

IMPROVING CROPS WITH NUCLEAR SCIENCE

increasing yields for smallholder farmers in the Peruvian Andes



On his second voyage to the “New World,” Genoese explorer, Christopher Columbus, sent a ship back to Spain carrying a letter to Ferdinand and Isabella, his sponsors and the Spanish King and Queen, dated January 30, 1494. He was asking for provisions for his men. Among the items on his list was “barley” and so the nutritious cereal was introduced to the Americas.

In the 1500s, barley came to the Peruvian Andes, where over centuries it has managed to adapt to extreme conditions and has become an important source of food and income for the seven million people who live there. It is one of only a few plant species that can thrive at altitudes of around 4,000 metres above sea level where soil is poor, water scarce and the winters harsh.

Up until the 1970s, the barley yields were meagre and the grain was low in quality. As a result, farmers used it primarily for animal feed and no effort was made by Peru’s agricultural research centres to improve varieties. This changed in 1968, when Professor Marino Romero joined the National Agrarian University La Molina in Lima and founded the Cereals Research Programme.

Romero grew up in the Andes. He was the son of a teacher who was also a farmer, so he was aware

of the importance of barley to the mountain communities. He set out on a mission to develop new varieties of barley that would thrive above 3,000 metres and would improve the diet, health and economy of the Andean population.

With the support of the IAEA’s joint division with the UN’s Food and Agriculture Organization, he managed to develop nine improved varieties of barley over the course of forty years that now account for over 90% of the barley cultivated in Peru.

Marino Romero died in 2005, but his work was continued by his wife, Professor Luz Gomez Pando, who since 1998 has led the Cereal Research Programme at La Molina University. “Before the intervention of my late husband, barley was largely ignored by plant breeders and researchers since it was associated mainly with beer and animal feed,” she says. “They didn’t realise that after potatoes it was the second most important source of food for poor communities.”

By cultivating the higher-yielding, improved varieties, farmers have seen an increase from 800 kilos of grain per hectare to 3,000 kilos and a two-fold increase in protein content from 7 to 14%. Two of the most successful barley types were developed using a nuclear technique known as ‘radiation induced mutation’. With

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(Photo: Louise Potterton/IAEA)

this method, breeders expose seeds to radiation to induce changes in plants. This speeds up a process that would normally take place under naturally occurring radiation.

“Radiation brings about changes,” says Gomez Pando, adding: “These could be big or small, negative or positive. We’re not adding anything to the plant, but in contrast to radiation, the natural process can take thousands or millions of years.” After seeds have been irradiated they are planted at experimental sites and monitored carefully by the breeders.

The seeds of the promising plants are harvested and replanted and this selection process continues for up to seven years, to identify the best improved types in field and laboratory conditions. Once an improved line has been identified, tested and officially confirmed, it is released as a new variety.

In 2006, La Molina released its latest barley ‘Centenario’, which was developed using the irradiation breeding technique and is proving to be the best so far.

Professor Gomez Pando says: “It has more protein than other varieties and a higher yield. It’s resistant to yellow rust, tolerant to frost and due to its inclined head does not get damaged by hail.” Thanks to Centenario, Andean farmers now produce enough grain to meet their personal needs and have a surplus to sell.

In the village of Conopa, farmer Erwin Ortega says: “Compared to all other types of barley, Centenario is the best, because it has more grains and they’re heavier. It also tastes better and it’s important for the development of our children.”

Centenario fetches twice the price of other barley varieties. In fact, it is so popular and abundant that the farmers want to expand their markets. Erwin’s brother, Armando, says: “We need to find new markets that will pay us the right price for this type of organic barley, perhaps in other parts of Peru or overseas. Now we sell barley to middlemen at a low price.”

The work of Professor Gomez Pando is being supported by the Peruvian branch of the organisation Caritas. Together they distribute Centenario seeds to the farmers and help them find ways to sell their grain.

