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The potential of organic potato production in the Central Highlands of Peru

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Abstract
Farmers of the Central Highlands of Peru have grown potatoes for centuries as their main subsistence and commercial crop in fields located 3500 to 4200 m above sea level. To cultivate potatoes under these harsh agro-ecological conditions they developed various unique technologies specifically adapted to the crop and the environment. In 2006/07 a diagnostic survey was conducted in five regions of the Andean Highlands of Peru to analyse farmers' practices for soil fertility management and to create an inventory of organic production techniques, which are still in use or which are still part of the traditional knowledge of farmers. More than 60 different technologies were recorded and will be evaluated in the future. To some extent farmers are aware of health problems related to pesticide use and claim that the organoleptic qualities of organically produced potatoes are superior to the ones cultivated with chemical inputs. However, low product prices and a market demanding a high product quality induce many farmers to relay on chemical inputs for pest control and fertiliser management. Organic potato production is possible in some regions of the Andean Highlands, especially were diseases like *Phytophtera infestans* or viruses are absent and infrastructure allows for an unproblematic market access. In this context the International Potato Centre through its Papa Andina Initiative develops strategies and concepts to link farmers of the Andean region to markets, considering the sustainability of their production systems as a major prerequisite

Introduction
The Central Andean Highlands of Peru and Bolivia are the centre of origin of the potato. Indigenous potato landraces are cultivated by small-scale farmers in fields located 3500 to 4200m above sea level, in erratic and harsh climatic conditions and on soils which often have a low inherent potential for crop production. For many centuries farmers grow potato as their major staple food and/or cash crop and developed a unique richness of potato production practices. Subsistence farmers in remote regions still use mainly organic inputs for crop production while more commercially oriented farmers in the vicinity of market centres use high amounts of inorganic fertilisers and chemical pesticides.
The International Potato Centre (CIP) through its *Papa Andina Initiative* is developing a strategy of linking farmers of the Andean region of Bolivia, Peru and Ecuador to markets considering the sustainability of their production systems as a major prerequisite (sistemas de agricultura sostenible con enfoque al mercado - SAS-M) (Devaux et al. 2007). In this respect the biodiversity of native potato varieties are a unique resource and a comparative advantage for farmers in the Central Andes to participate more pro-actively in the potato market chain and access new market opportunities. The basic hypothesis of this approach is that developing market niches for native

potato-based products and sustainable production technologies should improve the incomes and well-being of small-scale Andean farmers.
For that reason in 2006/07 a diagnostic survey was conducted in five regions of the Andean Highlands of Peru to analyse farmers' practices for soil fertility management and to create an inventory of organic production techniques, which are still in use or which are being 'rediscovered' by farmers changing to organic crop production. This inventory will be a first step in analysing and validating technologies and designing efficient crop production systems, which in turn yield value added products to serve the demand of market niches.

Material and Methods

Principally three sources of information were used to collect organic potato production technologies (in this context we refer to organic technologies to all technologies which do not use any chemical input), compile farmers' opinions about ecological (organic) production systems and about currently used production technologies.

