Protecting farms from costly whiteflies

Key fact:

An ambitious global R&D programme to combat tropical whitefly and the diseases it carries has prevented widespread losses in many essential crops.

Summary:

Tropical whitefly is one of the world's most serious agricultural pests. Feeding damage causes severe economic losses in a wide range of food crops grown by millions of smallholder farmers. However, it is the transmission of viruses by whiteflies that has the widest impact on global food production, including on key crops such as cassava, tomatoes, beans and sweet potatoes.

Whiteflies and mosaic disease caused cassava yield losses of 30-40% in 2003 *(CIAT)*

The Tropical Whitefly Project (TWP) has fostered collaboration amongst a range of partners, including several CGIAR centres, universities, national governments and the private sector to develop and share highly effective Integrated Pest Management (IPM) practices. Regionally-specific responses have been advanced in 31 countries, utilising new resistant varieties of crops and more rational pesticide use to keep the whitefly and its diseases under control.

Facts & figures

- Over 1,100 whitefly species have been identified in the tropics, 57 of which are particularly damaging to crops not only by feeding on the plants themselves but by carrying disease-causing viruses as well.
- Crops affected by whitefly include tomatoes, beans, cassava, cotton, cucumbers, potatoes, sweet potatoes, melons, gourds, and squashes.
- Whiteflies and mosaic disease caused cassava yield losses of 30-40% or 19-27 million tons of lost harvests. This translates into a conservative annual economic loss of US$1.9–2.7 billion for 2003. Such losses reveal that cassava mosaic disease is one of the most globally -damaging if not the most globally damaging plant virus disease (Legg and Fauquet, 2004).
- Countrywide surveys in Tanzania of cassava revealed multiple infections from more than ten cassava mosaic viruses. Multiplication and dissemination of cassava varieties resistant to *Bemisia tabaci* has helped reduce infestations and improve yields.
- TWP research contributed to producing the world's first whitefly-resistant cassava.
- TWP research has provided regionally specific IPM measures in 31 countries.
- In El Salvador, IPM strategies increased tomato yields by 40% and sweet pepper yields by 236%. Improved bean varieties are yielding 800 kg/ha compared to around 60 kg/ha from susceptible landraces (Ortiz, 2007).

Protecting farms against costly whiteflies

The notorious tropical whitefly is one of the most problematic pests in world agriculture, devouring a wide range of food crops grown by millions of smallholder farmers. Worse yet, the flies transmit numerous diseases including cassava mosaic virus (CMV) and sweet potato virus disease (SPVD). Like mosquitoes of the crop world, whiteflies spread pathogens that can obliterate entire harvests of cassava, beans, sweet potatoes, tomatoes and other important crops. Estimates of their destructive reach extend to 20 million hectares of crops and 15 million farmers.[1]

Whiteflies spread pathogens that obliterate entire harvests of cassava, beans, tomatoes and other crops *(CIAT)*

Long considered a purely tropical problem, whiteflies have benefited from global climate change and the global circulation of plant material, spreading even more widely and taking their diseases with them. Managing the pest has proven a uniquely complex operation, with different species of whiteflies carrying different types of viruses that affect different plants. Detecting and characterising the flies and viruses affecting each crop in each region often demands sophisticated molecular-level analysis.

To gain a better understanding of this complex problem, a global consortium known as the Tropical Whitefly IPM Project (TWP) was launched in 1997. The project has involved more than 100 research institutes, universities, governments, NGOs and private companies in more than 50 countries to develop and share highly effective Integrated Pest Management (IPM) practices. One of the most ambitious IPM projects ever attempted, the TWP has since introduced new pest management technologies to farmers fighting the whitefly in 31 developing countries around the world.

The first step of the TWP was to form a pan-tropical network of scientists researching whiteflies and viruses. Research insights enabled scientists to develop effective IPM strategies combining crop resistance, rational pesticide use, biological controls and cultural practices. Working alongside farmers, they further perfected these tools in the field.

Field research during Phase I of the project clearly showed that there are two main whitefly pests in the tropics, *Bemicia tabaci* and *Trialeurodes vaporariorum*. The species *B. tabaci* is responsible for spreading most diseases, including cassava mosaic disease (CMD), sweet potato virus disease (SPVD), bean golden mosaic disease and many diseases of tomato, hot and sweet peppers, squashes, melons and other horticultural crops.

Crop breeding for virus resistance has been essential *(CIAT)*

A key factor behind severe outbreaks of the whitefly and its viruses was identified by TWP as the abuse of pesticides. The whitefly's natural predators and parasites are often wiped out by heavy pesticide use. Along with dissemination of whitefly- and virus-resistant plant varieties, information was provided by TWP on proper insecticide use. The project has demonstrated that both rational pesticide use and better plant genetics are indispensable components of an IPM programme. Although the biological control of whiteflies is effective in cropping systems with minimal and rational use of insecticides, such control is most powerful when used on the right plant varieties. Crop breeding for virus resistance has been essential.

Farmer training and technical assistance were the means of achieving change in the field, and the discussions that came out of the process also helped influence IPM strategies to be more sustainable and economically viable. One of the most substantial achievements of the TWP was in demonstrating to smallscale farmers and national agricultural research institutions that whitefly and virus problems can be managed effectively. Consequently, crop production has been made possible in regions where certain crops had been abandoned due to the severity of whitefly and virus attacks.


