percent allocation to the different activities were kept. Estimates of costs are thus difficult to calculate. Benefits are likewise difficult to determine since there are only the vaguest guesses about yield differences and distribution of seed.

Investigation of credit supplies from official sources was also limited in this report as relevant institutions participating in the PPP were not contacted to obtain information on credit availability and use by potato farmers.

Training was also not systematically investigated. Training has been an important part of PPP and the RP-German program. A variety of techniques and resources have been used. Training for technical staff has included degree and non-degree programs overseas and in-country. Staff participation in workshops and seminars has encouraged on-going and in-service training by enforcing critical peer review of work. Training by PPP staff has also been significant. The training has been directed at other potato researchers, extensionists and farmers. Its content and usefulness was not investigated during this study.

Although the area of marketing was highlighted as a particularly weak part of PPP, individuals from the PPP agency with initial responsibility for marketing support were not contacted.

While there were numerous contacts with farmers, these were biased towards the more active cooperators with the seed program. Thus information from these sources may be skewed toward emphasis on benefits from and problems with BPI. An effort was made to include information about farmers from other sources. In this respect the sample selected by Francisco has the best probability of being a random sample, with non-participating and more remote farmers having an equal chance of appearing.

Future Research

This study has highlighted several points that have been left unanswered primarily because sufficient explanatory information does not exist or is contradictory. PPP has not conducted systematic monitoring research. Monitoring research enables assessment of progress towards program objectives and provides a valuable feedback link between a research program and its clients. A monitoring program requires definition of the indicators by which objectives are yield surveys, measurement of new variety dispersal and estimation of changes in nutrition and income. All of these are among the list of objectives in the original PPP agenda. Progress towards achieving those objectives is a subject for conjecture as verifiable research has not been conducted.

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Appendix 1

Comparing Reports of Potato Yields

This Appendix presents a comparison among different studies which report potato yields and highlights the variability in results. There is much uncertainty concerning yields of potatoes. The published data show wide variation in reported or estimated yields. The different yield figures are used with planted area estimates to calculate production, resulting in widely different estimates.

There have been various research efforts in northern Luzon during the last ten years which reported potato yields. Yield figures from these reports are included in the table below. Also available for comparison are reported yields for BPI farmer cooperators for wet and dry seasons of various years given in Table 10 and BAEcon estimates in Table A4. Except for Potts et al. and the BPI results, all the reported yields are based on farm surveys which rely on farmer recall. The BPI figures are supposedly verified by certification officers who visit the field during harvest though reportedly that does not happen frequently. The Potts et al. study made quantitative measures of yields avoiding problems of biased recall, but was not a random sample.

Data from the table is selectively employed. In various planning documents and reports PPP officials tend to use figures more in the range of Potts et al. than the BAEcon or other sources. Figures that should be persuasive, however, are the reported yields of BPI farmer cooperators as in Table 12. There have been a variety of things that adversely affected yields but these, after all, are farmer conditions and do provide evidence of average performance of BPI material in general circulation.

BPI regularly screens material in field trials and finds yields well exceeding the 20 t/ha mark. The fact that even the farmer cooperators do not reach that figure suggests there are various constraints other than planting material which limit yields. The verification of the existence of, and the identification of, elements which contribute to this "yield gap" might provide useful information for future research for BPI.

Table A1. Some research reports which include data for potato yields in Benguet and Mountain Province, Philippines

Study	Year	Yields (t/ha) Average	Range	n
Olgado et al.	1977-78 dry	7.3	3.1 - 14.7	126
Waibel	1979 wet		6.4 - 16.6	33
Potts et al.	1980 wet	28.2	8 - 44	184
	1980-81 dry	24.7	4 - 44	105
	1981 wet	17.1		56
	1981-82 dry	28.8		74
Perez & Alameda	1983	11.0		129
Francisco	1985-86		7 - 11	276

Source: As per references, compiled for this study.

Appendix 2

Table A2. Production of potato (000 t) by region, Philippines, crop years 1954-86

