DFID

a united effort against a global pest

helping poor farmers reduce crop losses and grow more food in a sustainable way

Introduction

Whiteflies cause severe damage to a wide range of crops in tropical and sub-tropical regions. In these areas, where most of the world's poor live, economic losses from these insects and the plant viruses they transmit result in real hardship for affected farmers. Substantial yield losses in subsistence crops, such as cassava and sweet potato in Sub-Saharan Africa, and common beans in Latin America, have serious implications for food security. In Latin America and Asia, extensive damage to cash crops such as tomato and pepper results in reduced cash earnings for farmers. This means families have less money to spend on basic requirements such as schooling for children, medicines and the type of food that will provide a balanced diet. Invariably, women and children are the most vulnerable in this situation.

The whitefly problem has worsened considerably over the past two decades. Insecticides are used as the main control measure, but these become less effective as the insect developes resistance to them. Farmers usually respond by spraying more frequently, thereby creating environmental and health hazards. They also create new pest problems by killing off beneficial organisms such as spiders and wasps, thus making possible outbreaks of insects that were previously kept under control by these natural enemies.

Another reason for the increased importance of whiteflies is that new forms of both insect and viruses have emerged in recent years. Some of the new forms of whitefly can infest a wider range of crops and weeds. They can often multiply more rapidly and spread viral diseases more efficiently than the indigenous whitefly species. The so-called B biotype is a prime example of this phenomenon and is causing much concern as it spreads to new areas. The B biotype was recently recorded in Africa, making it imperative for agricultural researchers to help farmers respond to this threat.

The United Kingdom's Department for International Development (DFID) supports research in the sustainable management of natural resources that aims at improving the livelihoods of poor people in developing countries. DFID has funded commodity-based research on whiteflies and whitefly-transmitted viruses, primarily in Africa, for nearly a decade through its centrally funded Crop Protection Programme (CPP). It is now aiming to build on this support by helping to create a global framework that will allow different whitefly research projects and activities to coordinate their efforts more effectively and produce research outputs which have positive and sustainable impacts on poor peoples' livelihoods.

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Whiteflies as vectors of cassava and sweet potato viruses in Africa

Bemisia tabaci transmits viruses that cause cassava mosaic and sweet potato virus disease, the main production problems of these crops in Africa

Yield losses pose a major threat to food security, thus making the development of effective IPM approaches essential

We are combining existing host-plant resistance with novel biocontrol and crop management strategies in a sustainable IPM strategy

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Whiteflies as cassava pests in South America

Host plant resistance to whiteflies in cultivated crops is rare

Resistance to a major whitefly pest of cassava, *Aleurotrachelus socialis*, has been identified in an Ecuadorian clone

This resistance is now being transferred to other cassava cultivars in the hope of controlling whitefly pests of this crop in the tropics

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Characterization and control of sweet potato viruses in East Africa

Sweet potato virus disease is caused by a virus complex transmitted by the whitefly, *Bemisia tabaci,* and aphids

These viruses compound each other's effects in infected crops, reducing yields to less than half of those of virus-free crops

IPM practices, including the use of resistant varieties, can effectively control sweet potato virus disease

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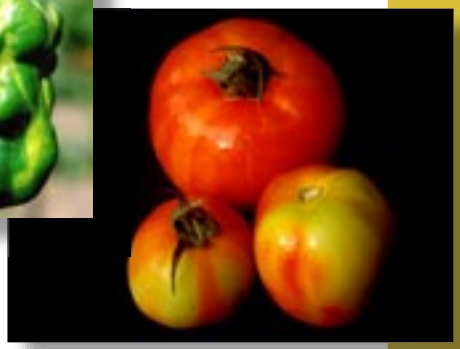
Whiteflies as pests and virus vectors in tropical America

The whitefly, *Bemisia tabaci,* attacks food and industrial crops throughout the lowlands and mid-altitude valleys of tropical America



Whitefly-transmitted viruses have ruined millions of small farmers who had attempted to diversify their traditional crops without technical assistance

Selected IPM measures contribute to sustainable food production and effective management of whitefly / geminivirus problems in mixed-cropping systems

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Whiteflies as virus vectors in eastern and southern Africa

Poor farmers in eastern and southern Africa are increasingly adopting horticultural crops as an important source of income

Unfortunately, whitefly-borne viruses attack these crops, inducing severe yield losses and widespread pesticide abuse

