

Promoting neglected and underutilized species can be a double-edged sword. A recent project with the communities that surround the Uyuni Salt Flat in Bolivia showed that although farmers' incomes rose, their use of crop diversity decreased and there may also have been bad nutritional consequences for farm families. But the study also showed ways to improve matters.

Quinoa: a delicate balancing act



In the developed world quinoa is something of a novelty, an exotic grain with a slightly fringe reputation for good nutrition and environmental friendliness. In the Andes, where people have cultivated quinoa for around 5000 years, quinoa has been the breakfast, lunch and dinner staple, not to mention snacks and sweets. The rise of quinoa in developed countries created opportunities for poor farmers in one of the harshest agricultural environments in the world, but it brought problems too. Damiana Astudillo, a Mickey Leland Congressional Hunger Fellow, has been working with Bioversity for the past two years to understand the challenges of commercial quinoa cultivation in the southern Bolivian Altiplano.

Conditions on the Altiplano are tough. Temperatures can range from -18°C to 27°C in a day. There is overnight frost 225 days a year, rainfall averages less than 25 mm a year and soils are sandy with very little organic matter. Quinoa (*Chenopodium quinoa*) is one

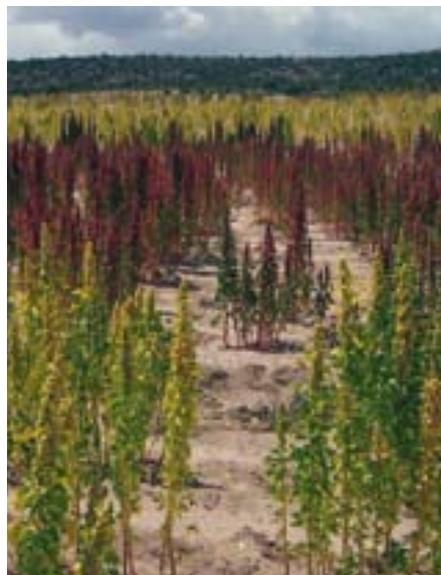
of the few crops that thrives there, and it provides excellent nutrition. Protein content ranges from 11% to 19% and is of very high quality, containing all eight amino acids essential for human health. The seeds are rich in vitamins and minerals too. In fact the United States' Academy of Sciences describes quinoa as "the most nutritious grain in the world".



D. Astudillo/Bioversity International

Above Roasting the quinoa seeds is an essential first step in processing, to loosen the layer of bitter saponins that cover the seeds.

Left Quinoa is one of the few crops that will thrive at high altitude and in thin soils.



D. Astudillo/Bioversity International

Growth in planted area and yield of quinoa in the southern Altiplano.

	1980	1985	1990	1995	1999	2000	2001
Area (ha)	10580	16237	20786	20575	20685	20575	20685
Harvest (t)	5639	7680	8938	10740	13342	13271	13549
Yield (t/ha)	0.53	0.47	0.43	0.52	0.65	0.65	0.66

Source: *Prospeccion de demandas de la cadena productiva de quinoa en Bolivia. Fundacion para el Desarrollo Tecnologico del Altiplano, Bolivia*

Although the communities of the southern Altiplano lack education, basic infrastructure such as roads and running water, and capital, they have not been slow to respond to demand for their wonder grain in Bolivian towns and cities and in the developed world. Production increased from about 5600 tonnes in 1980 to more than 13 500 tonnes in 2001, the result not only of doubling the area of land under cultivation, but also of a 25% increase in yield per hectare. In her study, Astudillo identified four major impacts of this switch from subsistence to commercial production.

Quinoa diversity is being lost. A single variety now makes up 37% of production, and the top three account for 72%. This is the flip side of market demand; although it has boosted the total amount of quinoa being grown, it has also created a focus on commercially valuable varieties that are homogeneous and large-seeded. Smaller-seeded and more variable varieties are no longer being planted as much.

Percentage of total cropping area planted to individual varieties.

'Blanca' produces the large, white seeds favoured in commercial markets.

Variety	Per cent of planted area
Blanca	37
Pandela	21
Toledo	14
Pisankalla	8
Negra	5
Kellu	5
Rosa blanca	3
Elva	3
Utusaya	2
Punete	2

Flowing from this have been changes in dietary diversity and impacts on the environment. Farmers and their families used to eat quinoa at almost every meal. Now, with the money they earn from quinoa sales, they can afford to buy other sorts of food. One reason they buy these foods is that they are much easier to prepare, while quinoa is time-consuming and laborious. With the demands on their time that commercial growing makes, it is no surprise that many women have turned to pasta, rice and processed foods. Dietary diversity has increased but, paradoxically, nutrition may have suffered, because the substitute foods are not nearly as nutritious as quinoa.

