Diagnostic of seed potato systems in Bolivia, Ecuador and Peru focusing on native varieties

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Abstract

The Papa Andina Initiative of the International Potato Center (CIP) and its partners in Bolivia, Ecuador and Peru promote technological, commercial and institutional innovations along the potato chain to link small-scale farmers to new urban markets taking advantage of potato biodiversity. Markets are responding and demands significant volumes of high quality native varieties. In order to meet this demand, farmers are challenged to improve yield and quality of their crops, but one of the main limiting factors is availability of seed. A diagnostic of potato seed systems in these three countries was carried out in early 2008. Main conclusions were: (i) the availability of most native varieties in the three countries depends on small farmers, who preserve these varieties *in situ*; (ii) in most cases seed of native varieties is produced under *campesino* or mixed systems, mainly for self-consumption and, in a lower degree, for the market; (iii) factors causing seed degeneration and agronomic technologies for seed production are well identified for improved varieties, but almost nothing is known for native varieties; (iv) there are many projects and institutions that are currently helping farmers to produce seed; and (v) sustainability of any seed production system depends on the quality requirements of the market, which becomes the driving force for the development of a quality seed market. Mixed and *campesino* systems were identified as the most promising alternatives for potato seed production with small farmers in the Andes to respond to market demands.

Keywords: Andes, seed production, formal system, informal system.

Introduction

Potato is a staple food in the Andean countries. Hundreds of native varieties are very well appreciated by farmers and their families because of their excellent culinary qualities. These varieties have now better and increased commercial perspectives as big companies, like Frito Lay, have developed new commercial products. In addition, consumption of fresh tubers is increasing. Part of the production is sold in urban markets, and another part is used for self consumption, which make native varieties very important for food security. Unfortunately, small farmers obtain very low yields, partly due to poor seed quality. In order to accomplish new plans to expand markets, it is required to improve the production and quality of seed tubers.

The Papa Andina Initiative of the International Potato Center (CIP) and its partners in Bolivia (PROINPA Foundation, Promoción e Investigación de Productos Andinos), Ecuador (INIAP, Instituto Nacional Autónomo de Investigaciones Agropecuarias) and Peru (INCOPA Project, Innovación y Competitividad de la Papa) implemented this study to diagnose the current situation of the production systems of tuber seeds focusing on native potato varieties of Bolivia, Ecuador and Peru, in order to propose actions for improving these systems, especially for small farmers.

Methodology

Secondary information was collected. Recent information was obtained in early 2008 through direct observations in the field and interviews to farmers and officials of governmental and non-governmental organizations. Interviews were based on visit guidelines and a work plan previously established. The information received was mainly qualitative.

It was difficult to obtain information about volumes of native potatoes for fresh consumption, because official statistics about native potato production are inexistent. However, it was possible to obtain information on the volumes of certified seeds of improved and native varieties produced in Peru and Bolivia, but not in Ecuador. After the field visits and interviews were completed, a workshop was conducted in each country to discuss the situation of the seed potato production. These meetings allowed the experts to discuss the results of this study and also to implement some actions to improve the tuber seed production of native varieties.

Results and discussion

The results of this study are grouped on the following topics: (1) situation of native varieties in each country; (2) formal, informal and mixed seed potato production systems; (3) potential demand and seed needs of native varieties; (4) problems affecting seed quality of native varieties; and (5) seed renewal.

Situation of native varieties in each country. It was established the availability of native varieties in each country.

In Ecuador, there are approximately 400 native varieties grown by indigenous communities (INIAP, 2006), but only 20 of them are present in local markets. Unfortunately, the original collections were lost, but INIAP is collecting again these materials. A publication of INIAP (INIAP-PNRT - Papa, 2005) mentions 17 commercial varieties grown in the central provinces of the country. FONTAGRO (Fondo Regional de Tecnología Agropecuaria) is supporting a project to eliminate pathogens ("clean-up") of several native varieties to multiply them for industrial purposes. FONTAGRO and two CIP projects (Cambio Andino and InnovAndes, Strengthening Capacity for Innovation and Poverty Alleviation in the Andes) are also promoting production and commercialization of native varieties in the central Andes of Ecuador.

In Bolivia, the PROINPA Foundation maintains a gene bank with approximately 1750 accessions. From those, approximately 1050 are multiplied ("refreshed") to produce seed tubers which are also used for commercial purposes. Every year approximately 150 to 200 accessions are cleaned-up. A catalog of potato varieties, mostly natives, was produced in 2002 (Ugarte and Iriarte, 2002). Another catalog of potato and oca varieties of the Candelaria area has been published in 2004, where 32 native varieties are included (Cadima *et al.*, 2004).

