The contribution of the CIP genebank
Andean potato diversity and agriculture development in Uganda
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Highlights

• Two of the ancestors of Victoria, a popular improved potato variety in Uganda, are the wild relative species Solanum bukusovii and a Peruvian landrace belonging to the species S. tuberosum sub. Andigenum. Both are in the CIP genebank collection.

• Based on the Relative Contribution of Provenance (RCP), the CIP genebank contributed 72% to Victoria’s germplasm.

• The gross economic benefit of Victoria in Uganda is estimated at $1.2 billion (2016 $USD) for a 25-year period (roughly $48 million per year).

• The total cost of running the genebank to conserve 16,718 accessions of potato, sweet potato, and Andean roots and tubers is estimated at $4 million per year, a small amount compared to the economic benefits derived from a single variety in one country.

Why we need the CIP potato genebank
The International Potato Center (CIP) contributes to making the diversity of potato, sweet potato, and other Andean roots and tubers available for food security.

The CIP genebank, located in Lima, Peru, holds an ex-situ collection composed of wild relatives, landraces, advanced lines, and improved varieties, which are held “in trust” under the Plant Treaty. It has one of the largest in vitro collections in the world and employs various conservation strategies (seed conservation, cryopreservation, and in vitro conservation and propagation) to conserve true-to-type and pathogen-free potato germplasm efficiently.

A large part of the CIP genebank collection has been available since 1972 and many accessions have been the source of desired traits for potato breeding. The varieties developed have been used not only in South America, but also in many different countries including several in Asia and Africa where potatoes have played an important role in the agricultural sector.

Data and methods
To estimate the contribution of accessions conserved in the CIP genebank to the economic benefits of growing the improved variety Victoria on farms in Uganda, we use a combination of detailed pedigree information, genebank affiliation data, and the economic surplus model.

We constructed the pedigree for Victoria and evaluated the affiliation to the CIP genebank of each ancestor in the pedigree. A direct affiliation occurs when the germplasm of the ancestor is in the genebank. Applying an algorithm called the Relative Contribution of Provenance (RCP), we calculated the proportion of the relative genetic contribution from the CIP genebank related germplasm to Victoria considering the relationships in the pedigree and the affiliation to the CIP genebank.

Applying an ex post model of economic surplus, we also estimated the gross economic benefits of Victoria in Uganda based on its adoption path over time, its yield benefits compared to other used potato varieties, and the economic value associated with productivity gains. The yield gain of Victoria compared to other varieties was calculated based on the 2005 CIP farm-household survey in Uganda.

From the Andes to the genebank to the African highlands
Potato (Solanum tuberosum) is native to the Andean region of South America, where its wild relative species and cultivated varieties are enormously diverse. Potato species are found in an immense variety of habitats and exhibit various levels of resistance to biotic and abiotic stresses.

Victoria is an improved variety that corresponds to the clone CIP 381381.20 developed by CIP breeders in Peru in 1981 and was released in Uganda in 1991. The same germplasm has been distributed, released and cultivated under different names in several other African countries including Kenya, Congo, Rwanda, Madagascar, Burundi, and Malawi.

Two of the ancestors of Victoria are: the wild relative species S. bukusovii (CIP 760015) and a Peruvian landrace belonging to the species S. tuberosum sub. andigenum (CIP 701221). Both are conserved and maintained within the CIP genebank collection.

Gross Economic Benefits > Genebank Costs
The gross economic benefit of Victoria in Uganda is estimated at $1.2 billion (2016 $USD) for a 25-year period (1991 to 2016), about $48 million per year. The total cost of running the genebank to conserve 16,718 accessions of potato, sweet potato, and Andean roots and tubers is estimated at $4 million per year, less than a tenth of the economic benefits derived from a single variety in one country.

The adoption of Victoria in Uganda led to farm-level productivity gains. Yield gain from Victoria is estimated at about 8% higher than for other varieties used in Uganda. Victoria’s high yield, early maturity, and good marketability resulted in a high adoption rate (estimated at 53% of total area planted to potato in 2010).

The example of Victoria illustrates how the CIP genebank enabled breeders to incorporate genetic diversity into an improved variety that benefits small-scale farmers in different regions of the world.

Pedigree of Victoria (CIP 381381.20)
Victoria is a product of 5 generations of crosses. CIP genebank collection contributed 30% to Victoria germplasm. The collection of CIP-derived breeding materials supported by CIP genebank contributed 42%.