



Farmers from Candelaria Cochabamba selecting Yaraq oca for the market

Photo: Graham Thiele

Andean tubers: from conservation to sustainable use

Andean tubers have been called the “lost crop of the Incas” and Candelaria in Bolivia is well known for its tuber production (Cardenas 1989). Farmers grow landraces of four different potato species (*Solanum andigena*, *S. x ajanbui*, *S. stenotomum* and *S. pbureja*), oca (*Oxalis tuberosa*), ulluco

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(*Ullucus tuberosus*) and mashua (*Tropaeolum tuberosum*). At the local market in Colomi they make an extraordinary and beautiful display of diversity.

Andean tubers form part of different ecological tiers that extend from the 3200m irrigated valley floor to 3900m. Rotations and associations with other crops (faba beans and tarwi) help reduce pests. However, much diversity has been lost with increasing market integration. Farmers in Candelaria and elsewhere in Bolivia, concentrate production on the few varieties of potatoes widely accepted

by the market. Monocropping tendencies and poor use of modern agricultural inputs have affected agroecosystem viability and increased pest damage.

The Foundation for the Promotion and Investigation of Andean Products (PROIN-PA) is custodian of the Bolivian Andean tuber germplasm collection. Its focus has shifted from *in situ* conservation and resolving specific production constraints to promoting the sustainable use of Andean tubers in the context of a complex local social, economic and political environment.

Initial approach

Work with Andean tubers began in 1993. Visits to agricultural fairs, markets and field reconnaissance identified 21 important Andean tubers zones. It was decided, after follow up visits, to concentrate *in situ* conservation work in Candelaria, one of the most important diversity microcentres.

An inventory of Andean tubers in Candelaria led to the phenotypical classification of 22 landraces of *Solanum andigena*, 5 of *S. stenotomum*, 2 of *S. x ajanbui*, 2 of *S. pbureja*, 27 of oca

(*Oxalis tuberosa*), 7 of ulluco (*Ullucus tuberosus*) and 9 of mashua (*Tropaeolum tuberosum*). Local knowledge on production and use was systematised.

Farmers classify oca varieties according to soil aptitudes, pest susceptibility, production and storage qualities, culinary properties and market suitability. It is important in local diets between May and December and is eaten in many different ways. Most commonly the tubers are left in the sun for several days to reduce the oxalic acid content and become sweet. They are then boiled in their skins, baked or used in stews or for thickening soups. Specific dishes have evolved to exploit differences in flavour, texture colour and cooking time. Lluch'u oca is spread on the ground on cold nights, left to freeze, trodden to remove water and sun dried to make *chuño* which can be stored for months or years. *Chuño* is ground into oca flour for bread, *buñuelos* (a kind of doughnut) and starch for thickening soups. The Puka Kamusa variety has medicinal uses. Other Andean potato varieties are equally versatile. Ulluco is used in soups and stews, “Salsa Lisa” for salads, and mashua

is good for fattening pigs and occasionally as medicine.

For two years a study was made of the way 12 families used and managed Andean tubers. On average they kept 8 landraces of oca, 2 of ulluco and 1 of mashua. Each family held between 5 and 11 landraces of oca. Between them they had 22 landraces. Some landraces were widely distributed.

Landraces managed by families varied over time. During 2 seasons, 4 families lost or eliminated one or more landraces and 5 families introduced a new one. Farmers have their own strategies for managing and replacing germplasm. They plant the same variety in different tiers to reduce the risk of loss and replace seed when it has become tired with seed obtained from another farmer, preferably outside their community. Seed is bought, bartered or paid for through labour. This dynamic, mosaic system that crosscuts local communities largely ensures germplasm is maintained. However, some varieties such as the ulluco "Llausa lisa" used for *chubño*, have been lost recently.

In situ conservation

PROINPA's principal support to *in situ* conservation has been the organisation of annual biodiversity fairs. The first was held in Colomi in 1994 in cooperation with the local government. Each participant or group was allocated a small stand where they laid out all the varieties they used. Prizes were given to participants with the largest number of varieties and to those who were most knowledgeable. One family brought 32 varieties of potato, 12 of oca, 2 of ulluco and 6 of mashua. Farmers were encouraged to exchange varieties. A follow-up of six families who had exchanged varieties showed they had planted 2 or 3 new varieties. The fairs helped PROINPA to discover new landraces and to meet the farmers managing them.

