

THE SEED POTATO SYSTEM IN BOLIVIA: ORGANISATIONAL GROWTH AND MISSING LINKS

Jeffery W. Bentley and Daniel Vasques

Abstract

Potatoes are a traditional, low-value staple food, produced by over 200,000 smallholders in Bolivia. Developing a formal seed system is a challenge; the seed is vegetative—not true seed—bulky, difficult to multiply and expensive to haul over dirt roads in the sparsely populated, dry Andes. In spite of these problems, Bolivia is one of the few countries with any kind of formal system for seed potato. This paper analyses the performance of individual components of the formal seed system and examines the interactions between the components. It highlights the importance of communication between projects and organisations and underlines the crucial role of local marketing and distribution in seed system development.

Donors have played a key role in the development of the seed potato system. A source seed project was initiated by the Swiss in 1984; a Dutch seed multiplication and extension project which organised small-scale seed producers into small seed firms began in 1990; a potato research project also began in 1990 with Swiss and World Bank funding; and seed quality control capacity was strengthened with US support, beginning in 1992. Bolivia's seed system is better integrated than one might expect, given the diversity of donors and projects, and there are several examples of excellent coordination. But there are also several serious gaps in communication within the seed system. Links with research and marketing are particularly problematic and these raise questions about the future performance and focus of the system.

Most institutions that work with small-scale Bolivian seed producers have marginalised community organisations, choosing instead to form alternative groups which are said to be easier to work with. All of these institutions are financially dependent on foreign donors. The demand for certified seed potatoes is small and easily saturated. Probably over half of this demand is stimulated by NGOs donating seed, rather than by the market. Other problems faced by seed firms include quality control (management of light, storage, sprout management and pest control) and nematode infestation—seed producers are cutting forests to escape nematodes. Another shortcoming of the current seed system is its lack of attention to indigenous marketing channels. The vast majority of Bolivia's (informal) seed potato is marketed by small-scale merchants, but seed projects have chosen to ignore this resource.

In spite of the above problems, Bolivia does have a functioning system for providing seed potatoes to farmers. Improved and European varieties are now widespread in Bolivia and smallholder farmers have accepted new varieties. Protected seedbeds, designed by researchers in farmers' fields, are proving to be effective for raising small amounts of high quality seed potatoes. A semi-formal seed system is developing spontaneously among farmers who can no longer grow certified seed.

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Acronyms and abbreviations

ARADO	Rural Agricultural Action for Organised Development
CIP	International Potato Centre
CNS	National Seed Council
GAPPs	Associated Group of Potato Producers
IBTA	Bolivian Institute of Agriculture and Livestock Technology
OLS	Seeds Office and Laboratory
PADER	Rural Development Support Programme
PESEM	Small seed firm
PROINPA	Potato research programme
PROSEMPA	National potato seed project
SDC	Swiss Agency for Development and Cooperation
SEMTA	Multiple Service Centre in Appropriate Technologies

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1 INTRODUCTION

This paper analyses the performance of the seed potato system in Bolivia. It is based upon intensive discussions held with individuals and groups involved in the seed sector. The paper begins with a brief introduction to the status of potato production in Bolivia. The majority of the paper is devoted to an analysis of the performance of (and links between) the major components of the formal seed system: variety development, source seed production, quality control, seed multiplication and marketing. The unexplored potential of traditional marketing systems are also described. The paper concludes with lessons for seed system development.

Potato farmers in Bolivia

Potatoes are the daily bread of Bolivia, produced by over 200,000 smallholders (Thiele, personal communication). A peasant family of eight can eat 25 pounds in two days. Total annual production in 1993/94 was estimated to be 677,000 tonnes (Zeballos and Hernán, 1997), equivalent to about half a pound per person per day. Although generally eaten boiled, they can be fried, stuffed and in the cold country above 4,000 metres, prepared from *ch'uñu*, traditional freeze-dried potatoes.

Potato seed producers are generally smallholders—indigenous highlanders who tend to produce less than a hectare of potatoes each year. In formal seed production, seed size is controlled by defoliating plants when tubers reach the right size. However, tuber size is not controlled in informal seed production. Informal seed potatoes are almost a by-product of ware (main crop) potatoes; smaller potatoes are sorted from ware potatoes during harvest in certain highland areas known for good seed and sold as seed. Traditional, informal seed flows are geographically, socially and economically complex (Thiele, 1997).

The consumers of seed potato are smallholder peasant farmers. Three geographical areas of seed users can be distinguished—the valleys of Santa Cruz; other valleys (higher than Santa Cruz); and the Altiplano ('high plains') (Map 1).

The valleys of Santa Cruz are usually located below 2,000 metres, where farmers need to buy seed potato annually, or at least every two or three years, because of virus and other problems; the aphids that transmit the most important virus thrive at lower altitudes (Thiele, 1997). These are the most commercial farmers, Spanish-speaking, but still small-scale, with one or two hectares of potatoes. They are located far from their seed sources and close to the french-fry market of the city of Santa Cruz, in eastern, lowland Bolivia.

Farmers in the higher valleys of Cochabamba are usually Quechua-speakers. These warm valleys are found between 1,000 to 3,000 metres above sea level and are semi-arid, with an average rainfall of less than 500 mm per year. Farmers who are fortunate enough to have irrigation can produce *mishka* [early season] potatoes, harvested in December or January. They are Quechua or Spanish-speaking and tend to produce two potato crops a year on a hectare or two of land. In this paper, they are referred to as 'commercial farmers', although much of their produce ends up on their own table.

At the other end of the spectrum are 'subsistence' farmers, found above 3,000 metres in the valley heads and at 4,000 metres or higher on the Altiplano. These farmers tend to be Quechua or Aymara-speaking and may sell some potatoes, including *ch'uñu*.

The nature of seed potato

Seed potatoes¹ are more difficult to produce and supply than grain or pulse seed. A seed:harvest ratio of 1:20 for potatoes is considered good, compared to about 1:400 for maize. One hectare may therefore require two tonnes of seed potatoes, compared with 18 kilograms of maize seed. Seed potatoes must be stored for several weeks before they can be planted and the right amount of light, warmth and humidity is crucial to ensure good seed quality. Bulky seed potatoes attract and transport pests. These include late blight, Andean potato weevils, nematodes, tuber moths and a virus—transmitted in the field by aphids and then carried from generation to generation in the seed—which cuts yields by up to 20 per cent (Thiele, 1997). Seed potatoes have high transportation costs because of the great distances in Bolivia; population density was only 6.7 inhabitants per square kilometre in 1993. Its villages are dozens of kilometres apart and often hundreds of kilometres from the cities, usually linked by mountainous dirt roads.