Year/ Region	Philippines	Ilocos	Cagayan Valley	Central Visayas	Northern Mindanao	Southern Mindanao
1954	7.2	-	1.4	-	0.2	5.5
1955	6.7	-	1.3	-	0.2	5.1
1956	8.1	-	1.6	-	0.2	6.2
1957	9.6	-	1.9	-	0.2	7.3
1958	10.2	-	4.0	-	0.3	5.7
1959	7.0	-	5.2	-	0.3	1.1
1960	6.6	-	4.8	-	1.3	0.08
1961	10.2	-	8.6	-	1.0	0.06
1962	10.5	-	9.0	-	1.0	0.06
1963	15.0	-	12.9	-	1.8	0.06
1964	18.0	-	14.1	-	3.1	0.07
1965	16.0	-	13.4	-	2.0	0.08
1966	17.0	-	14.5	-	1.8	0.2
1967	17.0	-	14.5	-	2.0	0.2
1968	12.3	-	9.7	-	2.0	0.2
1969	18.4	-	15.7	-	2.5	-
1970	20.1	17.6	0.07	-	2.1	0.2
1971	22.3	20.5	0.08	-	1.6	0.08
1972	24.7	20.6	0.4	0.2	1.9	0.4
1973	23.0	19.5	0.1	0.06	2.1	0.3
1974	25.4	22.3	0.1	0.06	2.2	0.6
1975	20.4	17.6	0.2	0.07	1.3	1.1
1976	18.9	16.3	0.04	0.08	1.4	0.5
1977	18.9	16.6	0.04	0.09	1.1	0.6
1978	20.0	17.5	0.06	0.09	1.3	0.8
1979	32.0	25.4	0.05	0.9	5.3	0.8
1980	36.9	28.5	0.06	0.1	6.9	1.1
1981	37.1	29.8	0.06	0.1	0.0	7
1982	40.7	31.5	0.07	0.1	7.0	1.9
1983	40.7	33.6	0.07	0.09	4.6	2.3
1984	36.7	28.6	0.09	0.07	5.2	2.4
1985	42.4	32.7	0.07	0.1	6.9	2.3
1986	48.5	38.0	0.05	0.1	7.8	2.3

Source: PCARRD and SAPPRAD, 1984. Later years supplied by Perez.
Notes: Columns do not sum to total due to omission of several minor production regions. The complete listing can be found in source.
A dash indicates no data available. 1986 data are preliminary.

Table A3. Area planted/harvested (000 ha) to potato by region, Philippines, crop years 1954-86

Year/ Region	Philippines	Ilocos	Cagayan Valley	Central Visayas	Northern Mindanao	Southern Mindanao
1954	1.8		0.8		0.04	1.0
1955	2.6		1.1		0.04	1.4
1956	3.0		1.2		0.05	1.6
1957	3.2		1.3		0.05	1.7
1958	3.6		1.9		0.06	1.4
1959	2.4		1.7		0.1	0.02
1960	2.1		1.6	-	0.3	0.01
1961	2.2		1.7	-	0.2	0.02
1962	2.2		1.8	-	0.2	0.01
1963	2.5		1.8	-	0.6	0.01
1964	2.6		1.9	-	0.6	0.01
1965	2.5		1.9	-	0.5	0.01
1966	2.6		1.9	-	0.5	0.02
1967	2.6		1.9	-	0.5	0.03
1968	2.5		1.8	-	0.5	0.03
1969	3.0		2.4	-	0.6	-
1970	3.0	2.4	0.04	-	0.6	0.04
1971	3.0	2.4	0.04	-	0.4	0.03
1972	3.6	2.4	0.1	0.09	0.4	0.1
1973	3.3	2.4	0.03	0.06	0.5	0.1
1974	4.0	3.3	0.04	0.06	0.4	0.2
1975	3.3	2.4	0.06	0.06	0.4	0.2
1976	3.1	2.2	0.01	0.07	0.5	0.1
1977	3.0	2.3	0.02	0.06	0.4	0.1
1978	3.2	2.4	0.02	0.06	0.4	0.2
1979	4.0	2.6	0.02	0.07	1.0	0.1
1980	4.1	2.7	0.02	0.08	1.0	0.2
1981	3.8	2.8	0.02	0.08	0.6	0.2
1982	3.9	2.9	0.02	0.08	0.5	0.3
1983	4.2	3.2	0.02	0.07	0.4	0.5
1984	3.9	3.0	0.03	0.08	0.4	0.4
1985	3.9	3.0	0.03	0.06	0.4	0.4
1986	4.3	3.3	0.02	0.06	0.5	0.4

Source: PCARRD and SAPPRAD, 1984. Later years supplied by Perez.
Notes: Columns do not sum to total due to omission of several minor production regions. The complete listing can be found in source.
A dash indicates no data available. 1986 data are preliminary.

