# Weevil resistant sweetpotato through biotechnology

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Sweetpotato Action for Security and Health in Africa

**With the aim of "feeding the people, not the weevils" this project is combining conventional breeding and biotechnology to combat the pernicious and devastating consequences of sweetpotato weevil. Results to date include the identification of three insecticidal proteins and the introduction of putative resistance genes into sweetpotato varieties. The resistance levels will be measured in coming months, with continuation to field trials if those levels are significant.**

Sweetpotato weevil magnified, *Cylas brunneus*

## What is the problem?

Weevils can destroy 60% - 100% of sweetpotato crops during periods of pronounced drought. As sweetpotato is at times the only food available, this can be quite devastating. The impacts of weevils can affect not only food security, but also sweetpotato production, marketability, and sustainability, especially in areas experiencing longer dry periods.

With climate change predictions for Sub-Saharan Africa (SSA) foreseeing an expanding dry season, the threat and impact of weevils may increase further. Adapting conventional integrated pest management practices among smallholder farmers does not work because of the great difficulty associated with controlling field sanitation in small-scale subsistence production systems. In addition, the common practices of in-ground storage, piecemeal harvesting, and strip harvesting mean that sweetpotato crops are exposed to weevils throughout a significant part of the year. Extensive efforts to develop weevil-resistant sweetpotato through conventional breeding methods have failed in spite of considerable investment for decades. As a result, there is currently little farmers can do when weevils infest their fields, other than to quickly try to harvest and salvage what is left of their crop.

## What do we want to achieve?

The aim of this project is to "feed the people, not the weevils" by developing weevil-resistant sweetpotato varieties through combined breeding and biotechnology. Bacillus thuringiensis (Bt) is a soil bacterium that is well-known for its crystal proteins with insecticidal activity against pests. Genes that produce such proteins can be made to resemble a native gene of the crop to protect from the pest and then introduced into the target plant to confer resistance. For example, Bt technology has been used successfully to increase resistance to bollworm in cotton and rootworm or stem borer in maize. The result has been decreased need for pesticide use and increased yields in those crops. In addition, there is well-documented evidence that they are safe for humans and confer positive environmental impacts.

Farmers, including small-scale producers, have been the primary beneficiaries of Bt technology. In the case of Bt sweetpotato, women would stand to gain back considerable time currently spent removing weevil infected sections in roots prior to cooking.

**Partners include:**

- National Crops Resources Research Institute (NaCRRI) and Kawanda Research Station (KARS) of NARO - [Uganda] for developing and testing resistance to weevils in sweetpotato plants, including a confined field trial
- Biosciences east and central Africa (BecA), Kenyatta University (KU) - [Kenya] for developing and testing resistance to weevils in sweetpotato plants
- University of Puerto Rico Mayagüez, Donald Danforth Plant Science Center - [USA] for testing resistance to weevils in sweetpotato plants including a confined field trial and for guidance and oversight in the development of regulatory dossier, respectively
- University of Valencia - [Spain] for understanding the mode of action of these crystal protein and producing these for safety studies
- University of Gent - [Belgium] for capacity building of African scientists and developing communication products.

Roots damaged by weevils (credit R. Mwanga)

## Where are we working?

Research on insecticidal proteins from Bt have taken place mainly in the US and Uganda over the past 7 years. Weevil resistant genes were introduced into African varieties two years ago in Peru at the CIP biotech lab, and soon after in Uganda and Kenya. Once resistance is observed in the lab, the best plant will be tested in a confined field trial in Uganda for the two African weevil pest species and in Puerto Rico for another sweetpotato weevil species of importance in Central America and Asia.

## How are we going to make it happen?

In 2004, with Rockefeller Foundation funding, CIP facilitated the foundation of the development of weevil-resistant varieties for SSA countries based on the Bt technology. With the National Agricultural Research organization of Uganda and Auburn University in the USA as partners, in 2007, CIP identified three distinct crystal proteins exhibiting weevil toxicity at levels similar to proteins expressed in commercial Bt crops. Soon after, weevil-resistant genes were made using genetic information from the sweetpotato crop itself in order to make 3 sweetpotato-like weevil resistance (WR) genes. These are now being introduced into susceptible varieties. The most promising plants with full resistance will be integrated into breeding programs to enable the development of new varieties that meet local farmer preferences and increasingly drier environmental conditions. This will be achieved using conventional breeding techniques, drawing on the long-standing experience of Ugandan scientists in the national sweetpotato improvement program.

## What have we learned so far?

We have identified crystal proteins with activity against the two African weevil pests. Genes resembling sweetpotato genes and producing these crystal proteins have been introduced into susceptible sweetpotato varieties. This process is challenging in sweetpotato. Two initially selected African sweetpotato varieties had very low transformation efficiency, but four were found subsequently to offer better results, and we have confirmed that the newly introduced resistance genes are functional, with crystal proteins accumulating in the leaves and the storage roots. The last important and long-awaited step is to demonstrate that these transformed sweetpotato plants have acquired resistance to weevil pests. In the coming months in Uganda and Kenya, by feeding our transformed roots and artificial diets to weevils, we will be able to quantify the level of resistance acquired. If the resistance levels are significant, we will move to field condition testing in Uganda and Puerto Rico, where appropriate facilities and policies exist.

To date, communication about this technology has mostly targeted to a scientific audience. With successes, it will be broadened to include a wider audience with a communication strategy designed to inform about the potential benefits of this genetically modified sweetpotato and the steps being taken to assure that it is safe for humans and the environment.

GM roots for weevil resistance tests (credit M. Ghislain)


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