Each region in Bolivia has its own native varieties that are utilized mainly for local consumption. In the north of Potosi, 200 native varieties were characterized and four were selected to promote their use. Other five varieties are being used by APROTAC (Asociación de Productores de Tubérculos Andinos de Candelaria), which has successfully consolidated the production and commercialization of seed and fresh tubers for the Cochabamba markets (Oros *et al.*, 2007).

In Peru in the Huánuco department, Mr. Victoriano Fernández (Jr.), a farmer who preserves native varieties in the district of Quishki, indicated that he grows 437 native varieties for tradition and eventual business. He also indicates that there are 14 other farmers who also preserves native varieties, and that each farmers maintains around 200 to 300 varieties. It is also known that CIP has returned 104 virus-free native varieties to the local communities in Chogobamba (3800 masl). In Junín, 15 native potato varieties are being multiplied by the NGO FOVIDA (Fomento de la Vida) and the platform CAPAC (Cadenas Agrícolas Productivas de Calidad), for further process testing by Frito Lay. In addition, INIA (Instituto Nacional de Innovación Agropecuaria) maintain an in-vitro collection of 18 pathogen-free native potato varieties, that was multiplied in Huancayo for the NGO ADERS (Asociación para el Desarrollo Sostenible) to be used for the industry and fresh consumption. In the region of Aymara (Huancavelica) there are several farmers that maintain native potato varieties; each farmer maintains approximately 400 varieties. A FONTAGRO project is supporting the evaluation of the processing aptitude of 12 native varieties for chips and mashed. In Paucarbamba, ADERS is conducting a seed project for multiplying five native varieties for industrial purposes. Farmers involved in this project attend farmer field schools (FFS) to receive training on seed production techniques. Some of these varieties are for fresh consumption in urban markets. It is also important to mention that UNALM (Universidad Nacional Agraria La Molina), CIP and INIA have initiated breeding programs oriented to select improved varieties with colored flesh pigmentation for industrial and fresh consumption purposes.

Finally, CIP maintains under custody the world potato gene bank constituted by samples of the potato germplasm collected in the countries of the Andean Region. This material is available to the scientific community upon request. For example, there are 758 accessions collected in Ecuador, 557 correspond to native

varieties and 211 are pathogen-free accessions that could be returned to this country. The three countries are particularly benefited with the presence of CIP, because of the availability of pathogen-free native potato varieties in the germplasm collection and technical assistance. CIP has returned the collected material to farmers and scientists for their use. Tuber seed production can be easily initiated because the materials available are pathogen-free.

Formal, informal and mixed seed potato production systems. The formal and informal seed potato production systems are defined in relation to the improvement, management, replace and distribution of seeds. In the formal system these elements are regulated by the public sector through a seed certification process. In the informal systems (hereafter referred to as *campesino* systems), the above mentioned elements are freely managed by potato farmers, with or without previously established regulations with any participation of a seed certification entity. Mixed systems combine both formal and *campesino* systems (Thiele, 1997).

The use of certified potato seed in Bolivia is relatively low: 3.01 % in 2005 and 2.37 % in 2006. This figure is even lower in Peru; 0.34% in 2005, 0.24% in 2006, and 0.46% in 2007. In Ecuador there is no information about the coverage of certified seed.

In Ecuador, seed certification is done at a low scale and, therefore, the formal system is not fully operative. There is, however, an efficient mixed system (formal/*campesino*) practiced with improved varieties by a farmers' organization (CONPAPA, Consorcio de la Papa).

In Bolivia, the formal system is practiced in five departments and it is implemented by the National Seed Office (ONS), which operates through Regional Seed Offices (ORS). In 2006-07, there were 15 native varieties under certification process (Programa Nacional de Semillas, 2006) distributed in Cochabamba (11 varieties), La Paz (5 varieties), Chuquisaca (2 varieties), Potosí (5 varieties), and Tarija (2 varieties). However, most native varieties are not officially certified and farmers utilize seed produced by *campesino* systems. In 2006, 68 farmers were registered to produce certified potato seeds of native varieties (Programa Nacional de Semillas, 2006). The size of the seed lots in Bolivia is still small.

In Peru, the formal seed certification system was implemented by SENASA (Servicio Nacional de Sanidad Agropecuaria) up to December 2008, and starting on January 2009 by INIA. The seed potato certification system is being implemented in nine regions and in six of them there is certification for native varieties (Ayacucho, Apurímac, Puno, Cusco, Huancavelica and Junín). In these regions, the certified native varieties are: Ccompis, Peruanita, Huayro, Tumbay and Amarilla. In Huancavelica, Cusco, Junín and Apurimac there is an active market of native varieties, but the seed used is non-certified or common seed. Through the InnovAndes project, the NGO FOVIDA and organized farmer communities are supplying Frito Lay with quality potato production of native varieties: Cceccorani, Gaspar, Huayro Macho, Wenccos, Kallhuay and others. Seed of these varieties come from Andahuaylas and have been planted in the communities of Chicche, Pomamanta and Chuquitambo. In Andahuaylas, at least five varieties (Ccompis, Peruanita, Huayro, Tumbay and Amarilla) are certified by INIA. Under the Peruvian seed legislation, the commercial varieties must be registered in the Register of Commercial Varieties in order to produce certified seed. At present, 61 Peruvian native varieties have been already registered.