The implementation of IPM practices against *Bemisia tabaci* is expected to increase productivity and reduce pesticide abuse

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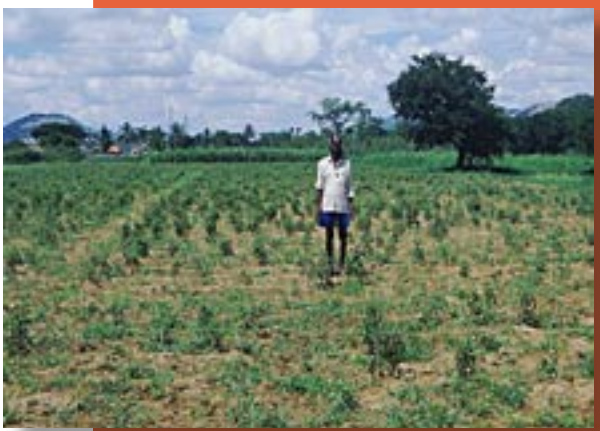
Whiteflies as virus vectors in South-East Asian mixed-cropping systems

Vegetables, particularly tomatoes and peppers, are important food crops that are now under attack by whitefly-borne viruses in South East Asia

The development of geminivirus-resistant vegetables in South East Asia is critical to increasing productivity and improving rural livelihoods



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Sustainable management of the whitefly-borne *Tomato leaf curl virus* in India

Tomatoes are an important source of income for Indian farmers. *Tomato leaf curl virus* causes devastating yield losses, frequently leading to crops being abandoned

Bemisia tabaci biotype B causes widespread tomato leaf curl epidemics and irregular ripening of the fruit

Developing virus-resistant tomato varieties is a sustainable and environmentally friendly control measure that is readily accepted by farmers

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Whiteflies as pests in the Andean highlands

The whitefly, *Trialeurodes vaporariorum,* attacks crops at higher altitudes (>1000 m) where *Bemisia tabaci* cannot thrive

Widespread pesticide abuse in cropping systems affected by Trialeurodes vaporariorum is causing the emergence of pesticide-resistant whitefly populations

IPM measures constitute a sustainable way of managing the whitefly problem and reducing pesticide use

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The whitefly projects described in this publication have been conducted in collaboration with:

National program scientists: Agricultural Research Corporation (ARC), Sudan; Bvumbwe Agricultural Research Station, Malawi; Centro Nacional de Tecnología Agropecuaria y Forestal (CENTA), El Salvador; Corporación Colombiana de Investigación Agropecuaria (CORPOICA), Colombia; Empresa Brasileira de Pesquisa Agropecuária (EMBRAPA), Brazil; Instituto Nacional Autónomo de Investigaciones Agropecuarias (INIAP), Ecuador; Instituto Nacional de Investigaciones Forestales, Agrícolas y Pecuarias (INIFAP), Mexico; Kenya Agricultural Research Institute (KARI), Kenya; Lake Zone Agricultural Research and Development Institute, Tanzania; Namulonge Agricultural and Animal Production Research Institute (NAARI) of the National Agricultural Research Organization (NARO), Uganda; National Horticultural Research and Training Institute at Tengeru (HORTI), Tanzania; Selian Agricultural Research Institute (SARI), Tanzania.

Universities of: Makerere University, Uganda; Montana State University, USA; Royal Veterinary and Agricultural University, Denmark; Tel-Aviv University, Israel; Universidad de El Salvador; University of Arizona, USA; University of Agricultural Sciences, India; University of Copenhagen, Denmark; University of Florida, USA; University of Gezira, Sudan; University of Wisconsin-Madison, USA.

Specialized research organizations: Biologische Bundesanstalt für Land und Forstwirtschaft, Germany; CABI Bioscience, United Kingdom; Commonwealth Scientific & Industrial Research Organisation, Australia; Danish Institute of Agricultural Sciences, Denmark; Donald Danforth Plant Science Center, Missouri, USA; John Innes Centre, UK; Museum of Entomology of the Florida State Collection of Arthropods, USA; Natural Resources Institute (NRI), UK; New Zealand Institute for Crop and Food Research, Ltd.

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caused

Diminishing support for food production research and lack of technical assistance to small-scale farmers have greatly increased pesticide abuse, thus causing severe environmental degradation and human health hazards in rural and urban communities throughout the tropics.

