GRO-Cocoa

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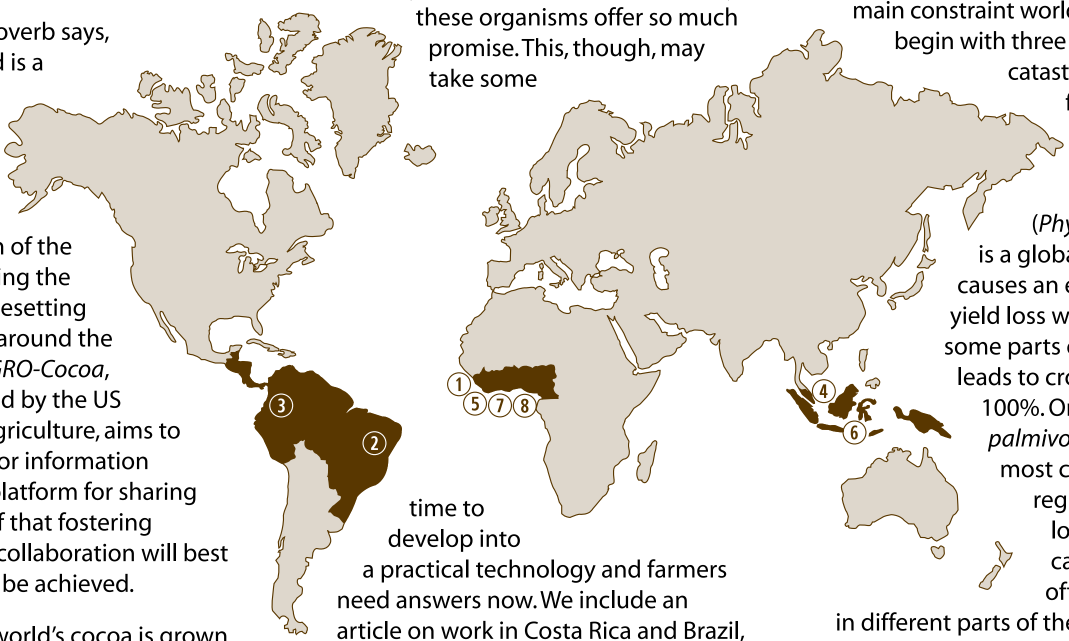
Global Research On Cocoa - *working with and for farmers*



A Problem Shared

Welcome to the first issue of *Global Research On Cocoa*, or *GRO-Cocoa*. This newsletter will focus on smallholder farmers and on research- and farmer-led research and training that can deliver practical IPM solutions to their pest and disease problems.

An old English proverb says, 'a problem shared is a problem halved'. It is too much to hope that an international newsletter can go even a fraction of the way towards solving the many problems besetting cocoa producers around the world. However, *GRO-Cocoa*, generously funded by the US Department of Agriculture, aims to provide a forum for information exchange and a platform for sharing ideas, in the belief that fostering cooperation and collaboration will best allow progress to be achieved.

Over 80% of the world's cocoa is grown by smallholders. Smallholder cocoa, grown mostly under shade trees and either intercropped or grown in a semi-natural agroforestry setting, is a particularly rich and stable habitat for many species. Cocoa can be an important engine of sustainable development to lift farmers above subsistence agriculture and hence contribute to an improved lifestyle. Cocoa farmers, however, face many obstacles that increase production costs and/or lower prices. Pests and diseases are amongst the most important constraints.

The International Cocoa Organization (ICCO) predicts not only a rise in world cocoa consumption over the coming years, but also a continuing drop in production, with demand exceeding production for the first time. Cocoa stockpiles provide only short-term relief, and an increase in demand for cocoa can only be met if pests and diseases are better managed, since they destroy almost half the potential production worldwide annually.

In this first issue of *GRO-Cocoa*, we begin by outlining the major diseases and pests of cocoa around the world. In this context we discuss invasiveness and the role of plant protection regulations and quarantine. Next, we report on the first meeting in Panama of a new working group set up by researchers developing a new area of disease control using endophytic fungi, and we describe why these organisms offer so much promise. This, though, may take some time to develop into a practical technology and farmers need answers now. We include an article on work in Costa Rica and Brazil, which is refining conventional pesticide spraying technology both for more effective and safer application of chemical pesticides and for use with biological agents in the longer term.