Potential demand and seed needs of native varieties. In the three countries there is no specific reference on the potential demand of seed of native varieties.

In Bolivia, it was estimated 5000 t of seed tuber is required for the highlands of the country and this amount can be supplied initially with 300 t of basic seed (Programa de Semilla de Papa, 1998). In Ecuador there are no references on any potential demand.

In Peru, it is known that seed producers from Andahuaylas attend seed request based on previous commercial and specific agreements. Recently, the chip industry of flesh colored native varieties would require approximately 500 t of commercial product annually. In order to produce this amount, it would be required the production of 20,000 pre-basic tuberlets produced in beds under rustic screen-house conditions or under green-houses in *aeroponic* facilities (see below). In Peru exists a big number of rustic screen-houses that can be used for the production of high quality pre-basic seed.

Problems affecting seed quality of native varieties. In any of the three countries there are studies indicating the problems that reduce the sanitary quality of the seed tubers of native varieties. It is recognized, however,

that certain diseases caused by fungi, bacteria, virus or nematodes, among others, can cause severe losses to the crop and the seed (Rioja and Barea, 2004 y 2006). For seed production purposes, it is essential to initiate the process using pathogen-free materials (Rioja and Barea, 2004 and 2006; Iriarte *et al.* 2001).

In Peru, it is estimated that diseases caused by viruses are an important factor in the degeneration of native varieties (Scheidegger *et al.*, 1995). These authors working with improved and some native varieties estimated on 50% the crop losses in plants with 100% incidence of viruses PLRV (Potato Leafroll Virus) and PVY (Potato Virus Y) transmitted by aphids. The contact viruses PVX (Potato Virus X), PVS (Potato Virus S), APLV (Andean Potato Latent Virus), and APMoV (Andean Potato Mottle Virus) did not affect significantly the yield. Due to the fact that potato producers utilize their own seed, virus incidence increases and consequently degeneration occurs, which makes necessary the periodic renewal with pathogen-free seed.

In the lower parts of Huánuco, Peru, still persist two potentially serious pathological problems that should be taken into consideration if native varieties are multiplied in this zone: PYVV (Potato Yellow Vein Virus) and Bacterial Wilt (*Ralstonia solanacearum).* The latter has not been reported in most seed production areas, but it is necessary to verify constantly the absence of it.

In Ecuador, Fankhauser (2000) demonstrated that the main causes of seed degeneration are not viruses, but soil pathogens and insects, such as *Rhizoctonia solani*, *Streptomyces scabies* and *Premnotrypes vorax*, with incidences from 17 to 78 % and losses from 17 y 30%. Viruses such as PLRV, PVY and PYVV had low incidence (< 3%) affecting individual yield (per plant), but not total yield because of a compensation effect.

Another limiting factor on potato production in the Andean zone, as well as on seed production, is the Potato Cyst Nematode (PCN, *Globodera rostochiensis*) (Pacajes *et al*, 2002; Franco *et al.*, 1999). Losses caused by this nematode are very important (Franco *et al.*, 1999), not only for commercial potato productions, but also for seed production. An obvious problem at present is that the rotation periods are too short, which makes almost impossible to multiply seed in areas with PCN incidence.

Seed renewal. For native varieties, seed renewal is done through "refreshing" procedures, i.e., periodic reintroduction of pathogen-free materials every four to five years. In Bolivia, in the Toralapa Experimental Station of PROINPA approximately 2.0 to 2.5 t of certified seeds of native varieties are produced. In addition, a FONTAGRO project is in the process of producing certified seeds of eight native varieties.

In Peru, CIP has repeatedly reintroduced native varieties into communities, since many of them were lost due to social turbulence, natural disasters and abiotic factors. From 1998 to 2006, CIP restored to their original places 3182 samples of 1350 native varieties in 38 communities in 7 departments of Peru (R.Gomez, CIP, personal communication). In Andahuaylas, seed renewal is done by buying certified seed of five commercially produced varieties (Ccompis, Peruanita, Huayro, Tumbay and Amarilla). This is not the case with the rest of native varieties that are produced by individual request. *Campesino* seed is also produced when special projects request seed for specific varieties. This is the case of the production of variety Cceccorani for a project of the NGO FOVIDA in Junín. Seed exchange in local fairs is a common source of seed renewal in Peru and Bolivia.