“When we started to support the farmers, by giving them the seeds and technical assistance, their production tripled,” says Juan Pio Silva,

head of Economic and Production Development at Caritas Peru.

“So there was a great supply of barley, but the market was not able to absorb it directly as grain. We then found the alternative of processing barley into flour and this opened new commercial channels for the farmers.”

Caritas has set up a chain of small processing plants in the Andes where farmers can work in a collective initiative to process the barley into flour and other cereal products that are sold to outlets in Lima and other parts of Peru.

“In the rural areas, especially in the High Andes, poverty is higher than elsewhere in Peru,” says Silva, “I think that the best way to support the people there is by developing the crops they’ve always harvested, such as barley.”

Following the success of Centenario barley, the breeders at La Molina University turned their attention to another Andean plant, kiwicha, a kind of amaranth. Using radiation induced mutation, they have developed a variety, known as Centenario-Kiwicha, that has a higher yield than other varieties, and is more nutritious.

Kiwicha was a staple food in the diet of the Incas. It has 30% more protein than common cereals, such as rice and wheat, and is high in dietary fibre and minerals such as iron and magnesium. Kiwicha is not as common as barley in the Andes or as easy to grow, but it enjoys the export potential that barley currently lacks.

There is a high demand for exports of Centenario-Kiwicha to countries like Japan and the USA, since this is an organic, high-quality product. One of Peru’s main exporters of Andean grains is Lima-based, Interamsa Agroindustrial. The company’s General Manager, Gustavo Pereda, saw the potential of Centenario-Kiwicha and has developed a business strategy that is benefiting both the farmers and his company.

“In 2002, I started cooperating with Professor Gomez Pando. She gave me Centenario-Kiwicha seeds. I went to the farmers in the Andes and asked them to plant them with the promise that I would buy the grain at harvest time.”

Impressed with the quality of the kiwicha, the cooperation progressed and now Interamsa Agroindustrial buys the seeds from La Molina and the farmers cultivate the kiwicha.

"I give the farmers the seeds, they do the work and when they harvest, I pay a fair market price for the grain."

He added that when the business deal goes well, he invests further in the farmers and provides them with new equipment.

"The market for kiwicha is growing every year. I sell it to the USA and Japan and am hoping to sell in Europe too," says Pereda.

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Plant Breeding

Around the world, the agricultural sector is facing many challenges, including climate change, droughts, floods, soil degradation, pests, and diseases. Sustainable crop improvement to increase yield, ensure food security and enhance farmers' incomes continues to be an important objective of agricultural policy in most countries. The use of new improved crop varieties with defences against these adverse environmental effects is an effective way of ensuring crop yields to meet the growing population demand.

Finding a Heat-Tolerant Tomato for Mauritius



Plant breeder Banamati Saraye was trained at the FAO/IAEA's Plant Breeding and Genetics Laboratory.

"Mauritius is a tropical country with temperatures exceeding 30 degrees, especially in summer. The tomato is a summer crop and it's very sensitive to high temperatures. At the IAEA, I worked on a project to find a heat-tolerant tomato variety, by using nuclear energy to induce changes in the fruit."

Greater Food Security by Improving Wheat and Barley in Jordan



Plant biotechnologist Faddel Ismail takes part in an FAO/IAEA project to create new varieties of grains.

"Jordan is expected to have an increase in temperature and reduction in rainfall. Breeding wheat and barley under such difficult conditions requires genetic variation. Inducing mutation by utilising nuclear techniques will accelerate the creation of plants, which have the required traits like resistance to certain pests, drought and salinity."

Growing Barley in the Peruvian Andes



Farmer Erwin Ortega is growing and selling a variety of barley called "Centenario" that was developed using nuclear technology under an FAO/IAEA project.

"Centenario barley is very important here in the Andes. It has a better yield than other varieties, so it has improved my income considerably. It also tastes better and has more protein. We use barley for our own consumption. It's very nutritious and is especially important for the development of our children."

Text: Louise Potterton & Juanita Perez-Vargas, Division of Public Information