Technical limitations

Until recently, agricultural research in Bolivia has ignored Andean tubers. To complement *in situ* conservation, the specific problems confronting farmers were identified, prioritised and investigated. Ulluco is attacked by *roya* (*Aecidium ulluci*), a disease farmers call "tojtú", a term also used to describe potato blight. By 1997, the specific pathogen causing *roya* had been identified and an efficient, but chemical, control strategy developed.

Farmers say that weevil in oca is a relatively new problem. Farmers also reported that some varieties resist weevil. The biology of the insect (*Systema sp.*) was studied and 200 entries in the national germplasm bank were evaluated during researcher-managed field trials. Forty varieties were found to be resistant to *Systema sp.* and two entries were able to act as nematode trap crops.

New approach

Farmers have managed germplasm for thousands of years under complex and changing conditions. The term "conservation" fails to capture the dynamics of adoption and selection, however. Technological interventions that target highly specific problems outside the context of the local agroecosystem do not allow the full utilisation of available biodiversity. PROINPA has tried to develop an alternative approach promoting new and sustainable uses of biodiversity in Candelaria.

PROINPA has joined the San Simon University's (Cochabamba) programme of Food Technology and Natural Products (PAPN) and the Institute for Socio-economic Studies (IESE) in forming the Integrated Candelaria Project (PIC). PAPN had already developed and evaluated a range of food products derived from Andean tubers and IESE had carried out studies on the market, price and demand for them. Within the PIC, realistic, interdisciplinary proposals for the sustainable use of biodiversity are being developed.

Linking farmers and PROINPA

Farmers replace seed when it has become tired. Potatoes, oca and ulluco tuber seed gradually becomes infected with viruses that lower yields. PROINPA has used meristem thermotherapy to produce virus-free seed in 24 potato landraces, and 2 landraces of oca and ulluco from the germplasm collection. Eight farmer families from Candelaria visited PROINPA's experimental station and selected 12 varieties. They were given 20 tubers of each variety and are now multiplying these for their own use. Plans to further improve farmer access to the materials held in the germplasm collection are being made.

PROINPA on-farm research has moved from developing interventions to target specific problems to studying the interactions of rotations, fertility and pests. Nutrient flows in the soil and the movement of pests between sites are being examined and 4 farmers are taking part in a study of the way Andean tubers are managed within the whole farm rather than the single field.

Markets

Accessing better quality germplasm and resolving production problems using an agroecosystem approach must be combined with identifying new markets for oca, ulluco and mashua. As PIC project members analysed market bottlenecks, farmers explained the detrimental effect of gluts on prices. Because ulluco does not store well, it has to be marketed immediately after harvest when prices are low. Farmers wanted to be able to take advantage of off-season prices. PAPN, together with farmers, concluded that improved storage and dehydrated flakes might solve the problem. PAPN developed and tested the technology for flakes and a pilot

product, sold in the University store, was well received by consumers. Market studies revealed a potential demand of 437 tonnes per year, easily absorbing current production in Candelaria.

PROINPA has helped farmers select and grade high quality ulluco and oca and IESE has sold well-presented, 100kg bags with ease at local supermarket where consumers were prepared to pay several times the local market price of the loose ungraded product. IESE has also developed new recipes that do not require sun exposure and these are supplied with the packaged product.

Mashua has very high yields of up to 90 tonnes/h. Being a rustic crop adapted to the Andes it requires few inputs. Farmers feed cooked mashua to their pigs and it could replace maize in commercial balanced animal feed. The Bolivian Private University (UPB) has estimated the potential demand for mashua as balanced feed is about 150,000 tonnes per year. PROINPA has undertaken to study yields and select appropriate varieties. UPB is testing gas-drying methods of feed production and preliminary results from commercial pig producers suggest mashua is an efficient substitute. PAPN is now investigating artisan solar dryers for farm use.

Scaling up

The PIC Project is basically a research initiative. To reach more farmers and have greater impact on biodiversity it must work with other institutions including local government institutions responsible for rural development. PIC project members have helped Colomi municipality to organise an agricultural workshop where NGOs, local institutions, private sector food processors and farmer groups can analyse the problems associated with the major crops and explored solutions. Potatoes were voted the most important crop, oca and ulluco were joint third. Four institutions involved in the workshop are working with Andean tubers. As these also work with other crops and livestock, good coordination should make it possible to implement an agroecosystem approach. PROINPA hopes the workshop will evolve into a local forum for agricultural development capable of promoting the sustainable use of biodiversity. ■

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