Demand for formal seed potato

An understanding of formal seed systems require an analysis of seed demand. Tripp (1997) describes conditions under which farmers might demand seed: (i) where chronic poverty leads to cyclical seed loss; (ii) in emergency situations; (iii) for seed management reasons; and (iv) to obtain a new variety. An important source of seed demand in Bolivia arises from the need to control virus and other seed health problems that affect production in the lower valleys. This

requires farmers to replace seed frequently. A second potential source of seed demand is the (occasional) acquisition of new varieties. About 10 varieties now account for nearly all commercial potato production in Bolivia and for much of the subsistence harvest as well. The potato research programme—PROINPA—lists 13 native and improved varieties (not counting imported varieties) as being commercially important.

Another 17 native varieties are of local importance (Ugarte *et al*, 1997), with most of these grown by subsistence farmers in the Altiplano. Dozens of other varieties are still grown in tiny amounts. An important result of development projects has been the loss of many of these native varieties.

The informal system

About 98 per cent of the Bolivian seed potato demand is met through the informal system (Thiele, 1997). Farmers' first option is to save their own seed (Gamboa,

1993). This is more feasible above 2,000 metres, where there are fewer virus problems. A second option is to exchange seed with friends or neighbours, although the practice is not as common as it once was. The third option is to buy informal seed from merchants. There are two kinds: *camioneros* [truckers] who have lorries; and more importantly *rescatistas* [salvagers] who deal in less-than-carload volumes. Improved roads and trucking since the 1950s and 1960s have increased the volume of purchased seed.

Table 1 Formal seed potato provision in Bolivia

Plant Breeding/ Variety Development	(PROINPA/IBTA or imported varieties)			
Source Seed	SEPA			
Seed Multiplication (PROSEMPA)	PESEMS	SEPA	ARADO	Small private seed producers
Quality Control	OLS	OLS	OLS	OLS
Marketing/ Distribution	Directly by some PESEMS or seed producers through PROSEMPA or other donor projects and NGOs	SEPA outlets	ARADO or input merchants	Input dealers,

Box 1 Institutions in Bolivia's formal seed potato sector

APROSEPA	Asociación de Productores de Semilla de Papa (<i>Association of Seed Potato Producers</i>). Encouraged by PROSEMPA.
ARADO	Acción Rural Agrícola de Desarrollo Organizado (<i>Rural Agricultural Action for Organised Development</i>). A growers' organisation in Cochabamba, which produces seed potato and other seeds.
CIP	Centro Internacional de la Papa (<i>International Potato Centre</i>). Part of the CGIAR system, has its headquarters in Peru.
CIPCA	Centro de Investigación y Promoción del Campesinado (<i>Centre for the Research and Advancement of the Peasantry</i>). A development agency directed by the Jesuits.
CNS	Consejo Nacional de Semillas (<i>National Seed Council</i>). Bolivian government seed quality control agency.
FDC	Fondo del Desarrollo Campesino (<i>Peasant Development Fund</i>). Bolivian government funding agency for smallholder farmer development.
GAPP	Grupo Asociado de Productores de Papa (<i>Associated Group of Potato Producers</i>). Potato seed users' organisations sponsored by PROSEMPA.
IBTA	Instituto Boliviano de Tecnología Agropecuaria (<i>Bolivian Institute of Agricultural and Livestock Technology</i>). Bolivian government agricultural research agency.
OLS	Oficina y Laboratorio de Semillas (<i>Seeds Office and Laboratory</i>). Departmental government seed quality control agencies, with financial support from PL-480 (US).
PADER	Programa de Apoyo al Desarrollo Rural (<i>Rural Development Support Programme</i>). A seed project for subsistence farmers, financed by UNICEF and operated by the local farmers' union, with technical support from PROINPA.
PESEM	Pequeña Empresa Semillera (<i>Small Seed Firm</i>). Potato seed producers' organisations sponsored by PROSEMPA.
PROINPA	Programa de Investigación de la Papa (<i>Potato Research Program</i>). A national-level project sponsored by CIP, Swiss Development and the World Bank. Formally part of IBTA.
PROSEMPA	Proyecto Nacional de Semilla de Papa (<i>National Potato Seed Project</i>). A national-level potato extension project sponsored by the CNS and the government of the Netherlands.
SEMTA	Centro de Servicios Múltiples en Tecnologías Apropriadas (<i>Multiple Service Centre in Appropriate Technologies</i>). A Bolivian NGO.
SEPA	Unidad de Producción de Semilla/Semilla de Papa (<i>Seed Production Unit/Potato Seed</i>).

2 THE FORMAL SEED SYSTEM

Formal seed potato projects in Bolivia are generally justified by citing low yields, which were only 6.8 t/ha in 1970-72, but had fallen to 5.4 t/ha by 1992-94 (Zeballos and Hernán, 1997). These kinds of official figures are however notoriously inaccurate and low—government estimates of total agricultural land are, for example, about half of cultivated land observed from satellites (Montes de Oca, 1989). Nevertheless, these are the kinds of figures that policy makers cite. Project designers attribute low yields partially to seed quality problems (e.g. virus, nematodes) and often assume new varieties will be higher yielding.

The institutions in Bolivia's formal seed potato sector are listed in Box 1 and the structure is summarised in Table 1.

Until 1989, potato breeding was carried out by the Bolivian Institute of Agricultural and Livestock Technology (IBTA). In 1989, the Swiss Agency for Development and Cooperation (SDC) funded a research programme—PROINPA—in association with the International Potato Centre (CIP), the World Bank and the Bolivian government. PROINPA has a breeding programme and generates and adapts technology for potato growing. It has three breeders, access to four experimental stations and an extensive on-farm research programme. PROINPA currently offers eight varieties, with another 25 in the pipeline. However, it only has small amounts of seed available for its varieties. PROINPA has cleaned the virus from about 30 local potato varieties and returned them to farmers. It also operates a gene bank with about 50,000 acquisitions.

PROINPA passes its finished varieties to SEPA, a Swiss-funded source seed project initiated in 1994. It is striving to become a private, self-sustaining enterprise by the year 2000. SEPA however receives the majority of its varieties from other sources. SEPA has introduced many new varieties and gained a reputation for high

quality seed, produced with smallholder contract farmers. This was facilitated by its links with ARADO, an NGO that has been organising farmers since 1964 and producing potatoes since 1975. SEPA offers seed of eight varieties, three of which account for the majority of demand.

