New varieties of potato can feed the poor

Crops such as potato have the potential to feed and contribute to the food security of vulnerable populations who depend on this ancestral tuber for their daily nutrition. But high-quality varieties are required. This Canadian–Colombian research project uses innovative genetic techniques to produce biofortified potatoes with higher crop yields and greater resistance to disease. Already available genetic information from native varieties forms the basis of this work.

The opportunity: focusing on the staple crop

Smallholder indigenous farmers represent more than 90% of Colombia’s potato growers. Potato is the main crop produced in the highland communities of the Department of Nariño in southwestern Colombia. This region is also one of the poorest, with the second highest rate of malnutrition in Colombia. Nearly 70% of households report food insecurity compared with the national average of 43%. Researchers believe potato has significant potential to reduce food insecurity in the Andes, but improving quality is essential.

The challenge: improving on native varieties

Unfortunately, indigenous growers have not had access to seeds of varieties with enhanced nutritional value that also produce high yields and are disease resistant.

Late blight (Phytophthora infestans) is the main threat to potato production, not only in Colombia, but also worldwide, particularly when there are changes in typical temperatures and rainfall. This common disease attacks the leaves and stems of potato plants spreading rapidly through the whole plantation. Studies show that approximately 265,000 t — or 10% of the total potato production in Colombia — are lost every year to late blight.

Heavy fungicide application is the primary method used to combat this disease. According to estimates, farmers spend about 6% of their potato crop income on chemicals to control late blight and other diseases — a high cost that also has environmental and health consequences.

In search of a more resistant and nutritious potato

In recent studies, researchers at the Universidad Nacional de Colombia (UNC) have developed potato cultivars that are more productive and disease resistant. These new cultivars are being tested in the Nariño region, where their nutritional value will also be further assessed. The International Potato Centre (CIP) in Peru is working closely with the project team, providing late blight resistant potato clones and expertise in the evaluation of micronutrient content.

The project is building on existing genetic data available from UNC and CIP to continue identifying and producing potato cultivars with increased nutritional value, productivity, and resistance to disease. Innovative genetic and biochemical crop-breeding methods, as well as crop improvement techniques, such as cisgenesis, are being used to advance knowledge (see box on the following page).
“Improved potato cultivars are expected to yield more, and thus can feed the family,” says Dr. Ajjamada Kushalappa, McGill University’s lead researcher. In Colombia, typical potato yields are 16 t/ha, after as many as seven fungicide applications every eight to ten days.

David Cuellar, a researcher at UNC, says, “With an improved and more resistant potato, production could at least double to between 32 and 40 t/ha and chemical applications could be reduced to four.” Reducing the use of chemicals would save farmers about 40% of current costs and lessen environmental impact.

The project also aims to produce a more nutritious potato by selecting cultivars that can store more minerals, such as zinc and iron. The team received 100 advanced cultivars of diploid potatoes from the UNC breeding program for further analysis. After reproducing and studying these, they selected 30 for a first trial with community participation. A second trial, in seven communities, was carried out using eight cultivars, selected for yield, yellowness of skin and flesh, roundness, shallow eye depths, palatability, resistance to late blight, good abiotic stress performance, nutritional value, and community acceptance. More than 450 farmers have participated in these trials.

Crops produced in the second trial were analyzed for moisture, ash, fat, protein, starch, and total dietary fibre. Significant diversity in the nutrient composition was also found in the various potato types; for example, some contained higher concentrations of iron and zinc. The team is now determining nutritional values of the various cultivars.

Data gathered during this part of the investigation are being used to select new cultivars. The eight cultivars were found to produce virus-free plantlets. Three superior genotypes are being selected for replication and delivery to Nariño potato producers in collaboration with field agricultural schools (a method for farmer-to-farmer learning). Participation of farmers through these schools, in terms of collection, sowing, selecting, and harvesting will facilitate community dissemination of information and adoption of the new varieties.

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Innovative metabolomics-based technology
Canadian researchers at McGill and the University of New Brunswick have developed new technologies for plant breeding. Dr. Ajjamada Kushalappa of McGill is using an innovative metabolomics-based method to identify late blight resistance genes that could be applied to potato cultivars (Figure 1). Metabolomics is the study of the molecules that participate in cellular functions — the intermediaries and products of metabolism known as metabolites.

The work has identified several metabolites related to disease resistance and their corresponding genes. This has led to the selection of potato varieties resistant to late blight. The resistance genes will be confirmed and validated before being transferred to elite cultivars in indigenous communities using a genetic technique called cisgenesis, the transfer of genes between closely related organisms of the same species. Unlike transgenesis, which transfers genes from one organism to a completely different species, cisgenesis is a fast, precise, and less invasive way of doing traditional breeding. Cisgenesis could occur naturally, but it would normally take many years.

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The project team has characterized the role of potatoes in the diet of indigenous families to identify nutritional deficiencies. A 24-hour diet recall exercise provided information about the preparation of food as well as the ingredients, quantities used, and portions consumed.

In an innovative approach, the team uses a sequence of instruments and visual aids that resemble food items in standardized sizes and weights to increase accuracy of data collection in terms of food quantities. This has helped identify food consumption patterns and has revealed opportunities for improving nutrition. For example, most people peel potatoes during food preparation, discarding the skin where most nutrients are concentrated.

In addition, the team has uncovered good ancestral nutritional habits associated with a number of traditional dishes, which are currently only prepared on special occasions because of the cost of ingredients. Traditional culinary practices and recipes using potatoes identified through this process will be part of a community-based manual of good dietary habits.
PROJECT DETAILS

Project title: Improving potato production for increased food security of indigenous communities in Colombia

Website: http://168.176.5.28/san/index.php?id=1&L=2

Lead researchers
Dr. Teresa Mosquera, Universidad Nacional de Colombia, Colombia
Dr. Ajjamada Kushalappa, McGill University, Canada

Partners
Canada: McGill University, and University of New Brunswick
Colombia: Universidad Nacional de Colombia, and Fundelsurco
Peru: International Potato Centre

Country: Colombia
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For more information on this project, contact:
Renaud De Plaen, Senior Program Specialist, Ottawa, Canada (rdeplae@idrc.ca) or Delphine Larrousse, Program Officer, Montevideo, Uruguay (dlarrousse@idrc.ca).

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International Development Research Centre
PO Box 8500, Ottawa ON Canada K1G 3H9
Telephone: +1 613 236 6163 • Fax: +1 613 236 7293
cifsrf@idrc.ca • www.idrc.ca/cifsrf