Regional cooperation and collaboration is all-important for tackling the scale of the pest and disease problems facing cocoa growers. We report on a workshop in West Africa that defined skills and gaps in cocoa IPM in the region, and drew up a priority list of problems and possible solutions for farmer-based research. We also have a report on a visit by Indonesian cocoa IPM extensionists and scientists to Malaysia. Agricultural research is wasted if farmers do not adopt the outputs, so we close this issue with an article from Indonesia describing how farmer-based training is improving cocoa yields in Sulawesi.

This is *your* newsletter, and the Editors welcome suggestions and contributions. The next issue will be published in December 2002, so get in touch if you have news and information to share.

Global Challenge

The map, which keys the main pest and disease constraints facing cocoa growers around the world, indicates the global nature of the challenge they present. In this article, we summarize the major pests and diseases in each region, and discuss why global awareness is vital. Diseases are the main constraint worldwide, and we begin with three diseases causing catastrophic losses to farmers in two continents.

- Black pod (*Phytophthora* spp.) is a global problem. It causes an estimated 44% yield loss worldwide, and in some parts of West Africa leads to crop losses of up to 100%. One species, *P. palmivora*, is endemic in most cocoa-growing regions while other localised species cause varying, but often huge, losses in different parts of the world. In West Africa measures generally found effective against *P. palmivora* are proving totally inadequate against *P. megakarya* (**1**, see map), and yields

In This Issue

Dragon Prints

Invasives: Prevention Better Than Cure

We describe the three major diseases of cocoa as 'invasive', but what does this mean? An invasive species is one whose establishment and spread threatens ecosystems, habitats or species with economic or environmental harm.

The majority of invasives are invasive alien species (IAS), imported deliberately to or arriving accidentally in a new environment. Freed from natural enemies that contain them in their area of origin, populations may explode and spread to cause severe problems. Many species have been introduced to new environments over the centuries, often through man's activities, and very few have actually become invasive. It has been estimated that of the species introduced to a new environment, 10% become established, and of these 10% become invasive, and of these 10% cause substantial damage. But that percentage can spell disaster.

Occasionally, indigenous species become invasive. This can be triggered by a number of factors. Changing land use is a common cause; growing cocoa in plantations and away from the shaded forest canopy may allow pests or diseases to thrive better. Genetic change in the crop or the disease can also lead to a previously quiescent species becoming invasive.

The Convention on Biological Diversity (CBD) recognises the severity of the threat from IAS and places a strong emphasis on prevention. The risk of invasion has escalated over the last century as travel became easier, so that more people travel, and more commodities are shipped around the globe more quickly. There is now a serious risk of cocoa pests and diseases reaching new regions and even continents.

The CBD emphasises the importance of identifying pathways by which an IAS might gain entry (some may not be immediately apparent) and of developing measures to minimise the risk of such introductions. Phytosanitary regulations which are followed and vigilance at potential entry points are a country's first line of defence. Clearly, IAS will spread most easily to adjacent countries, so regional cooperation and agreements are important. History has shown, however, that many pests and diseases have spread between continents with devastating results (e.g. coffee berry borer and coffee leaf rust), so development of and adherence to international standards, such as those of the IPPC (International Plant Protection Convention), are crucial.

The Global Invasive Species Programme (GISP) has been developing a series of resources to enable countries to tackle the threat posed by IAS, including the *Toolkit of Best Prevention and Management Practices*.

More information:
CBD: http://www.biodiversity.org
IPPC: http://www.fao.org/waicent/faoinfo/agricult/agp/agpp/pq
GISP: http://jasper.stanford.edu/gisp

continue to decline in areas affected by this species, despite farmers' best efforts.