A seed multiplication service—PROSEMPA—was established in 1989 with Dutch financing and organised farmers to multiply source seed from SEPA. Most seed production is in the hands of PESEMs, multi-household farmer firms (more like village co-operatives) which have been established and supported by PROSEMPA. SEPA also sells seed directly to organisations and NGOs. Rural Agricultural Action for Organised Development (ARADO), works closely with hundreds of farmers to produce formal seed from SEPA source seed. There are also a few small private firms, but there is little information on their operations. Quality control is provided to the PESEMs and SEPA (nominally, as their own internal quality control is excellent) by the USAID-supported Seeds Office and Laboratory (OLS).

The marketing of formal seed is generally carried out by producer organisations. For example, ARADO and SEPA sell directly to institutions and to farmers. SEPA also sells through commissioned merchants (agrochemical stores) in the valleys of Santa Cruz and in Chuquisaca. Marketing is a major weakness of the PESEMs, which in most cases still depend on PROSEMPA agronomists to help them make contacts with buyers (whether institutions or farmers). PROSEMPA has organised groups of seed users (GAPPs) to stimulate demand, although some of these have now begun to work like PESEMs. Some GAPPs that have bought seed to grow ware potatoes have been disappointed with the quality of the seed they bought from PESEMs. Merchants are conspicuously absent from the formal seed network.

Box 2 Description of farmer organisations (PESEMs and GAPPs)

PESEM—Small Seed Firms

Formal organisation of smallholder farmers in a single rural community, dedicated to producing seed potatoes. Membership is usually by household (e.g. a husband and wife join the PESEM together). Some PESEMs have over 30 members, others as few as seven. Not all households in a community choose to join the PESEM.

Responsibilities and benefits of individual PESEM members:

- Buy bio-chemical inputs
- Provide land
- Hire labour and provide household labour
- Manage seed production
- Sell the seed and keep the earnings

Collective responsibilities of the PESEM:

- Manage the flow of money, information and inputs between the PESEM and source seed provider (usually SEPA), technical assistance (usually PROSEMPA), quality control and certification officials (OLS)
- Coordinate with PROSEMPA to find buyers (who buy from individual members).
- Some PESEMs arrange for bulk purchases and transportation of agro-chemicals.
- Some PESEMs have communal silos, built by donors. Others have individual silos.
- Some PESEMs have contact with scientific research institutions (e.g. PROINPA).

GAPPs—Associated Group of Potato Producers

Sponsored by PROSEMPA, they resemble PESEMs, but their purpose is to stimulate demand for seed produced by PESEMs. GAPPs are made up of smallholder farmers who raise commercial food potatoes.

Box 3 Contrasting philosophies of PROSEMPA and PROINPA

	PROINPA	PROSEMPA
Mandate	Research	Extension and multiplication
Topic	All phases of potato production	Mainly seed
Client farmers	Subsistence and commercial	Smallholder and commercial
Geography	Valleys and Altiplano	Emphasis on valleys
Number of varieties	Interested in all	Five or six commercial varieties
Kind of varieties	Emphasis on biodiversity, esp. of Andean (andigena) types. Keeps large germplasm bank	Especially imported "Dutch" (tuberosum) types

3 VARIETY DEVELOPMENT

Developing and importing new varieties

Farmers' varietal demands depend on geography. Farmers on the Altiplano demand frost, drought and hail resistance and seek varieties that are palatable when boiled or freeze-dried. Altiplano farmers maintain many varieties for their different tastes, colours etc. Valley farmers, especially those in the lower valleys, demand varieties that respond well to irrigation and fertiliser and in some areas, resistance to frost and hail is also important. Valley farmers want varieties with market demand—especially potatoes for frying. Farmers in both the valleys and the Altiplano demand varieties that are resistant to certain pests, especially late blight and nematodes. Most commercial farmers show little concern over biodiversity and are content to grow monocultures of Desirée (Tripp, 1996).

PROINPA is the only major potato research organisation in Bolivia and develops new varieties often utilising genetic material from CIP. However there has been little uptake of their varieties. In 1998, the Bolivian government withdrew support from PROINPA (and from much of the rest of the government's agricultural programmes) and it became a semi-private foundation with continued support from SDC.

PROINPA began work in 1989 with a diagnostic survey to set the research agenda (Watson, 1990). It continues to study the limiting factors identified by farmers, including problems with climate (frost, drought) and pests. Many of its staff are young professionals who started in the early 1990s as thesis students and morale is high. Prior to 1989, IBTA's plant breeding programme had experienced a certain degree of success, re-releasing several native varieties such as Waych'a which displaced Imilla Blanca and became widespread (Thiele, 1997). PROINPA tried to repeat this success in 1992, by releasing Gendarme, based on evaluations of material in

the germplasm bank. Despite its apparently high potential, PROINPA has not been able to meet the demand for seed and expansion has been slow. Early in the programme, PROINPA breeders brought 350 advanced materials from CIP and Colombia and selected five hybrid varieties all with durable resistance to late blight. These are almost ready for release, but there have been problems with seed regulations, the costs of registration and once more a lack of seed. PROINPA offered eight native or introduced varieties in 1997/98 which are not available in the formal sector (Ugarte *et al*, 1997).

PROINPA conducts a broad research agenda, on-station and on-farm. Social science and farmer participation are important, even for on-station research (Thiele *et al*, 1996, 1997; Unidad de Innovación Tecnológica, 1996). PROINPA maintains good relations with farmers in some communities, especially near research stations and where participatory research is conducted. Although PROINPA was supposed to research varieties for PROSEMPA to multiply and extend, the two organisations have evolved different philosophies and have difficulties working together (Box 3). There is no longer a State extension service and extension capabilities are lacking, so PROINPA is starting to work directly with some NGOs.

Consequently there is little opportunity for feedback from PROSEMPA to PROINPA to allow researchers to refine technologies. Some PROSEMPA staff complained that much of PROINPA technology was irrelevant and that PROSEMPA already had the technology it needed.

PROSEMPA has helped form *foros paperos* [potato forums] with elected representatives of seed growers. One of the intended functions of these forums was to provide feedback and channel farmers' demands to researchers; they represent an opportunity for contact between seed producers and users. Although the forums were originally proposed by PROINPA, they have been developed by PROSEMPA and there is little feedback from farmers to researchers. The forums have helped test some new PROINPA varieties but still need support.