Table A4. Value of potato production (000 pesos) by region, Philippines, crop years 1954-86

Year/ Region	Philippines	Ilocos	Cagayan Valley	Central Visayas	Northern Mindanao	Southern Mindanao
1954	5,065.9	-	978.1	-	127.7	3,868.2
1955	4,887.1	-	458.9	-	73.8	2,299.5
1956	3,085.3	-	475.5	-	79.3	2,471.1
1957	3,656.4	-	563.6	-	94.0	2,928.4
1958	4,138.5	-	1,868.4	-	151.1	1,990.8
1959	3,412.1	-	2,394.2	-	136.5	589.5
1960	2,732.2	-	1,791.5	-	627.8	32.8
1961	3,956.0	-	3,172.3	-	410.4	16.4
1962	3,978.1	-	3,356.0	-	327.5	29.4
1963	5,933.0	-	4,875.6	-	831.6	25.2
1964	7,007.8	-	5,365.1	-	1,413.6	29.5
1965	6,290.9	-	5,107.3	-	897.5	32.3
1966	6,656.7	-	5,508.3	-	870.4	70.0
1967	6,163.4	-	4,929.4	-	969.0	78.1
1968	4,167.8	-	2,919.0	-	925.3	87.2
1969	11,267.6	-	9,903.0	-	1,125.6	-
1970	13,416.4	11,431.6	62.0	-	1,715.4	168.6
1971	16,796.7	15,353.6	60.6	-	1,273.7	67.8
1972	18,880.7	15,619.7	283.1	121.6	1,653.2	291.6
1973	20,764.2	16,947.1	96.7	62.1	2,508.7	344.9
1974	52,589.0	45,521.0	129.0	77.0	5,198.0	1,580.0
1975	39,650.1	32,574.1	352.9	210.0	3,055.2	2,754.4
1976	24,539.4	20,245.7	54.3	241.4	2,255.3	807.1
1977	23,266.0	18,087.0	58.0	246.0	2,366.0	1,579.0
1978	28,439.0	22,516.0	114.0	270.0	2,288.0	2,181.0
1979	60,243.0	41,806.0	132.0	322.0	14,720.0	2,755.0
1980	81,424.0	61,341.0	151.0	376.0	16,314.0	2,799.0
1981	85,542.0	64,742.0	180.0	395.0	16,836.0	2,902.0
1982	121,784.0	91,382.0	182.0	597.0	23,873.0	5,080.0
1983	91,938.0	70,205.0	167.0	316.0	12,026.0	8,863.0
1984	127,963.0	93,739.0	329.0	433.0	19,137.0	12,950.0
1985	184,838.0	126,382.0	419.0	796.0	42,269.0	12,485.0
1986	48,520.0	37,961.0	53.0	187.0	7,760.0	2,281.0

Source: PCARRD and SAPPRAD, 1984. Later years supplied by Perez.
Notes: Columns do not sum to total due to omission of several minor production regions. The complete listing can be found in source.
A dash indicates no data available. 1986 data are preliminary.

Table A5. Average yields per hectare (t/ha) by region, Philippines, crop years 1954-86

Year/ Region	Philippines	Ilocos	Cagayan Valley	Central Visayas	Northern Mindanao	Southern Mindanao
1954	4.0	-	1.9	-	4.4	5.7
1955	5.6	-	1.2	-	4.1	3.6
1956	2.7	-	1.3	-	4.0	3.8
1957	3.0	-	1.4	-	4.7	4.2
1958	2.7	-	2.1	-	4.8	3.9
1959	2.9	-	3.0	-	2.4	3.9
1960	3.1	-	2.9	-	4.8	8.2
1961	4.6	-	5.0	-	2.4	3.0
1962	4.7	-	5.0	-	4.8	6.0
1963	6.0	-	7.0	-	3.2	6.1
1964	6.9	-	7.4	-	5.5	7.2
1965	6.3	-	7.2	-	3.9	7.9
1966	6.7	-	7.6	-	3.8	7.6
1967	6.6	-	7.6	-	3.8	5.9
1968	4.9	-	5.4	-	3.8	6.2
1969	6.1	-	6.7	-	4.5	-
1970	6.7	7.7	1.8	-	3.8	6.1
1971	7.6	8.4	1.9	-	4.2	2.8
1972	6.8	8.4	2.9	1.8	4.4	2.8
1973	6.9	8.0	3.6	1.0	4.7	3.6
1974	6.3	6.7	3.1	1.1	5.3	3.3
1975	6.2	7.2	2.7	1.1	2.9	4.6
1976	6.1	7.2	4.0	1.2	3.1	3.9
1977	6.2	7.3	1.9	1.4	2.8	4.3
1978	6.3	7.4	2.7	1.4	3.0	5.0
1979	8.0	9.8	2.4	1.4	4.8	5.3
1980	8.9	10.7	2.9	1.3	6.3	5.2
1981	9.7	10.5	3.0	1.3	-	0.3
1982	10.4	10.7	3.5	1.8	14.5	5.6
1983	9.7	10.5	3.5	1.2	12.4	4.9
1984	9.4	9.8	3.0	1.4	13.0	6.2
1985	10.8	11.1	2.5	1.6	16.0	5.9
1986	11.2	11.5	2.6	1.8	16.1	6.0

Source: PCARRD and SAPPRAD, 1984. Later years supplied by Perez.
Notes: Columns do not sum to total due to omission of several minor production regions. The complete listing can be found in source.
A dash indicates no data available. 1986 data are preliminary.