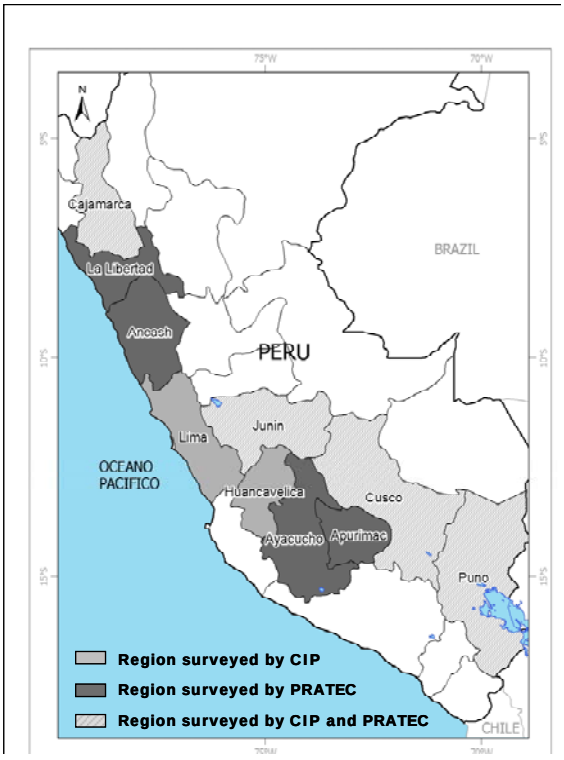

Fig. 1. Regions of Peru where information was collected by CIP and PRATEC

The first source was a survey conducted in 33 farmers' communities in six regions of Peru in 2006/07. A total of 287 farmers were interviewed in groups or individually using questionnaires with mainly open-ended questions. The communities were not selected representatively but according to information provided by NGOs or other institutions and organizations to increase the probability of capturing organic technologies (Fig. 1). For example, communities close to big market centres use high chemical inputs for potato production and very few other technologies are in practice or are known by farmers. Therefore communities in more remote areas were selected, which have less access to chemical inputs and focus more on production for their subsistence.
The questionnaire had a total of 20 questions about production technologies which are in use or known by farmers and about their opinion and knowledge of organic agriculture.
A second source of information was a collection of Andean crop production technologies compiled by PRATEC (Proyecto Andino de Technologias Campesinas), a Peruvian NGO, in 122 communities of eight regions, by interviewing several hundred farmers over a period of almost 25 years (1987-2002).
As a third source surveys and information collected by the Integrated Crop Management Division of CIP within the scope of several research projects in the Andean region were used to assess and validate the use and potential of technologies given by farmers. Additionally, researchers of the potato program of INIA (Instituto Nacional de Investigación Agraria) were consulted to explain specific local technologies and help to translate farmers' terminologies in Quechua or Aymara. Descriptive analytical methods were used to organize and present the data.

Results and Discussion

In the 33 communities, covered by the CIP survey, farmers cultivated 23 different crops. Potato was identified as the most important crop in 88% of the communities; other crops of importance were barley, quinoa, faba bean, maize etc. 64% of the farmers used always agro-chemicals to

some extent in their crops, while 29% claimed they would never apply any inorganic inputs and 7% used them sometimes in small quantities. Hence, the communities represented a mixture of market and subsistence oriented production systems with potato as the crop receiving most inputs and attention by the farmers. This is also reflected in the fact that with the CIP survey 42 organic technologies could be registered, while PRATEC with its much more intensive study recorded 47 production technologies and 6 for food processing. In total 67 different technologies were identified, of which some are used by most farmers in all regions, while others are rather regional limited either to the northern, central or southern Andes of Peru (Fig. 2). A few technologies were mentioned in one or two communities only. These were sometimes localized traditional technologies but more often new technologies, such as use of pheromones or *Baculovirus phthorimaea* for pest control. They had been introduced by NGOs or extension organizations in recent years, but they are not widely used presently.

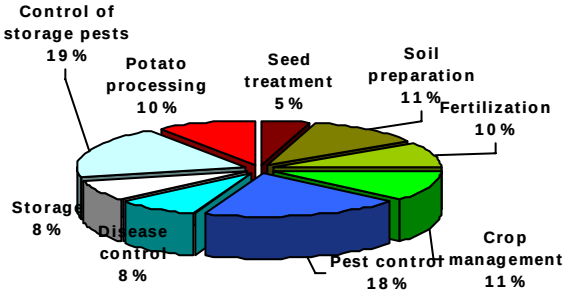

Fig. 2. Distribution of Andean potato production technologies according to their use

Generally, there are two crucial topics to organic crop production: (1) providing nutrients to the crop and soil and (2) controlling pests and diseases (Finckh et al. 2006). For the potato crop these topics are even more critical because potato usually has a high nutrient demand and many pests and diseases attacking foliage and tubers. Thus, in this article technologies developed for these two areas will be analyzed in more detail.

I. Soil preparation and fertility management

There are three different techniques of land preparation used by farmers for the potato crop of which two techniques are probably unique for the Andean region (Table 1). They have been developed to conserve the upper soil layer, while planting on steep slopes and are fully adapted to the harsh environmental conditions of the Andean highlands. Potatoes planted in tipka usually have lower yields and smaller tuber sizes than the ones in chacmeo or barbecho, but they are more resistant to drought spells and frost.