A steering committee exists to facilitate collaboration, with representatives from PROINPA, PROSEMPA, the Ministry of Agriculture, National Seed Council (CNS), IBTA, the Dutch Technical Mission and SDC. The directors of PROINPA and PROSEMPA sit on the committee, but do not have voting rights. The committee has failed to induce close collaboration between the two organisations. PROINPA does supply PROSEMPA with cleaned up local varieties and there are some instances of local collaboration, such as setting up potato forums with representatives from PESEMs. However, cooperation remains largely outside the formal chain of command and is based on personal friendships, usually between agronomists who knew each other in university.

SEPA also has its own varieties, including natives (e.g. Waych'a) and European imports. The most important import is Desirée, by far the most popular variety in the valleys. It has a short cycle (three months instead of four or more) which allows it to escape hail damage. It also

Box 4 How protected seedbeds were developed

The idea was apparently first conceived in La Paz by two Bolivian NGOs: Multiple Service Centre in Appropriate Technologies (SEMTA) and Centre for the Research and Advancement of the Peasantry (CIPCA). According to Gino Aguirre, a PROINPA agronomist, some of CIPCA's Spanish priests may have based the idea on traditional European vegetable greenhouses. Most of the greenhouse designs were inappropriate for the Altiplano, although NGOs continue to promote them there. The seedbeds evolved from smaller, more appropriate greenhouses (Kohl, 1991). SEMTA and CIPCA introduced the first seedbeds during the drought of 1983-84 in La Paz, the provinces of Pacajes and Ingavi, near Lake Titicaca and the Peruvian border. The seedbeds originally grew vegetables, including some potatoes. In 1988, Peruvian agronomists visited the seedbeds in Bolivia. The Peruvians, especially Juan Aguila, adapted the seedbeds for growing seed potatoes.

responds well to fertiliser and irrigation. Desirée is in high demand in the cities, because it is ideal for frying. Most native varieties are best boiled, which is the way rural people prefer them. They have also brought, imported and released Mexican varieties. SEPA and PROSEMPA feel that PROINPA does not release enough new varieties and complain that even when it does, the variety has no market. On the other hand, PROINPA breeders would like to release more varieties, but problems arise with their inability to produce seed and legal restrictions: PROINPA's directors originally understood that to secure breeders' rights, they would have to pay an annual fee of hundreds of dollars per variety.

Protected seedbeds and participatory research

PROINPA's protected seedbeds are a partial solution to the problem of how to multiply tiny amounts of high quality seed. Seedbeds enable 50 kilograms of good seed to be produced from two to three kilograms of pre-basic mini-tubers—which are high quality, virus-free and about the size of large marbles (Box 4). The basic idea is simple: a box of stone or adobe, less than a metre high and about 1.5 x 10 metres is built. This protected enclosure can be fertilised with organic manure and covered with plastic sheeting during hail storms or frosts and hand watered during droughts or in the dry season. One of the major expenses incurred is bringing in fresh, pathogen-free soil.

Gino Aguirre had worked with SEMTA in the 1980s before joining PROINPA and was familiar with the original seedbeds. Aguirre and PROINPA began research with seedbeds in Bolivia in 1992. At the same time, PROSEMPA had a Peruvian technician, Ricardo Wissar, who was familiar with the concept of seedbeds. Wissar extended the seedbed technology to 40 families. Although Aguirre and Wissar were aware of each other's work, they worked separately.

The Rural Development Support Programme (PADER) is a project financed by UNICEF and operated by the Farmers' Federation in Llallagua, Potosí. They

Box 5 Categories of formal seed potato in Bolivia

Elite and super-elite—imported, extremely high quality seed, used only by larger, more technical institutes such as PROINPA and SEPA as a source of new varieties.

Pre-basic—mini tubers (about the size of large marbles) produced in nurseries from micro tubers (about the size of pearls), which are produced in the laboratory, *in vitro*.

Basic—the highest category of regular seed. Produced in fields. Seed produced from pre-basic is Basic 1, if quality is maintained, the next generation is Basic 2, then Basic 3 and then Registered 1.

Registered—produced from basic seed. The first generation is Registered 1 and the second generation is Registered 2, even if quality is maintained.

Certified—produced from registered seed. There are two generations: Certified 1 and Certified 2.

Inspected seed (*fiscalizada*)—produced from registered seed. OLS certification inspectors may decide to classify seed produced from higher categories as inspected seed if there are certain quality control problems. This is a terminal category; only commercial food potatoes are produced from inspected seed.

prepare over 400 protected beds each year with farmers. The seedbeds allow them to do participatory research, e.g. varietal trials with farmers and PADER collaborates with a PROINPA agronomist based in Llallagua. PADER avoids marketing problems, since all seed produced is used by farmers for their own use. It is the only case of an organisation that works directly with *sindicatos* [farmers' unions] and is one of the few with strong ties to researchers. PROINPA staff collect data from seven households which are multiplying new varieties in protected seedbeds around Llallagua. For each variety grown, PROINPA asks each household about:

- Acceptance—what do the people think about the variety?
- Their perception of the variety's behaviour.
- If the family was familiar with the variety already (sometimes they recognise the new variety as an old variety that they had lost or that their grandparents had grown under a different name).
- Yield.
- Preference—which varieties the family likes best?

The overriding limitation remains the lack of seed. If PROINPA had more seed, they would do similar participatory research with more families (Gino Aguirre, pers. comm.).

4 SOURCE SEED—SEPA OPERATIONS

SEPA has its headquarters near Cochabamba, produces its source seed through contracts with smallholder farmers in Cochabamba and supplies it to PESEMs which multiply the formal seed. SEPA offers eight varieties. Of these, Desirée, Waych'a and Alpha are those most frequently mentioned by farmers. SEPA also sells seed to farmers who grow ware potatoes. Most of the seed is basic, registered or certified (Box 5). The prices of categories fluctuates; until recently SEPA's prices varied only by size and farmers naturally demanded higher categories.

Seed is grown by 629 contract smallholder farmers, on 247 hectares in two highland regions of Cochabamba: Ayopaya and Carrasco. In 1996-97, the total seed yield was 2,746 tonnes. The Carrasco regional activities are

headquartered at Monte Punku, a dispersed settlement of Quechua-speaking farmers. Three agronomists and an extension specialist each supervise a zone, with the help of two or three para-technicals. One of the agronomists also serves as regional manager, supervising the others. The Carrasco region works with 340 contract farmers. The relations are formal and hierarchical, with the agronomists supervising the para-technicals, who supervise the farmers. SEPA staff are typical field agronomists ‘with muddy boots and sun burns’ and maintain close contact with farmers.