Table A6. Estimated input-output costs of seed potato production/hectare using tuber seed and rooted cuttings, Philippines

	Tuber seed		Rooted cuttings	
	Man-Days	Amount	Man-Days	Amount
I. Variable Cost				
Labor costs (₱30/day)				
Land preparation (includes cleaning, 1st and 2nd hoeing, furrow/bed preparation, application of fertilizer	260	7,800	300	9,000
Planting	40	1,200	50	2,400
Care and maintenance irrigation	80	2,400	90	2,700
Weeding and hilling up	60	1,800	120	3,000
Spraying	60	1,800	75	2,250
Roguing	10	300	--	--
Harvesting (includes sorting, grading and hauling)	60	1,800	60	1,800
Post-harvest handling (includes resorting and seed treatment)	24	720	24	720
Sub-total	594	17,820	749	22,420
Purchased inputs				
Cost of planting material[1]		30,000		4,800
Fertilizer[2]: 14-14-14		3,825		220
Urea		--		520
Chicken manure (100 sacks/ha)		5,000		6,200
Insecticide/fungicides				
Tamaron (4 qts/ha x 3 times at ₱293/qt)		3,516		3,516
Curzate (4 kg/ha x 10 times at ₱215/kg)		8,000		8,000
Sticker (2 qts/ha x 10 times at ₱80/qt)		1,600		1,600
Sacks (800 pcs at ₱3/pc)		2,400		2,400
Sub-total		54,341		30,286
II. Fixed Cost				
Land rent (₱2,000/ha/yr)		2,000		2,000
Depreciation				
5 units knapsack sprayers (4 gallons capacity at ₱1,200/unit 6 years)		1,000		1,000
12 pcs grab hoes no. 3 at ₱152/pcs with handle for 6 years		304		304
Repair and maintenance		100		100
Contingencies (10% of insecticides/ fungicides)		1,188		1,188
Sub-total		4,592		4,592
Total cost of production		76,753		57,348
Break-even price based on different levels of yields (mt)				
Yield/ha				
10 mt	₱ 76,753 / 10,000 = ₱7.67		₱ 57,340 / 10,000 = ₱5.73	
15 mt	₱ 76,753 / 15,000 = ₱5.12		₱ 57,348 / 15,000 = ₱3.82	
20 mt	₱ 76,753 / 20,000 = ₱3.83		₱ 57,348 / 20,000 = ₱2.87	

Sources: Tuber seed schedule adapted and updated from Technopack, rooted cuttings schedule adapted and updated from memo by Marilou Castañeda, SAPPRAD Tissue Culture Specialist

Notes: 1. Planting material: 2.5 t sprouted tuber seed x ₱12/kg; 60,000 cuttings @ .08 cents each.
2. Fertilizer: 14-14-14 @ ₱225/bag; Urea @ ₱190/bag; Chicken manure @ ₱50/sack.

Table A7. Seed potato certification requirements, Philippines[1]

	Seed Type			
	Basic	**Certified I**	**Certified II**	**Certified III**
Field standards[2]				
Varietal mixtures	0.25	0.50	0.75	1.0
Gap due to roguing and not germinating	5	10	10	10
Golden nematode	0	0	0	0
Bacterial wilt	0	0	0	0
Rhizoctonia with rolling leaves and stem rotting	5	8	10	15
Severe virus diseases	0.25	1.0	1.5	4
Varietal purity	100%	99.99%	99.95%	99.0%
Virus diseases				
Severe viruses (PLRV, PVY, mixed infections)	1	4	8	12
Mild virus (PVX, PVS, PVM)	5	10	20	30
Postharvest disease tolerances after storage and before selling for all classes of certified seeds				
Dry rot	1% by weight			
External damages (cuts, bruises, insect damage, malformed tubers, etc.)	3% by weight			
Scab (no more than 20% of tuber surface is attacked)				
Field requirements before planting				
.5 ha minimum area				
1,600 m minimum altitude				
Rotation of non-*solanum* crops previous two seasons				
Absence of gold nematode, bacterial wilt and ground keepers				
Minimum isolation distance between				
Basic and certified 2 m				
Certified and table 20 m				
Basic and table 50 m				

Source: Technopack.
Notes: 1. All standards are in percent or tolerance level. 2. Field standards are permitted tolerances for first inspection. Three inspections are required.