East Africa has been one of the worst areas affected by whitefly *(CIAT)*

East Africa, for example, has been one of the areas worst affected by whitefly, with farmers losing more than two-thirds of their cassava crops to a pandemic of the whitefly-borne CMD. An epidemic of severe CMD spread throughout much of Uganda in the 1990s and devastated the country's cassava production. Losses were valued at in excess of US$60 million annually between 1992 and 1997 (Otim-Nape et al., 1997). Many farmers abandoned the crop in large parts of the country. In eastern districts widespread food shortages led to famine-related deaths (Thresh and Otim-Nape, 1994).

During the second half of the 1990s, the epidemic spread to the neighbouring countries of Sudan, Kenya, Tanzania and eastern Democratic Republic of Congo (DRC), with a similar impact on cassava harvests (Legg, 1999). Countrywide surveys in Tanzania revealed multiple infections from more than ten cassava mosaic viruses. Multiplication and dissemination of cassava varieties resistant to CMD has helped reduce infestations and improve yields.

Central America is a centre of bean cultivation, but due to largely whitefly-borne diseases farmers here had come to expect only 1/3 of the yields enjoyed in other bean-growing regions. More than a million hectares of bean production have been abandoned in Latin America as a whole (Anderson & Morales 2005), and many countries in the region have been forced to import their beans from as far away as China.

In El Salvador, despite applying ever increasing levels of pesticide, bean farmers were experiencing losses of up to 90 per cent due to whitefly and golden mosaic virus. The TWP produced and helped distribute improved bean seeds to 100,000 Salvadorian farmers who were also trained in the judicious use of insecticides. As a result, farmers have been able to recover hundreds of hectares of land abandoned to the flies. Resistant bean cultivars now yield over 800 kg/hectare versus 60 kg/hectare produced by the susceptible local landrace under virus attack. Estimates of the economic impact of increased yields in this and other crops range from a net benefit of US$428 per hectare for beans, to US$2400 for tomatoes and US$3170 for hot peppers (Ortiz, 2007).

In Asia, vegetables, particularly tomatoes and peppers, are important food crops often attacked by whitefly-associated viruses. Durable and stable virus resistance requires cross breeding plant varieties with multiple resistance genes. In India, improved varieties provided yields of 30-35 tonnes per hectare versus 19 tonnes per hectare for local varieties. Net profits from production of these resistant lines averaged US$3000 per hectare (Ortiz, 2007).

Additional case study information

Costs and benefits:

While DFID invested nearly £2.5 million to increase project reach in Phases II and III of the TWP, the potential payoff is incalculable. Numerous socio-economic and environmental benefits of more effective pest control methods will continue to accrue in the future through the tropics and beyond. The real impact lies in the whitefly and disease epidemics that will be avoided, the scale of which we can only imagine. In the early 1990s, an alarming whitefly outbreak in the United States, well outside the tropical zone, brought US$500 million worth of damage in a single year (Oliveira, et al. 2001). Such disasters can be curtailed by the application of IPM.

At the same time, in regions where whitefly is entrenched, the new tools bring farmers benefits that are less dramatic but more important to secure livelihoods year after year. Estimates of the economic impact of disseminated technologies to control whitefly and associated diseases in Central America range from an annual net benefit of US$428 per hectare for beans, to US$2400 for tomatoes and US$3170 for chillies. The internal rate of return was 42, 47 and 45 per cent, respectively (Ortiz, 2007).

Research milestones:

- 1995 CIAT in Cali, Colombia is designated as the convening centre of the CGIAR Whitefly IPM Task Force by an Inter-Centre IPM Working Group.
- 1997-2000 Phase I: Three whitefly problems are prioritised: (1) pests in highland tropics, (2) pests and virus transmitters in cassava, and (3) pests and virus transmitters in mixed cropping systems in low and mid-altitude tropics. DFID and other donors contribute three additional priorities: (4) whiteflies as vectors of viruses in Southeast Asia, (5) whiteflies as vectors of viruses in cassava and sweet potato in Sub-Saharan Africa, and (6) whiteflies as pests of cassava in South America.
- 2001-2004 Phase II: DFID and other donor funding supported project researcher networks to mitigate the Cassava Mosaic Disease (CMD) pandemic in Tanzania, to advance post-crisis management and stabilisation of cassava in Uganda, and develop numerous management programmes against diseases of cassava, sweet potato, beans and vegetables in Africa, Latin America, and Asia.
- 2005-2008 Phase III: DFID funding enabled the project to expand coverage to countries recently affected by whitefly pests and whitefly-transmitted viruses; to work on new crop protection partnerships countering sweet potato and tomato viruses in Sub-Saharan Africa and India; and to collaborate with the Farmer Participatory Research (FPR) Working Group.

Photo credits:

CIAT: For high res images contact Neil Palmer (n.palmer@cgiar.org)

Links:

Tropical Whitefly IPM Project: www.tropicalwhiteflyipmproject.cgiar.org

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[1] http://www.research4development.info/casestudies.asp?ArticleID=172

DFID, the Department of International Development, is the part of the UK government that manages Britain's aid to poor countries and works to get rid of extreme poverty.

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