SEPA organises contract farmers into *grupos* [groups] of four to ten farmers. *Grupos* overlap community boundaries and are built around 10 hectares of seed. A farmer may belong to more than one group if he has land with SEPA in more than one place. SEPA tries to minimise travel costs by clustering the parcels together. The groups have no internal organisation and no function other than working with SEPA, which self-consciously avoids working with the *sindicatos* [grass-roots farm unions]. ARADO and PROSEMPA also avoid working with *sindicatos*, preferring to set up weaker, substitute farmer organisations that are more easily handled.

SEPA provides the farmer with seed, fertiliser and pesticides on credit. The farmer provides the land and labour and agrees to sell only to SEPA. At harvest, SEPA discounts seed and fertiliser costs and six per cent for pesticides (without interest) and buys the rest of the harvest at market price, plus 10 per cent (with a 20 per cent premium for early harvest)². Travel costs are high—farmers’ fields around Monte Punku for example are typically on 50 degree slopes, accessible over several kilometres of rough jeep trails—SEPA contracts local farmers to haul out the harvest on trucks.

SEPA takes steps to maintain high quality. For example, fields must not be planted to potatoes again for four years before growing more seed potato and no ‘SEPA’ field may ever be planted with non-SEPA seed to avoid nematode contamination. SEPA agronomists (with para-technicals and groups of farmers) check each field each season for nematodes, evaluate each parcel for size of tubers, which are kept small by chemically defoliating once optimal seed size has been reached, and advise on pest control. Within a few years there may be no nematode-free land left in the highlands of Cochabamba and the quest for land beyond the ‘nematode frontier’ has accelerated land clearing. Agronomists prefer ‘virgin’ land for growing potatoes and farmers are only too glad to clear remnant stands of endangered *qhiwiña* forests (*Polylepis* spp.) to plant in virgin soil.

SEPA—Sustainability

Sustainability as a private business was not part of SEPA’s original mandate but was added years later (Bidaux *et al*, 1992). Seed sales now cover 80 per cent or more of its budget, an unusual achievement for a development project, with donors and leadership claiming that it is close to being able to operate as a

commercial firm. SEPA proposes transferring the Swiss shares to contract farmers so it will then be owned by:

Contract farmers	40%
IBTA (i.e. the Bolivian government)	30%
ASAR (NGO, founder of ARADO)	30%

SEPA staff were not interested in owning shares. This plan avoids giving majority ownership to the government.

However, any consideration of SEPA’s sustainability must acknowledge that much of the demand for SEPA’s seed is an institutional artefact. About 30 per cent of sales are to institutions and the rest to individual farmers. While the relatively low percentage of institutional sales might suggest that there is a market demand for formal seed, much of the remaining 70 per cent sold to farmers is actually bought by PESEMs and similar organisations that are supported by PROSEMPA. Much of *their* demand in turn comes from other institutions. As long as this continues, SEPA may remain profitable.

SEPA—Links

SEPA maintains good relations with OLS. SEPA’s regional managers determine when their areas will be ready for certification inspection. Their national leadership informs OLS who plans the team’s visit to SEPA’s fields and personal relations between field-level OLS and SEPA staff are good.

SEPA and PROSEMPA also collaborate well. PROSEMPA sponsors farmers from PESEMs on tours of SEPA’s facilities, where PESEM members are encouraged to buy source seed from SEPA. Some individual PESEMs are thinking of ways to reduce their dependency on SEPA.

SEPA and ARADO have the oldest ties of any of the formal seed potato institutions and ARADO still buys source seed from SEPA.

SEPA and PROINPA largely ignore each other. SEPA produces its own source seed (pre-basic seed for the varieties it already controls) *in vitro* and shows little demand for new PROINPA varieties. In 1997-98 SEPA and PROINPA are carrying out some joint trials for the first time. SEPA staff repeat familiar complaints about PROINPA—research takes too long; the results are not relevant to real world field conditions; and PROINPA doesn’t co-ordinate with others. Nevertheless, SEPA staff admit that they have no research scientists and depend on PROINPA for technical support—much of SEPA’s working information about nematodes and insects comes from PROINPA.

The weak link with scientists is probably most serious with respect to the growing problem of nematode infestation. If SEPA are to survive they will have to do one or more of the following:

- persuade OLS to relax the norms of certification to include nematode-infested seed;
- use chemical nematicides;
- find a nematode-resistant variety; or
- go out of business.

Table 2 Formal seed potato production in Bolivia, 1987 to 1996

Year	Production (tonnes)
1987	281.40
1988	493.3
1989	1,611.32
1990	2,049.97
1991	2,722.68
1992	3,096.05
1993	3,572.46
1994	4,384.97
1995	3,172.11
1996	3,595.63

Source: Consejo Nacional de Semillas (CNS)

5 QUALITY CONTROL

Bolivia has a regionalised, relatively flexible regulatory service, unusual for developing countries. Bolivia is divided politically into nine *Departamentos*, each with its own OLS, staff and board of directors to help set norms. The board is made up of 50 per cent public and 50 per cent private sector representatives. Each departmental OLS chooses the crops it works with based on local geography, and is supervised at the national level by the National Seed Council (CNS). The CNS and OLS are funded by the sale of certification services to farmers (30 per cent), the government of Bolivia (20 per cent) and the US government (50 per cent) (Rosales, 1995). The OLS offices seem to perform adequately. OLS staff visit seed producers between one and three times per cycle to ensure norms are observed—especially that fields are free of nematodes and disease. OLS charge \$37–60 per hectare for seed inspection. Some OLS officials are antagonistic towards informal seed, which accounts for at least 95 per cent of the market.

SEPA sits on the OLS board and it argued to have the norms changed in 1997 to allow SEPA to sell nematode-contaminated seed to Santa Cruz. The Cochabamba OLS had a norm prohibiting any seed with *meloidogyne* nematodes, which were originally found in Santa Cruz, but not in Cochabamba. Apparently the norm had been set to keep potatoes from Santa Cruz out of Cochabamba. However, this backfired when *meloidogyne* nematodes were found in Cochabamba seed plots in 1997. PROINPA nematologists found some females but no eggs in the potatoes. The board of directors of the Cochabamba OLS agreed to release the contaminated seed, as long as it went to Santa Cruz which already has these nematodes.

6 SEED MULTIPLICATION AND STORAGE

The PROSEMPA/PESEM system

PROSEMPA works closely with SEPA to promote the use of high-quality seed among smallholder farmers and is largely responsible for the explosion in the supply and demand of formal potato seed in Bolivia. As Table 2 shows, formal seed potato production increased more than 15 fold between 1987 and 1994 and then declined slightly.