The DFID Crop Protection Programme operates in those regions of the world that are affected by whiteflies and whitefly-borne viruses. It promotes the development and exchange of sustainable IPM methodologies to control these globally important pests.

DFID Department for International Development

CPP

This publication includes outputs from research projects wholly or partially funded by the United Kingdom Department for International Development (DFID) for the benefit of developing countries. The views expressed are not necessarily those of DFID.

Crop Protection Programme
R 7492 Control of sweet potato viruses
R 7505 Management of African cassava mosaic virus disease
R 7460 Bemisia tabaci and tomato leaf curl virus disease management
R 8041 Whitefly Initiative Phase II - CGIAR System-wide Whitefly IPM Project
R 8222 Strategic modelling to minimise threats to production systems by begomoviruses




Tropical Whitefly IPM Project







International cooperation to solve a global problem

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Introduction

In 1996, a Whitefly IPM Task Force conceptualized the project "Sustainable Integrated Management of Whiteflies as Pests and Vectors of Plant Viruses in the Tropics". The project, currently known as the Tropical Whitefly IPM Project (TWFP), defined the following activities as priorities:

a) Form a pantropical network for research on whiteflies and whitefly-transmitted viruses (geminiviruses or begomoviruses).
b) Diagnose and characterize whitefly-related problems in selected regions and crops.
c) Collect published and 'grey' literature on whiteflies as pests and vectors of plant viruses in the Tropics.
d) Conduct basic research on whitefly ecology and disease dynamics.
e) Test Integrated Pest Management strategies in selected pilot sites.
f) Train national scientists and farmers on the use of suitable IPM strategies.
g) Implement Farmer Participatory Research activities and disseminate technology using various communication media.
h) Assess impact of IPM strategies adopted.

Phase I of the Project, from 1997-2000, concentrated on activities a, b and c. Phase II, from 2001-2004, built on Phase I by developing, testing and implementing IPM strategies in selected pilot sites identified during Phase I. A web site was also developed to share information generated by the TWFP.

Phase III includes different activities in the areas of Farmer Participatory Research, Farmer Field Schools, Communication and Knowledge Management, and Technology Dissemination. To this end, the TWFP will collaborate with specialists in the above-mentioned areas, currently working within the Systemwide IPM Project.

Phase I

Networking	Diagnosis
Establish network links	Regions affected
Create directory of specialists	Crops attacked
Standardise methodology	Yield loss
Bibliographic searches	Pesticide use
Produce technical publications	Whitefly species
Develop a website	Whitefly biotypes
	Begomoviruses

Phase II

Basic Research	IPM Technology
Whitefly biology	Resistant germplasm
Whitefly population dynamics	Biocontrol
Epidemiology	Cultural practices
Geographic Information Systems	Reduced pesticide use
Validating IPM Practices	IPM packages

Phase III

Technology Dissemination	Impact Assessment
Farmer Participatory Research	Adoption of technology
Farmer Field Schools	Whitefly/Virus knowledge
Economic Analyses	Increased production
Crop improvement	Pesticide reduction
Information and Communication	Socio-economic benefits
Technology	Food security

Whiteflies as vectors of cassava and sw

The whitefly *Bemisia tabaci* transmits viruses that cause cassava mosaic and sweet potato virus disease, the main production problems of these crops in sub-Saharan Africa.

Yield losses pose a major threat to food security, thus making the development of effective IPM approaches essential.

We are combining existing host-plant resistance with novel biocontrol and crop management strategies in a sustainable IPM manner.

Milestones

Country-wide surveys of cassava mosaic geminiviruses (CMGs) in Tanzania revealed the occurrence

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veet potato viruses in sub-Saharan Africa

of more than 10 CMGs commonly found in mixed infections. An important current topic of study is the effect that these virus mixtures have on disease expression and therefore on yield.

Bemisia tabaci biotype B develops poorly on cassava clones, MEcu 72, CG 489-34, CMC-40, MPer 334, MPer 273 and MEcu 64. These clones are being tested for resistance to *Bemisia tabaci* in Africa.

Research plans for Phase III

The secret to the effective management of whitefly-vectored viruses of cassava and sweetpotato in sub-Saharan Africa, lies in combining virus and whitefly management components into an integrated package. In Phase III, we will work with farmers to validate such IPM approaches and disseminate results and experiences widely in the target regions.

Whiteflies as pests and vectors

Poor farmers in eastern Africa are increasingly adopting horticultural crops as additional sources of income.