- Witches' broom (*Crinipellis perniciosa*) (**2**) is presently restricted to Latin America, yet it accounts for 21% loss of global production. It arrived in Bahia State in Brazil in 1989, and by 2000 it had reduced output catastrophically in this key centre of cocoa production. Inflicting total crop loss on some growers, production plummeted to a tenth of forecasts made some years earlier.
- Frosty pod (*Moniliophthora roreri*) (**3**), similarly presently restricted to Latin America, accounts for 5% loss in global production. This potentially devastating and still relatively restricted disease also has the ability to cause total crop loss, as has occurred in parts of Peru since its recent arrival.

The impact of these diseases is exacerbated by their invasiveness as they spread rapidly into new areas:

- *Phytophthora megakarya* is a more aggressive and invasive species than *P. palmivora*. It is causing increasing alarm as it spreads through the key cocoa producing areas of West Africa. Probably originating in the forest zone of Cameroon/Nigeria, it has already seriously impacted on cocoa production in Ghana and has recently reached Côte d'Ivoire, the world's largest cocoa producer.
- Witches' broom has spread since its initial discovery in Surinam to Guyana, Venezuela, Trinidad, Peru, Ecuador, Colombia, central Brazil (Bahia State) and southern Panama. Its progress into Central America appears to have been halted at present by the implementation of a zone of hygiene in Panama.
- Frosty pod probably originated in the forests of the western Andes of Colombia/Ecuador, but has now spread through Colombia, Ecuador, Venezuela and Peru. It is still advancing northwards through Central America, and it is now found in Panama, Costa Rica, Nicaragua, Honduras and Guatemala. In addition, the Andes barrier has been breached, almost certainly vectored by human agency and it is now present in eastern Ecuador. It seems only a matter of time before it spreads eastwards into northern Brazil and southwards into Bolivia.

Highlighting the danger of these diseases is not intended to detract from the other fungal and viral diseases which can be locally or regionally disastrous to cocoa production.

- Vascular stem die-back (VSD, *Oncobasidium theobromae*) (**4**) in South East Asia can cause total crop loss, representing 9% lost global production.
- Cocoa swollen shoot virus (CSSV) (**5**) vectored by mealybugs causes up to 11% crop loss in West Africa.

In addition, while South America is fighting the double-edged sword of witches' broom and frosty pod, Africa and Asia have serious insect pest problems to contend with.

- Cocoa pod borer (CPB, *Conopomorpha cramerella*) (**6**) in South East Asia causes up to half regional production to be lost. In Indonesia, up to 20% of the country's cocoa is infested with the pest, which inflicts significant losses on production in this, the world's third largest producer.
- A battery of pests attacks cocoa in West Africa. Mirid or capsid bugs (**7**) infest 25-30% of Ghana's cocoa resulting in substantial reduction in crop yield. Significant losses are also caused by local outbreaks of a cossid moth stemborer (*Eulophonotus myrmeleon*) (**8**) in this region.

Most problems in cocoa production are regional in nature although a few, such as black pod, are global. Should we worry about problems in another region or not? The history of another commodity crop, coffee, suggests that we should. Many once-regional coffee diseases and pests are now found in all, or all but a few, coffee growing countries, and it is only reasonable to anticipate that cocoa pests and diseases will go the same route unless we take action. The Box, 'Invasives: prevention better than cure' outlines the background and identifies global initiatives addressing the invasives threat.

Until now, control has relied largely on cultural and chemical methods, allied with inputs from plant breeding. Specific cultural controls remain a cornerstone of sustainable pest and disease management, and effective chemical

Cacao Endophyte Working Group, Barro Colorado Island, Panama (H.C. Evans)

methods remain the best-bet option in some cases. However, in others chemicals have proven to be uneconomic and/or ineffective, as the continued spread of the 'big three' diseases amply illustrates. In addition, in the recent economic climate farmers have often been unable to afford to spray as often and at the doses recommended, and pesticide application is often inefficient.

Even where insecticides are effective against the target pest, indiscriminate effects may decimate the natural enemy fauna as a whole, which may facilitate secondary insect pest outbreaks. Similarly, fungicides can precipitate disease outbreaks. Plant diseases may be suppressed by other elements of the cocoa ecosystem mycobiota, which may be disrupted by fungicides (as has been seen in coffee).