Box 6 Contrasting styles of PESEMs

One group of 10 women, *Las Juanas*, works well because the group is old (it was founded by their mothers) and spontaneous. The women trust each other and honed their organisational skills on handicrafts and other economic activities before trying seed potatoes. They are now diversifying into grain seed. *Las Juanas* go as a group to fairs and to other communities to sell seed collectively.

APROSEPA, a PESEM in Villazón, Potosí seems to be evolving into a private firm, managed by two men. They have telephones, own trucks and have learned to manage a middle-sized seed business. While it is more efficient for the two men to manage most of the information than to submit every decision to the whole association, there are suspicions that (at least one of) the men is profiting from running the operation.

A PESEM in **Puka Puka**, Chuquisaca, has been successful in attracting financial assistance from other organisations, including donors, to market and buy agro-chemicals.

PROSEMPA (with SEPA, OLS and others) have succeeded in increasing the demand and supply of formal seed potato.

On the surface, PESEMs appear to be working well. All members interviewed were enthusiastic about producing seed. None of the seed is sold through merchants, although PROSEMPA have made efforts to help PESEMs organise buyers. Most sales are to farmer groups such as GAPPs and NGOs who distribute seed to *campesinos*. One reason the PESEMs appear to be profitable is the hidden subsidies they receive in the form of marketing and technical assistance from PROSEMPA.

Sustainability

The biggest limitation of PESEMs is their dependence on PROSEMPA to help make connections with buyers. Most buyers are institutions (especially NGOs) which distribute seed on credit or as gifts to other smallholders. This is an unstable, distorted demand. Sustainability of the formal system depends on continued demand from NGOs.

Most PESEMs are financially sustainable in that they can afford to buy chemical inputs on the open market and have access to land and labour (using household labour and traditional labour markets). Most already have enough buildings and equipment to continue for years. The sustainable profitability of growing seed potatoes will depend on:

- Supply—many new groups are entering the seed potato business, encouraged by the high profits of PESEMs. Their entry will raise supply and depress prices;
- Quality control—problems include nematode contamination, poor yields by commercial farmers who plant PESEM seed, poor light management and other storage problems, poor seed size sorting;
- Annual price fluctuations—e.g. 1996 was dry, with low potato yields and high prices for ware potatoes. This encouraged more potato planting in 1997, a wet year with high yields and low prices for food potatoes. This discouraged some commercial farmers from buying the 1997 seed crop.

Although PESEMs are called *empresas* [firms or businesses], they function more like cooperatives, are inefficient in making decisions and have high management costs. Most PESEMs depend on PROSEMPA for

Table 3 Six contrasting strategies of seed producer organisations

Name	Place	Characteristics	Links with
APROSEPA	Villazón, Potosí	Starting to be managed like a business.	PROSEMPA, Proyecto San Juan del Oro
Las Juanas	Hornos, Puna, Potosí	Old group of women.	PROSEMPA, PROINPA
Puka Puka	Tarabuco, Yamparáez, Chuquisaca	Acquire funds from donors.	At first with PROSEMPA. Plan International Critas, FAO Fertilisuelos, FDC, ACLO, Foundation Against Hunger
Most other PESEMs	Various	It is not clear that these groups are sustainable.	PROSEMPA
ARADO	High country of Carrasco, Cochabamba	The technical people are employees of the group. Credit.	ASAR
PADER	Llallagua, Potosí	They work with farmers' unions. They use technology based on protected seedbeds.	PROINPA, UNICEF

marketing, some credit and organisational support, for instance when holding meetings. A few groups have developed alternative styles, which may help make them more sustainable (Box 6).

Links

Currently, PROSEMPA links PESEMs with its clients and is aware of the need to strengthen communication links. One of PROSEMPA's contradictions is that despite its emphasis on commercial, market varieties, it avoids linking with seed traders and merchants. This creates several problems, as seed producers are usually found on the Altiplano, while their potential market is in the valleys below 2,500 metres. Almost all commercial ware potato and informal seed potato in Bolivia is transported by private merchants. The largest merchants are successful peasants with lorries; the smaller ones are indigenous women who buy half a dozen bags at rural fairs. Most PESEMs are emphatic that they will not transport seed themselves. When PROSEMPA closes in mid 1998, PESEMs say that they will try to promote their seed but if buyers do not come to them, they will not haul seed themselves.

Nearly all PESEMs can and do contract their departmental OLS themselves which depends on smallholder farmers for its seed certification mandate and identity. Links between PESEMs and scientific institutions such as PROINPA are sporadic.

PESEM relations with SEPA are generally strong, but there is growing dissatisfaction with SEPA's prices for source seed. Some seed producer groups are adjusting to price and quality constraints by buying pre-basic seed (mini-tubers) from SEPA or PROINPA and rearing basic seed themselves in protected seed beds. If properly managed in a protected seed bed, a kilo of pre-basic seed can yield 50 kg of basic seed (worth about \$28). While seedbeds are a way of guaranteeing supply and lowering dependence on an external source of seed, raising seed in protected seedbeds does not save producers money, but farmers claim that the crop is more likely to be free of disease and nematodes.

Storage and technical problems

Donors tend to support communal silos for potato storage. It is not clear whether this is due to romantic ideas about peasant cooperation, or to save disbursement costs. Communal silos are rapidly abandoned or taken over by a single household as farmers do not like walking long distances to them and villagers do not always trust their neighbours. Donors are slowly realising that farmers want household silos, which are versatile enough for storing seed and ware potatoes. Agronomic problems experienced by many PESEMs include:

- Light—silos are dark or too bright;
- Management of ventilation and humidity in the silos;
- Sprouts—producers in general do not know to remove sprouts from Dutch varieties;
- Pests—several institutions are biased toward chemical control. In the long run this could create more problems with insect pests.

Farmers and extensionists are starting to complain about technical problems with PESEM seed. Perceptions of poor quality create high transaction costs and lower demand (Thiele, 1997; Tripp, 1997).

The ARADO alternative

ARADO was started by ASAR about 1964 as a farmers' organisation. After 1975, ARADO and ASAR grew potatoes on a share basis—ASAR provided bio-chemical inputs and technical assistance and ARADO provided land and labour—dividing the harvest 50:50. Around 1985 ARADO separated from ASAR and hired its own technical staff. Shortly thereafter, ARADO experienced problems with imported seed potatoes. Membership declined sharply, many technical staff members found other jobs and ARADO's outside donations stopped.