The shift to commercial cultivation has also impacted on the environment. Previously, family farms were small and quinoa was grown mostly on the slopes. Villagers reap larger harvests by moving quinoa off the hills and onto the flat lands, but this has promoted the use of inappropriate technology, such as disc harrows, that promotes wind erosion. In addition farmers are not leaving the land fallow as long as they once did, leading to further erosion and a depletion of the few nutrients present in the soil.

Finally, there has been an impact on the social life of the community. Before, although plots were family-based, families helped one another when needed and often worked together.



D. Astudillo/Bioversity International

Now, with increased mechanisation, the work tends to be much more solitary and families do not need one another's help. The result is that they are more isolated.

Astudillo did more than merely record what was going on in the communities of the southern Altiplano. She also worked with the people to see whether things could be changed. Workshops



D. Astudillo/Bioversity International

aimed at parents with young children focused on the importance of good nutrition and raised awareness of the value of local quinoa, but one of the perennial complaints about quinoa is that it is boring. Working with the parents, Astudillo helped to develop new recipes that made quinoa more appealing, including a quinoa pancake that had children queuing up for more. Even the best recipes, however, do not address the fundamental problem: preparing quinoa is a pain.

Quinoa seeds are coated with a layer of saponins; exceedingly bitter, toxic chemicals. To get rid of this layer, women first toast the seeds on a metal tray over a fire. This helps to loosen

Above After roasting and treading the seeds, the saponin dust is removed by winnowing in a steady breeze.

Left Just some of the quinoa diversity, much of which is disappearing from farmers' fields as they concentrate on a few more marketable varieties.

Right The quinoa harvest drying in the fields.

the saponin layer and, while it may not be strictly necessary, enhances the flavour of the seeds. Then the hot seeds are tipped into a stone basin and the women tread them with their bare feet. The friction loosens the saponin coat and reduces it to dust. Treading also often gives the women blisters and chronic lower back pain. The saponin powder now has to be cleaned from the seeds, which is done by waiting for a day with the right kind of steady wind and then winnowing the seeds repeatedly so that the wind blows the dust away. Finally the seeds are rinsed in a couple of changes of water and set out to dry.

Quite apart from the sheer drudgery and discomfort of the work, which is usually carried out in the bitter cold of winter immediately after the harvest, it can take 6 hours to process 12 kg of quinoa.

In some ways, this proved an easy nut to crack. Astudillo worked with Rolando Copa, a local mechanic and inventor, to build a quinoa processing machine that duplicates all the necessary steps and that reduces the time it takes to process 12 kg of seed from 6 hours to 7 minutes. The communities were at first deeply sceptical that the machine would produce acceptable quinoa. To overcome that, Astudillo arranged for blind tastings in five different communities. Not only did the families find the machine's quinoa totally acceptable, they even said they would be willing to pay up to 75 US cents to process 12 kg. This is crucially important, because the machines cost around US\$ 800, more than a family could afford. There are, however, precedents for making

a machine available as an income-generating opportunity to a family or an entire community, not least from Bioversity's work in the Kolli Hills of India (see Annual Report 2005, p. 23). As Astudillo notes, "the machine will reduce the burden of women's work, have a positive impact on their health and potentially improve nutrition by facilitating the consumption of a nutritious grain. This is a low-input, high-impact opportunity for any organization committed to practical rural development and the improvement of livelihoods of marginalized populations."



D. Astudillo/Bioversity International

That leaves the problem of quinoa diversity in the field. Although the local genebank stores samples of essentially all known quinoa varieties, so that they will be available for future use, for the farmers those varieties appear to have little value at the moment. Nevertheless, diverse quinoa varieties do have different agronomic and nutritional properties. Some are more frost resistant, for example, while



D. Astudillo/Bioversity International

Above Women clean the seed immediately after threshing.

Left This machine, developed with the help of a local mechanic and engineer, eliminates the drudgery of quinoa preparation. And the sceptical villagers agreed in blind trials that the quinoa it produces tastes just fine. Investors are needed to help villagers obtain the machines.

others mature early. Nutritionally, there is the overall difference in protein quantity, which varies from 11% to 19%, and there are almost certainly differences in other components, like vitamin and mineral contents. These differences were probably much more important when farmers were growing quinoa as an element of their survival strategy. These days, farmers are freely abandoning most varieties to concentrate on the few that have the greatest value in the market. That may one day prove to be an error, in which case the samples stored *ex situ* will have earned their keep.

On the other hand, many families are using the extra money they are earning to educate their children, and those children may well decide to abandon the hard life that quinoa cultivation represents. In which case, there might be no immediate need for the genebank samples. But where, then, will the developed world get its quinoa?

Further information
m.bellon@cgiar.org



D. Astudillo/Bioversity International