In Ecuador, seed renewal of native varieties is almost inexistent, as there is no production of certified seed. However, INIAP is cleaning up several native varieties. Exchange in fairs is also low, as most native varieties are not present in markets.

Technical alternatives to produce high quality seeds of native varieties

In order to improve the seed production systems of native varieties in the three countries, it is necessary to take into consideration that most seed comes from *campesino* seed systems. Exceptions are certified seeds produced under the supervision of the ORS in Bolivia and by INIA in Peru. Farmers usually do not practice any type of plant selection (positive or negative) due to the lack of knowledge on limiting factors and also because of cultural beliefs. For example, killing a cultivated plant (i.e., negative selection) is not accepted by many Andean cultures. The following alternatives are proposed to produce high quality seed of native varieties:

Follow a formal system. Under this alternative production is conducted under the regulations of a seed certification scheme based on existing seed laws. It requires a lot of personnel, knowledge and investment from the public sector. Previous experiences in Bolivia, Ecuador and Peru (and in many developing countries) show

that this alternative is feasible for large farmers, but not for small farmers. The expected sustainability of these systems is low, since it is necessary a market that demands quality potato production which acts as a driving force to develop demand for certified seed. Low multiplication rates of conventional techniques are not capable of lowering the price of pre-basic mini-tubers to start a seed multiplication program. An innovative technology called *aeroponics* is being tested in Ecuador and Peru for production of pre-basic mini-tubers. Early results suggest that this technology could dramatically reduce the cost of mini-tubers, making more affordable certified seed.

Follow a mixed system. These systems are suitable for small farmers connected to dynamic markets and includes the following components: (i) using seed produced under the formal system (e.g., pre-basic, basic, registered, certified) every certain number of years (usually four or five); (ii) training farmers to re-use the seed that they receive; and (iii) implementing an internal quality control system (e.g., Montesdeoca, 2005). There are good examples of such systems in the three countries, which apply at least one of the components: APROTAC in Bolivia, ADERS in Peru and CONPAPA in Ecuador. The expected sustainability of these systems is medium, as farmers depend on seed from outside every certain number of years.

Follow an informal system. These systems are particularly suitable for small farmers with low connection to markets and living in remote areas with high climatic risk. In this case, farmers are trained to select and manage their own seed to become self sufficient and secure seed supply. The expected sustainability of these systems is high, although the quality of seed stocks can decrease rapidly with poor cultural practices. Examples of these systems are described elsewhere (e.g., de Haan, 1999).

In mixed and *campesino* systems there are at least three points to be considered: (i) in regions with high climatic risk, rustic greenhouses or protected beds (e.g., PROINPA, 1998) could be used to produce small amounts of high quality seed, but the requirements of water, labor and cash could be too high for small farmers; (ii) positive, negative and clonal selection are key elements in both systems and, therefore, training farmers on these simple techniques is crucial; and (iii) small farmers has to be organized in order to implement mixed or *campesino* systems.

Conclusions

The availability of most native varieties in Bolivia, Ecuador and Peru depends on small farmers, who preserve these varieties *in situ*. Small farmers use these varieties mainly for self-consumption, and also to supply the increasing demand of the industry and the fresh market.

Seed of native varieties is mostly produced under *campesino* systems. Although poor cultural practices and free exchange of planting material derived from these systems are some of the main factors for pathogen dissemination, mixed and improved *campesino* systems are the most promising alternatives for potato seed production for small farmers in the Andes to respond to market demands.

A limitation for using formal systems is that native potato varieties need to be registered officially in order to produce certified. This represents an administrative constraint, since bureaucratic paperwork is demanding and time consuming, and it is not clear if this is responsibility of a national or private entity. The work done under the leadership of INCOPA in Peru illustrates how private partners have worked together towards official registration of native varieties.

Seed production techniques and agronomic technologies for seed production have been developed and are well identified for improved potato varieties, but need to be adapted to improve seed production systems for native varieties. New techniques, such as aeroponics, are promising and can have an impact on seed systems. Nevertheless, simpler technologies, such as positive and negative selection, training and technical assistance remain as the key factors to strengthen the existing seed systems to respond quickly to market demands. Similarly, factors causing seed degeneration are well identified for improved varieties, but need to be validated for native varieties.

After the International Year of the Potato, it is evident the increasing demand for native potatoes. As response, an increasing number of NGOs, OGs and projects are helping small farmers to produce seed. It is, therefore, urgent for CIP and its partners to guide these efforts to avoid costly mistakes, such as implementing formal systems, which have proved to be inadequate for small farmers.

Finally, sustainability of any seed production system depends on the quality requirements of the market. A quality demanding potato market (for fresh or processing) will be the driving force for the development of a quality seed market and, therefore, market requirements is a crucial variable when designing and implementing seed systems.

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