With the continued commitment of remaining members and the support of other organisations, ARADO survived and has gradually begun to recover. It now works in two areas, including the highlands of Carrasco, Cochabamba where it produces seed potato. It is also involved in other activities including wheat and barley seed production, small-scale irrigation, rural roads and renting trucks. ARADO

Table 4 Informal and semi-formal seed potato provision in Bolivia

	Informal	Semi-formal
Plant Breeding/ Variety Development	Local varieties and MVs retained by farmers	Local varieties and MVs retained by farmers
Source Seed	Selected by farmers or purchased in markets	Selected by farmers or purchased in markets
Seed Multiplication	Individual farmers	Individual farmers (often with experience from the formal system); some PESEMs
Quality control	Farmers and merchants	Farmers—no formal certification due to nematodes
Marketing/distribution	Used on farm/bartered to local farmers or sold to traders	Sold at potato markets through PESEMs/GAPPs

produces seed in the same area as SEPA and experiences similar problems with nematodes. It is getting more difficult to find 'clean' parcels. ARADO's seed is certified by OLS. Most is sold to institutions and the rest to farmers. ARADO membership is divided into two regions (Alturas and Pojo) with 22 centres and a total of 225 members. Each centre and region has officers elected by the members.

ARADO extends seed and agro-chemicals to members on credit. Some of this seed is bought from SEPA; some of it is certified seed produced by ARADO members, purchased and stored by ARADO. At harvest, members must repay the seed in kind, plus 35 per cent to offset shrinkage in storage. Debts for agro-chemicals are re-paid with 15 per cent annual interest. After repaying debts, members sell the remaining harvest to ARADO at market price plus a premium and ARADO re-sells this as seed. The ARADO price premium is based on two principles: honest weight and an additional percentage. According to an ARADO economist, a *carga* in the El Puente market is 110 or 120 kg ARADO buys *cargas* of an honest weight of 100 kg at the same price (or better) as the El Puente market. On top of this, ARADO pays an additional percentage—5 per cent over the El Puente price for informal seed and 10 per cent over for registered seed (Box 5).

Table 3 summarises different management styles of PESEMs, ARADO and PADER.

Although ARADO's seed producing region is in the same area as SEPA's and is near to a PROINPA research station, relationships with SEPA and PROINPA are deteriorating. ARADO still buys source seed from SEPA, but is suspicious of SEPA's closer links with the OLS. In 1996-97, when SEPA was able to have the norms changed so that seed potato from 15 hectares of nematode-infested SEPA farms could

be sold to farmers in Santa Cruz valleys, ARADO was forced to sell 15 hectares of nematode-infested seed as ware potato. Since 1997, SEPA has no longer accepted members of ARADO as contract farmers with SEPA, claiming that the demands of each organisation are so high that farmers cannot work well with both.

ARADO may be able to emulate the semi-formal system as a partial solution to the nematode crisis (Box 7).

In future, ARADO could work with members whose soil is infested with nematodes, helping them to produce good seed with an honest label, at a lower price than certified seed, but higher than ware potatoes. For example, PROSEMPA creates GAPPs in nematode infested areas where farmers produce informal seed.

Table 4 illustrates how the semi-formal system has evolved from informal seed provision.

7 FORMAL MARKETING

Tripp (1997) observes that a number of NGO seed projects have tried to develop seed 'producer-sellers', but these efforts have been flawed by the assumption that farmers have the requisite marketing skills they need. Most PESEMs depend on PROSEMPA for marketing. PROSEMPA extensionists help some PESEMs organise field days to bring farmers from

Box 7 The semi-formal system

A few farmers in the Carrasco highlands are starting to raise 'semi-formal' seed potato. Many are former members of ARADO or contract farmers of SEPA. Their land has become contaminated with nematodes and so they are unable to raise formal seed. As in the formal system, they control the size of tubers, keeping them small by defoliating the plants when tubers reach seed size; and they compensate for smaller tuber size by planting more densely. This semi-formal system is perhaps the clearest example that the formal system has had an impact on Bolivian farming. If the formal system ever ends or is greatly modified, the semi-formal system may be one of its lasting contributions.

Box 8 Independent marketing strategies

Las Juanas dislike the paperwork and taxes involved in selling to institutions, preferring to sell to other farmers. The women sell seed at the weekly market fair in their area and hold demonstrations in neighbouring communities, returning several times from planting till harvest, when they cook and eat the potatoes with potential clients, to show them how good the crop is and to take orders for seed.

APROSEPA leaders claim to sell directly to other farmers in warm valleys all over Bolivia, using promotional methods they learned from PROSEMPA, although they complain that they cannot sell all their seed. In 1997, APROSEPA organised a national seed potato fair, attracting many farmers and institutions to Villazón.

The members of **Puka Puka** sell in large lots to institutions (e.g. 20 tonnes to PLAN and 35 tonnes to Fundación Contra el Hambre, for Peru). They now want to make a promotional video to show to institutions. They dedicate 20 hectares to growing formal seed for sale to institutions and 10 hectares for informal seed for *mishkero* farmers in nearby valleys.

ARADO has a marketing specialist, who handles all the marketing for the institution. Buyers may purchase potatoes either at the Complex in Carrasco or at ARADO headquarters in Cochabamba.

Box 9 Bolivian Quechua folk categories for commercial potato sizes

(Also generally used when speaking Spanish).
 In order of largest to smallest:
Chapara—very large commercial food potatoes.
Qulqi—also means silver or money. The most common size of commercial food potatoes.
Murmu—about the size of hens eggs—seed potato.
Ch'ili—also means small. Very small and damaged potatoes. Used as animal feed

other areas to meet PESEM members and see their product being grown. PROSEMPA also makes contacts with institutions that buy PESEM seed. At the time of purchase, buyers come to the PESEM, meet the director and buy seed from individual farmers, renting a truck to haul the seed. Many groups do not have the same buyers from year to year and so have not built up relations with clients. PROSEMPA staff are aware that most PESEMs lack market skills and contacts. Some of the more successful formal seed producers in Bolivia have developed more independent marketing strategies (Box 8).

8 INFORMAL MARKETING

Marketing is a weak link in the formal seed system. Despite this most organisations continue to ignore the potential offered by informal marketing channels. West of Tiraque, along the old highway to Santa Cruz, there is a vast area of isolated farms, with no towns and few nucleated villages. SEPA, ARADO and PROINPA all work here as it is prime potato country—over 3,000 metres and with a yearly rainfall of about 450 mm. A hundred kilometres from Cochabamba there is a cluster of houses known as El Puente [the bridge], where there is a fair every Monday. Travelling merchants and farmers meet to buy and sell, especially potatoes. These markets are common in rural Bolivia. Larson (1998) reports that small-sale merchants—usually women of peasant origin—trading in agricultural produce have a tradition stretching back at least 200 years.