Table 1. Land preparation techniques used for potato planting in the Central Highlands of Peru.

Type of land preparation	**Barbecho** – turning the land with the last rains; making rows for planting	**Tipka/chiwa** – lifting a lump of soil with the chaquitaclla, placing a potato tuber and covering it with the same soil; making row and turning the soil some weeks after planting	**Chacmeo** – turning the soil with the chakitaklla at planting – planting the tuber above the former surface
Characteristics	capillary water flow interrupted – conserves soil water; soil pests exposed; well prepared seed bed;	rapid planting – planting operations distributed in time; soil conservation – for planting in slopes; protects against night frosts tubers less exposed;	soil conservation (slopes); well prepared seed bed; faster emergence than with tipka;

The main tool farmer use for these planting operations is the chakitaklla or Andean foot plough, which was already developed and used by Incas in pre-Columbian times (Bourliaud et al. 1988).

For the restoration of soil fertility and plant fertilization two basic technologies are utilized by almost all farmers of the Andean region. These are crop rotation (with fallow periods) and application of manure or other organic fertilizers. In rotations potato is always the first crop making best use of the accumulated nutrients in the soil. There are crop rotations in individual fields or rotations of whole sectors of communal land, also called sectoral fallowing (Pestalozzi, 2000). Farmers state that fertility is the most important reason for their rotation and fallow system while control of pest and disease comes second in importance (weeds are no constraint).

Cattle and sheep manure is used in quantities between 3 to 10 t/ha for the potato crop only. Farmers are aware that a sustainable production of potato is not possible without application of organic matter even if chemical fertilizers are used in high quantities. Other advantages and disadvantages of manure application on potato are mainly quality and production aspects (Fig. 3).

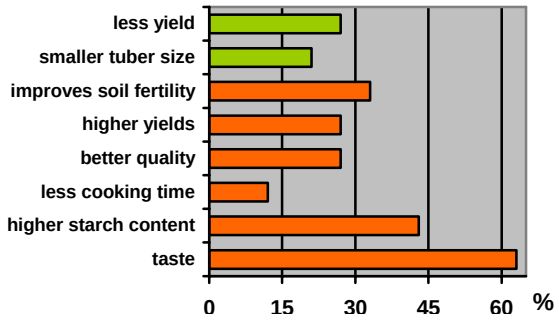

Fig. 3. Farmers' perception of advantages and disadvantages of organic fertilizers on potato.

The techniques cited by farmers comprised for soils:
barbecho, tipka, chacmeo, traditional soil classification (colour, texture), recuperation of eroded soils, use of Andenes (stone walled terraces), drainage;
and for fertilization:
preparation and application of manure and biol (home made leaf fertilizer), majadeo (animals left grazing during the day will be sheltered in a corral during the night, in the next planting season potatoes will be grown on this land), burning of straw and natural vegetation, application of lime or green manure.

II. Plant protection

For the survey most techniques were recorded for the control of pest in the field and in storage (Fig.1 and 4). Disease control measures were of less magnitude because late blight (*Phytophtera infestans*) and virus are less important in the high altitude areas of the Central Andes. Furthermore, farmers know little about the concept of diseases of plants. Pest attacks are much more obvious and of increasing severity (for example *Premnotrypes* sp. or *Symmetrischema* sp.).

