Potato diversity display at genebank of International Potato Center (CIP), Lima Peru. Photo Michael Major for Crop Trust

Safeguarding a future for the world's potato genetic resources

Executive Summary:

- Low genetic diversity means a tough outlook for the commercial potato, which is at substantial risk from disease epidemics, pest pressures and climate change.
- Climate-linked yield losses of up to 26% are projected by 2085 in the absence of adaptation, raising major food security issues for the world's most important non-cereal crop.
- Potato pests and diseases cost billions of dollars in inputs, management, and chemicals to control each year, and have the potential to devastate yields by up to 100%.
- Research and plant breeding are vital to combat these challenges, and these require the secure. conservation of the biodiversity of the crop in genebanks.
- Funding is urgently needed to preserve the world's potato genebanks, which guarantee long-term global access to this invaluable resource.
- Thanks to genebanks, potatoes, both wild and cultivated, that are more climate resilient, disease resistant, and more nutritious are already being identified and used in crop improvement.
- The Crop Trust is working to secure funding for the creation of a secure, cost-effective, and rational conservation system for potato biodiversity.

A Global Staple Under Threat - the Much-Loved Potato

The potato is the world's most important non-cereal food crop – its domestication dating to around 8,000 to 10,000 years ago in the Southern Andes. Covering 18.1 million hectares around the world[1], with yields two to four times higher biomass by weight than cereals, and with better water use efficiency, the potato is essential for regional food security and poverty reduction worldwide.[2,3]

However, a lack of genetic diversity in the commercial potato leaves the crop vulnerable to pests, disease, and – most pressingly – climate change. Genetic diversity has been at a relative standstill for potato over several decades.[4] This lack of diversity poses an obstacle for attempts to increase the productivity, sustainability and resilience of the crop.

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A 2018 study predicted up to a 26% decline in global potato yields by 2085 – a result of rising temperatures, only partly offset by higher atmospheric CO_2.[5] Earlier studies[6] illustrated a similar outcome, if varieties better adapted to warming temperatures are not developed and widely adopted. Such a severe cut in yields, alongside 1.47% year-on-year growth in global potato consumption[7], would cause major food security concerns for billions of people.

Moreover, a catalogue of daunting pests and disease also threatens the potato. Nineteen different quarantine pests have been recorded that threaten to wipe out potato crops by up to 100%.[8] Such diseases are costly to control, difficult to manage and have potentially overwhelming consequences for food security (see late blight case study). Research, and the development of new varieties, are required for the resilience of potato cultivation to future environmental changes and shocks. These require potato biodiversity as their raw materials. Without the continuous conservation and use of potato diversity, the crop has no future.

Securing Potato Genetic Diversity- The Essential Role of Genebanks

The good news is that using a combination of seed storage, field plots, tissue culture and cryopreservation, researchers are conserving around 80,000 different types of potato in genebanks around the globe. This diversity is the essential raw material for the development of new varieties which can withstand climate change, pest attacks and disease epidemics. The maintenance, improvement, and ongoing funding of such genebanks is crucial for the survival of the potato as a global crop.

Late Potato Blight – a Billion Dollar Disease

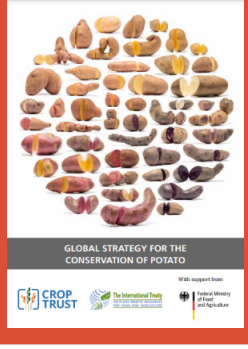
Potato late blight is remembered for the European potato failures of mid-1840s, which drove millions into disease, famine, and poverty. They would not have happened if the crop had been more resistant and diverse.

Variety development has evolved since this dark time, but even today late blight costs over one billion USD to control every year – in inputs, chemicals, and management. Global climate change makes this control ever more challenging.

Varietal resistance is an essential part of controlling late blight. In 2021, a new blight resistant variety – CIP-Matilde – was developed in Peru, with support from the Crop Trust. Disease-resistant, climate resilient and high-yielding, this new variety is an important step forward, but many more such steps are needed, as the pathogen continues to evolve. The fight against late blight will never end.

The Global Strategy for Conservation of Potato, commissioned by the Crop Trust and developed in cooperation with global partners, presents a comprehensive overview on the current state of the conservation and use of potato diversity. It identifies priorities for strengthening potato conservation globally:

- Comprehensive DNA fingerprinting of all existing collections.
- Investment and development of potato genebanks in the centre of diversity.
- Global standardization of documentation, record keeping and taxonomy.
- Cryopreservation of collections for safety.
- Promoting global accessibility and multi-lateral networking.



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Essential Traits to Develop Long-Term Resilience

Prioritizing the efficient conservation of genetic diversity is an essential step in ensuring that the potato is ready for the future. Of the 88 species of potato wild relatives which should be prioritized for conservation, 43 were confirmed to have traits of potential use in crop breeding for improved flavour, colour, quality, and resistance to pest, disease, and climate stresses. A small sample of these traits and uses are illustrated in the figure below. [10,11,12,13,14,15]

Resistance to biotic stress

This Central American species *Solanum demissum* shows late potato blight and Potato Leaf Roll virus resistance. It may also hold Potato virus Y and Cyst nematode resistance, amongst others.

Resilience to climatic events

This South American potato species *Solanum boliviense* has frost tolerance and may have both heat and drought tolerance.

Improving yield

Studies involving the native South American species *Solanum chacoense* have confirmed potential for higher levels of both dry matter and yield. Quality traits, climate resilience and disease resistance have also been confirmed.

Improving quality

From Peru, *Solanum raphanifolium* has confirmed resistance against cold induced sweetening which makes for a better chip.

Safeguarding the Potato for an Uncertain Future

The preservation of potato genetic diversity is essential for the long-term prospects and sustainability of the potato supply chain. The need is pressing, but the steps are well defined, and the benefits are clear.

The Crop Trust is working to secure funding for the creation of a secure, cost-effective, and rational conservation system for potato diversity. For this system to be in place, and provide the necessary long-term funding to sustain it, the Crop Trust is seeking to raise USD 45 million for its endowment fund. This will provide the annual USD 1.8 million needed to fund collections globally that are essential for the long-term preservation of potato diversity. The International Potato Center (CIP) will be the major recipient of this funding. Founded in 1971, CIP hosts the most important genebank for potato conservation worldwide, with over 7,000 samples, making it the largest genebank for potatoes globally. The germplasm conserved at CIP has been utilized in breeding and release of economically important CIP-related varieties.[16] CIP requires USD 1.3 million in annual funding to maintain this vital source indefinitely.

Industry leaders are needed to spearhead this critical work and ensure potato can respond to existing and future challenges and continue to contribute significantly to the world's food supply.

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