Unfortunately, whiteflies and whitefly-borne viruses attack these crops, resulting in severe yield losses and alarming pesticide abuse.

The implementation of IPM practices against *Bemisia tabaci* and *Trialeurodes vaporariorum* is expected to increase productivity and reduce pesticide abuse.

Milestones

Silverleaf symptoms found in Cucurbitaceae in the Sudan indicate that the aggressive *B. tabaci* biotype B is becoming established in the region. Horticultural zones in Tanzania already show 100% whitefly-borne virus infection in tomatoes. AVRDC and the University of Gezira, Sudan, have identified potential virus-

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# of plant viruses in Eastern Africa

resistant tomatoes and cucurbit genotypes, respectively.

The *Trialeurodes* sp. whiteflies affect different horticultural crops in the highlands, requiring the implementation of an IPM approach.

The protection of a nascent horticultural crop industry against whiteflies and whitefly-borne viruses is critical to improve the livelihoods of small-scale horticultural farmers in Africa.

Research plans for Phase III

Work with farmers in a participatory manner in order to implement IPM measures to control whiteflies and whitefly-transmitted viruses in East Africa and other "hot spots" .

Whiteflies as cassa

Host plant resistance to whiteflies in cultivated crops is rare. Resistance to a major whitefly pest of cassava, *Aleurotrachelus socialis*, has been identified in Ecuadorian and Peruvian clones.

MEcu 72 has consistently shown resistance to the cassava whitefly *A. socialis.* Laboratory experiments showed whitefly mortality levels around 70% for MEcu 72, MPer 334, and MEcu 64.

This resistance is being used to develop high-yielding, whitefly-resistant

cassava cultivars. It is expected that whitefly-resistant cultivars will reduce pesticide use and lower production costs for the small cassava farmer.

Milestones

A cassava hybrid, Nataima-31, from a MEcu 72 x MBra 12 cross, has

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ava pests in South America

been field-evaluated for four years and released by the Colombian Ministry of Agriculture. Nataima-31 represents a unique case of a commodity cultivar released for whitefly resistance.

The resistance to whitefly damage identified in South American germplasm, seems to be promising to control *Bemisia tabaci,* the vector of cassava mosaic geminiviruses, in Africa.

Research plans for Phase III

Additional cassava germplasm will be field and laboratory tested and higher-yielding whitefly-resistant hybrids developed. An IPM package that includes resistance will be developed and implemented with growers through Farmer Participatory Research and Farmer Field Schools.

Whiteflies as pests and vectors

The whitefly *Bemisia tabaci* attacks food and industrial crops throughout the lowlands and mid-altitude valleys of Middle America.

Whitefly-transmitted viruses have ruined millions of small farmers who had attempted to diversify their traditional crops without technical assistance.

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IPM measures contribute to sustainable food production and effective management of whitefly /begomovirus problems in mixed-cropping systems.

Milestones

Virus-resistant common bean varieties have been developed in the region, wherever *B. tabaci* transmits viruses to this important food crop.

# of plant viruses in Middle America

Resistant bean cultivars yield over 800 kg/ha vs. 60 kg/ha produced by the susceptible local landrace 'Rojo de Seda', under virus attack.

Tomato plants protected by microtunnels produced over 60 MT/ha. Unprotected tomato plots were completely destroyed. Profits for protected tomatoes exceeded US$ 10,000/ha.

Research plans for Phase III

Virus-resistant bean varieties and physical whitefly-control methods for horticultural crops have been identified in Central America and Mexico. A major effort is now required to demonstrate to farmers the economic and health benefits derived from reduced pesticide applications. We plan to educate farmers about the economic, environmental and health benefits accrued from the reduction of crop protection costs and adoption of IPM strategies.

Whiteflies as pests in the And

The whitefly *Trialeurodes vaporariorum* attacks crops at higher altitudes (>1000 m), where the whitefly *Bemisia tabaci* cannot thrive.

Widespread pesticide abuse in cropping systems affected by *Trialeurodes vaporariorum* causes the emergence of pesticide-resistant whitefly populations.

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IPM measures constitute a sustainable way of managing the whitefly problem and reducing pesticide use.

Milestones

Promising IPM tactics have been identified, which include the replacement of broad-spectrum insecticides, timing applications

dean highlands of South America

according to pre-established action thresholds, and use of natural enemies, such as the wasp *Amitus fuscipennis, and the fungus Verticillium lecanii*.