Seed (and ware) potatoes at El Puente are sold by local merchants to private merchants who transport them out of the region for re-sale. As farmers have become more sophisticated, the El Puente market began offering premium prices for informal seed potatoes. At another market in nearby Tiraque, farmers pay truckers to have their ware and informal seed potato hauled to a pavilion in the middle of the town. Each farmer sets his bags on the crowded floor and merchants mingle among them until they agree on a price with a particular farmer. The farmer pays the municipality to have the potatoes weighed and the merchant pays labourers to load trucks. A representative from the local farmers' federation collects a fee per bag loaded, paid by the merchants. Most truckers do not buy potatoes, but merely transport them for a group of merchants—often three or four women. The merchants see their potatoes loaded onto trucks, then board buses for the places where they will meet their product, see it unloaded and sell it.

The social structure and economics of these small-scale merchants is not fully understood. It is a competitive,

Box 10 A farmer who could produce formal seed, but will not

DM is a Quechua-speaking smallholder farmer in Cochabamba, an ideal habitat for seed potato. In the past he worked with ARADO and SEPA producing formal seed potato. He is a 'wealthy' peasant, producing about four hectares of potatoes. He speaks Spanish and asserts that he knows how to contact the OLS office and make arrangements for certification inspections. DM understands perfectly how to produce formal seed. Nevertheless, except for the seed potatoes he produces for SEPA, he does not produce seed potato on his own, claiming that it is too much trouble. He sells seed-sized potatoes to merchants who re-sell it in other communities. DM does not even use formal seed in his own fields; buys informal seed, claiming that it is of higher quality and cheaper than formal seed.

information-intensive market, dominated by small firms in much the way that potato production is dominated by small, household firms. Merchants have little capacity to promote new varieties and reputation for quality among farmers is uneven. Many of the formal institutions see them as a menace, claiming that they will sell anything as seed. Most purchased seed however comes from this informal sector. Their market niche is cheap seed, delivered in a timely, abundant manner. Farmers who buy informal seed distrust merchants they do not know. The merchants' 'neighbourhood certification' consists of assuring that the seed is from certain highland areas with a reputation for high quality seed (Thiele, 1997). At harvest, farmers sort potatoes into folk categories (Box 9).

Overall the market niche for formal seed is poorly developed (except in some places such as the Santa Cruz valleys) and farmers often prefer to produce informal seed (Box 10).

9 LESSONS

Bolivia has a functioning formal seed system for potatoes. The system owes its existence to the efforts of individual donor projects that have been active over the past decade. It encompasses several organisations responsible for different elements of seed provision. These organisations benefit from the services of competent, professional Bolivian staff. The system delivers a significant quantity of seed potato to Bolivian farmers. The financial sustainability of this system is however open to question. Donor funding still provides crucial support. The Bolivian government has recently announced its inability to guarantee funding for agricultural research. SEPA, the source seed producer, is struggling towards commercial independence. The quality control agencies charge for their services, but still depend on some donor support. Seed multiplication is carried out by farmer organisations, but the demand for their seed is often inflated by donor and NGO projects.

Financial stability is not the only concern, this paper has devoted its attention to the organisational strengths and weaknesses of the seed potato system. One notable strength is the capacity of the individual organisations that contribute to the seed system. They have well-focussed mandates and strong central leadership. But this organisational strength must be contrasted with the relative weakness of the majority of farmer organisations that participate in the seed system. The strategy has been to set up weak, easily manipulated

farmer organisations, rather than strengthening existing entities such as farmer unions. Future studies are needed to judge the effectiveness of this strategy.

Another strength of the current system is the excellent communication that exists between several of the organisations. Relations among seed producers, quality control agencies and the source seed supplier seem to be satisfactory. The personal and professional links that characterise these relations bode well for organisational sustainability. But there are also several serious gaps in communication within the seed system. Links with research and marketing are particularly problematic and these raise questions about the future performance and focus of the system.

The seed system has little contact with the agricultural research service. This situation has arisen because imported varieties comprise the majority of seed demand among the commercially oriented farmers, who are the principal clients of the formal seed system. Poor communication between researchers and the seed system severely limit the possibility of delivering improved varieties to these farmers. The research service also devotes considerable effort to developing new varieties, or providing clean sources of traditional varieties, that are of interest to the more subsistence oriented farmers. But current lack of communication means that these varieties have little chance of being delivered through the formal seed system. The research service has been forced to explore alternative means of delivering seed of new varieties to these farmers.

Another shortcoming of the current seed system is its lack of attention to indigenous marketing channels. The vast majority of Bolivia's (informal) seed potato is marketed by small-scale merchants, but donor seed projects have chosen to ignore this resource. It is ironic that donors emphasize seed production through smallholders in order to raise rural incomes, but they are unsympathetic to marketing by equally impoverished, generally female, merchants. Instead, the focus has been on established farmer groups taking on the dual responsibilities of seed multiplication and marketing. This strategy is based on the questionable assumption that farmers are willing and able to develop the necessary marketing skills. The strategy has been unsuccessful and donors and NGOs have assumed many of the seed marketing tasks supposedly assigned to farmer groups. It is significant that the few groups or associations that appear to have a chance of commercial survival are those that already have marketing experience.

Finally, there are concerns about the sustainability of current seed quality control strategies. Nematodes are a limiting factor to potato production and quality control procedures seek to limit their spread through seed. But nematode-free land for seed production is becoming scarce. It is unlikely that current standards can be maintained and already some compromises have been made. This is one example of the larger issue of deciding what standard of quality control is appropriate for the formal seed system. Seed of the highest quality necessarily costs more and in many cases farmers may not be willing to pay this price. As the growth of the semi-formal seed system demonstrates, farmers seek the quality of seed

appropriate to their needs.

The semi-formal seed system includes farmers with commercial seed production experience who sell uncertified seed. The emergence of these alternatives illustrates how seed systems evolve. The Bolivian seed system has profited from various donor efforts. Bolivian farmers have access to a more secure supply of seed potato than do their counterparts in most other developing countries. This paper has described the accomplishments of this system, as well as pointing to several deficiencies. Further evolution of seed provision capabilities in Bolivia will certainly include a diversification of strategies, as represented by these semi-formal examples. But seed system growth will be limited unless more attention is given to strengthening links with agricultural research and taking advantage of local marketing capabilities.

ENDNOTES

- 1 The term "seed potatoes" is used in this paper even though potatoes are tubers and therefore not true, botanical seed
- 2 See Section 7 and Table 3, which describe ARADO's price premiums; SEPA's price regime seems to have been inspired by ARADO's.

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