The need for additional and alternative solutions to cocoa pest and disease problems has been voiced many times and in many different fora in recent years, and there is now a wide diversity of projects and programmes around the world aimed at delivering sustainable IPM of various cocoa pests and diseases. Over the coming issues, we hope to cover their progress.

Sampling endophytes from Herrania *sp. stem and pods, Los Rios Province, Ecuador (H.C. Evans)*

Cacao Endophyte Working Group

Panama was the venue for the first meeting of the Cacao Endophyte Working Group (CEWG) in April 2002. Hosted by the Smithsonian Tropical Research Institute (STRI) on Barro Colorado Island, it was attended by scientists from STRI, the US Department of Agriculture (USDA), CABI *Bioscience*, Mars/Almirante Cacau (Brazil), INIAP (Instituto Nacional de Investigaciones Agropecuarias, Ecuador) and industry representatives from Mars Inc. and ACRI. It provided an opportunity to review knowledge, develop links and plan future collaborative work.

Endophytes have until now been little studied and are largely unfamiliar to the non-specialist [see Box, 'Endophytes fight out of sight'], but they show promise for development as biological control agents. Preliminary results presented at this meeting gave an indication of the breadth of possibilities.

One reason for the excitement about endophytes is that it is believed that a loss of natural endophyte populations when cocoa (*Theobroma cacao*) is transferred from its natural forest ecosystem to exotic agroecosystems (plantations) has led to an increase in susceptibility to disease. It is thought that cocoa is initially endophyte-free, but is rapidly colonised by endophytes in the environment (horizontal transmission). Cocoa seeds, and thence seedlings, carry no endophytes from the parent tree (vertical transmission). The horizontal mode of endophyte transfer explains why exotic plantation cocoa has few naturally occurring endophytes and how beneficial endophytes have been lost.

Between them, the scientists at this workshop have collected endophytes from cocoa in Brazil, Ecuador, Peru, Mexico, Panama and Costa Rica. Which are likely to be the best? This depends partly on the approach you wish to take: see Box, 'Disease IPM with Endophytes' (p. 4).

Endophytes in cocoa, and its relatives, in natural forest ecosystems may have co-evolved specifically with their hosts in a mutualistic association, and thus present a potentially rich and novel source of biological control agents. A team led by Harry Evans and Keith Holmes from CABI *Bioscience* has been conducting exploration in the Upper Amazon region, considered to represent a centre of high diversity of the genus *Theobroma* and related genera, for stem endophytes which could be utilised as classical biological control agents. Carmen Suarez at INIAP is currently organising the first field trials to screen endophytes, obtained by the CABI *Bioscience* team in their Ecuador survey, for potential as biological control agents against frosty pod (*Moniliophthora roreri*) and witches' broom (*Crinipellis perniciosa*) in Ecuador.

Endophytes Fight out of Sight

Most people are familiar with epiphytes (bromeliads, for example), but endophytes are more of a mystery. An endophyte is an organism that lives asymptomatically within the host plant for all or part of its life cycle. They have been found in most plants studied so far. So why the interest here? Because they include organisms with properties that could help fight cocoa disease pathogens by:

- Out-competing and excluding the pathogen
- Directly parasitising the pathogen itself ('hyperparasitism' or 'mycoparasitism' in the case of an organism that attacks a fungal pathogen)
- Producing metabolites that inhibit pathogen growth (antagonists)
- Inducing host resistance mechanisms (induced systemic resistance)

These properties are not mutually exclusive, and a single organism may exhibit some or all of them as part of a battery of strategies employed, particularly by co-evolved natural enemies of a pathogen.

Luis Meija and Enith Rojas prepare to apply endophytes, Bocas del Toro, Panama (H.C. Evans)

Disease IPM with Endophytes

Classical Biological Control (CBC)

Introducing co-evolved natural enemies, which have originated with and adapted to the host over a long period of time, as biological control agents (BCAs) with the aim of reducing a population to a level at which it is no longer a problem. It involves returning to the area of origin of the target organism and surveying for co-evolved natural enemies, then introducing them to the adventive range. CBC has been successful against many weed and insect pests, but this is the first time a plant disease has been targeted.