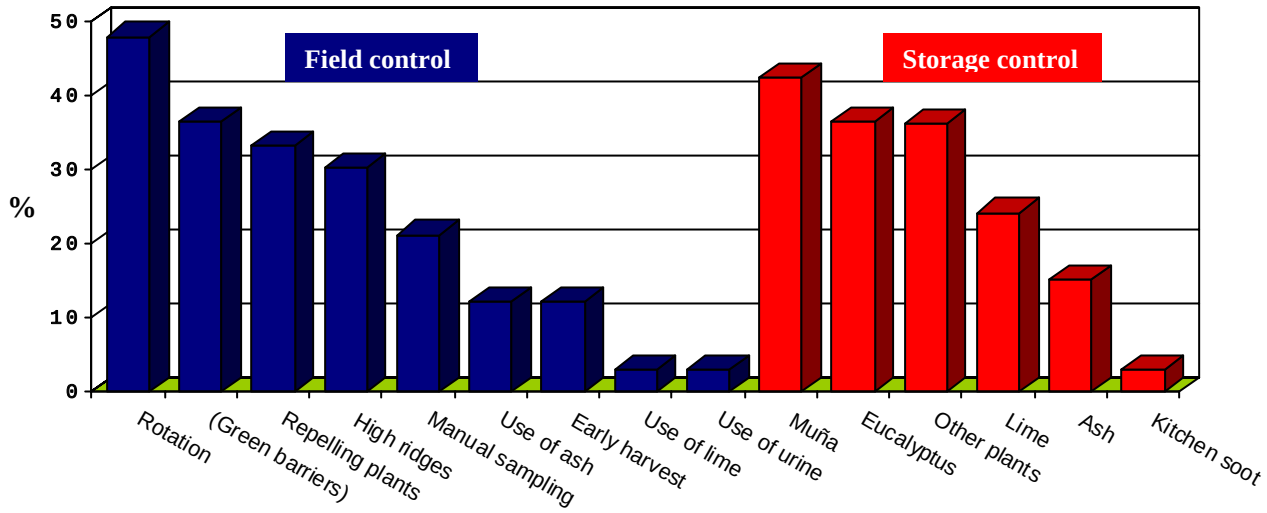

Fig. 4. Technologies for pest control in the field and in storage

Rotation, especially rotation of entire sectors of communal land, reduces populations of the Andean potato weevil (*Premnotrypes* sp.), one of the most important pests in the Andean region. Other techniques are the use of repellent plants and herbs, which are mixed with water and applied as a foliar spray, or the application of lime and wood ash as repellent of leaf sucking and mining insects. There were other techniques mentioned such as the use of green barriers (*Lupinus mutabilis*) around the fields or the use of pheromones etc., which are actually recommended by extension agents and therefore known to farmers but which are almost not in use. These new, innovative technologies could help to mitigate the increasing pest pressure due to more intensive cultivation techniques in the future without relying on pesticides.

Farmers very rarely use chemicals for storage of potatoes but rather repellent plants, such as Muña, *Minthostachys* sp., *Eucalyptus* leaves etc. or powders of lime and ash. No special care is given to seed tubers for the coming season which might result in damaged and less vital seed material.

The regional study showed that organic technologies exist for all steps of potato production starting with the seed treatment for planting, continuing with land preparation, crop management, pest control, storage and processing. They have in part coevolved with potato becoming the major staple food crop of the region and are specifically adapted to these agro-ecological and climatic conditions.

More than 60 different technologies were recorded and will be evaluated in the future. To some extent farmers are aware of health problems related to pesticide use and claim that the organoleptic qualities of organically produced potatoes are superior to the ones cultivated with chemical inputs. However, low product prices and a market demanding a high product quality induce farmers to relay increasingly on chemical inputs for pest control and fertilizer management. Apart from environmental hazards this trend bears as well the danger of a continuous erosion of traditional knowledge which could be observed in market oriented communities.

Organic potato production is possible in some regions of the Andean Highlands, especially were diseases such as *Phytophtera infestans* or viruses are absent and infrastructure allows for an unproblematic market access. Constraints might be rather missing incentives, as there is still only a rather small market for value added organic potato products in Peru, a costly certification process to get access to an organic label and the necessary transformation of the raw product, because for phytosanitary reasons fresh potato cannot be exported to the US or European markets.

References

Bourliaud J., D. Herve, P. Marlon and R. Reau. 1988. Chakitaklla. OSTROM, PISA, Lima, pp 102.

Devaux A., C. Velasco, G. López, T. Bernet, M. Ordinola, H. Pico, G. Thiele, and D. Horton. 2007. *Collective Action for Innovation and Small Farmer Market Access: The Papa Andina Experience*. CAPRi Working Paper (in edition).

Finckh M.R., E. Schulte-Geldermann and C. Bruns. 2006. Challenges to Organic Potato Farming: Disease and Nutrient Management. Potato Research, 49, 27–42

Pestalozzi, H. 2000. Sectoral fallow systems and the management of soil fertility: the rationality of indigenous knowledge in the high Andes of Bolivia. Mountain Research and Development 20 (1): 64-71.