Whitefly resistance to organo-phosphates, carbamates and pyrethroids, has been detected in Colombia and Ecuador. Whitefly management alternatives in both countries led to reduction in insecticide use of 60-70%.

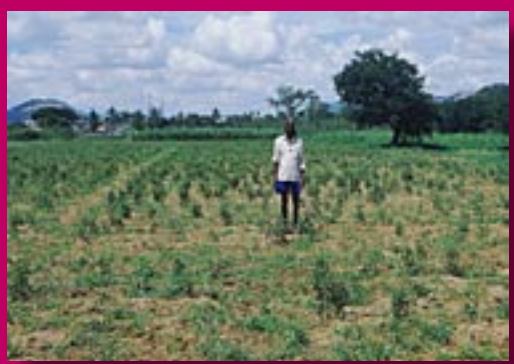
Research plans for Phase III

To disseminate information to small scale farmers on the most effective IPM measures for whitefly control in the highlands of Tropical America and Africa. Technology adoption and economic impact will be assessed in a participatory manner.

Whiteflies as virus vectors in mixed-

Vegetables, particularly tomatoes and peppers, are important food crops that are now under attack by whitefly-borne viruses in South East Asia.

The development of geminivirus-resistant vegetables in South East Asia is critical to increasing productivity and improving rural livelihoods.



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Milestones

The genetic variability of whitefly-transmitted viruses affecting tomatoes in South and South East Asia has been determined.

Sources of resistance to whitefly-borne viruses in tomato have been identified, which are effective both in Asia and the Americas.

-cropping systems of South East Asia

Three geminivirus-resistant tomato lines, 'Sankranti', 'Nandi', and 'Vybhav' were released in south India.

Their yields were 30-35 t/ha versus 19 t/ha of the local variety 'Arka Vikas'. Net profits for production of the resistant lines averaged US $ 3000 per hectare.

Research plans for Phase III

Durable and stable geminivirus resistance in tomato is best achieved by combining multiple resistance genes. Using new sources of resistance effective in the Americas and Asia, we will pyramid multiple and complementary resistance genes into new tomato cultivars. We will also investigate the potential use of safe and non-toxic inscticides to reduce vector populations on tomato and other crops as an alternative to toxic agrochemicals.

Promoting on-line access to scienti

Website: The TWFP WebSite describes the project's history, structure and global partnerships. Its interactive applications and databases, together with a complete list of keywords, allow users direct access to relevant IPM information on whiteflies and whitefly-transmitted viruses. **Team building:** Through email and four mailing lists created using open source software, the TWFP promotes access to scientific information.

www.tropicalwhiteflyipmproj

ific information

Special emphasis is placed on sharing knowledge on the most suitable IPM methodologies available to minimize yield losses caused by whiteflies and whitefly-borne viruses, and to reduce pesticide abuse.

Printed material : A book describing the results of the extensive surveys and diagnosis work done during Phase I will be produced in 2004.

ject.cgiar.org

Communication Strategy for Phase III

A documentation database will be created to allow access to information such as summaries and full text of pertinent references.

Website contents and interfaces will be translated into Spanish, French and Portuguese.

Three electronic bulletins will be developed for different audiences covering 1) traditional communication media, 2) national and regional associations of producers and farmers, and 3) national scientists.

A major effort will be made to produce simple, illustrated visual aids for small-scale farmers, on whiteflies, geminiviruses and best IPM practices available to control these pests.

Acknowledgments

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Diminishing support for food production research and lack of technical assistance to small-scale farmers have resulted in severe environmental degradation and human health hazards in rural and urban communities due to pesticide overuse.

The Tropical Whitefly IPM Project conducts research in tropical regions of the world affected by whiteflies and whitefly-borne viruses, and promotes the adoption of sustainable IPM methodologies to control these pests and reduce pesticide use.

This publication has been produced by Dr. Francisco Morales <f.morales@cgiar.org>, Coordinator of the Tropical Whitefly IPM Project, based on the contributions of the various TWF subproject coordinators, and with the support of the Project's Information and Communications Asisstant Mr. Oscar Escobar <o.escobar@cgiar.org>, and the collaboration of Ms. Sylvia Cadena <sylvia@colnodo.apc.org>.

www.tropicalwhiteflyipmproject.cgiar.org

visit our project's website for more information about whiteflies as pests and vectors of plant viruses in the tropics

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