Augmentation/Inundation

Rearing and releasing natural enemies already present in an ecosystem in such a way that the impact on the target pest is increased (a process that can also be used to enhance the impact of a classical BCA). Biopesticide application is one way in which this can be achieved.

Induced Plant Resistance

Using a biotic or abiotic agent to activate a plant's chemical or physical defence mechanisms, such that a subsequent challenge from a pathogen elicits a strong and rapid response.

Safety testing to ensure that an exotic fungus is safe for introduction to other countries and then obtaining permits is likely to be a lengthy and complex process, so what other options might give faster results?

Cocoa has acquired endophytes in areas away from its Amazonian origins, and these are being assessed to see whether their augmentative release could help control cocoa diseases. This would not require as much specificity testing, although some safety testing would still be required, as for any new plant protection product. An STRI team including Allen Herre, Enith Rojas and Luis Meija has conducted extensive research on indigenous leaf endophytes in Panama, and some strains are showing potential for protecting cocoa against black pod disease (*Phytophthora* spp.).

The success of (especially augmentative/ inundative) biological control depends as much on delivery systems as on the virulence of the pathogen. Indigenous endophytes look to be good candidates for development as biopesticides.

At Almirante Cacau in Bahia State, Brazil, a team led by Alan Pomella, in collaboration with CABI *Bioscience*, has demonstrated in laboratory screening that seed inoculation with endophytes can control witches' broom. He has also been working in collaboration with the University of São Paulo on the potential of bacterial endophytes and rhizobacteria for the biological control of cocoa pathogens.

At USDA-ARS, Beltsville, Gary Samuels is lending taxonomic support to cocoa endophyte researchers, and has identified numerous isolates. He is currently working on apparently new species of *Trichoderma* from cocoa in Ecuador and Peru with possible anti-fungal activity. A common theme emerging from the workshop is the key role of identification and characterisation of strains, which is considered essential in underpinning the use of microorganisms in the field.

Tom Gianfagna at Rutgers University, New Jersey, USA has been working with cocoa cultivars with varying susceptibility to the witches' broom pathogen, and studying induced plant resistance. He has demonstrated that caffeine synthesis is 'turned on' in response to witches' broom infection and by anti-fungal compounds such as the aspirin (salicylic acid) analogue BION. He found that the response increased markedly with natural resistance to the pathogen. Gianfagna also found the majority of endophytes from CABI *Bioscience* exploration demonstrate anti-fungal properties, some of which appear to be novel metabolites.

The many and varied types of research outlined here make it clear that the new working group is bringing together 'Endo-Fighters' from many institutions and disciplines with the common aim of controlling the three major cocoa diseases following a previously little researched line of attack. In a final session, Prakash Hebbar (USDA/Mars Inc.) led a discussion that identified strengths, needs and collaborative opportunities for the working group to address, and lead persons were identified to coordinate further action.

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Best-bet Solutions for Cocoa Diseases

Controlling cocoa diseases in Central and South America is a technical challenge under any circumstances, and in a world of depressed cocoa prices it teeters into

Figure 1. CFValve™ (GATE LLC, USA) spray management valve in use with a directional cone spray (D2-45 nozzle combination). Results indicate that such combinations could improve frosty pod control by maximising dose transfer (R.P. Bateman)

economic inviability. It is in this context that a new approach has evolved away from pure biological control towards rational pesticide use (RPU). The aim is to provide a mechanism for 'fast tracking' practical solutions for farmers.

A collaborative project, funded by the US Department of Agriculture (USDA) and conducted by CABI *Bioscience*, CATIE (Centro Agronómico Tropical de Investigación y Enseñanza, Costa Rica), and a number of partners in Brazil, the UK and the USA is giving technical support for 'lab to field' trials to evaluate practical disease control for witches' broom (*Crinipellis perniciosa*) and frosty pod (*Moniliophthora roreri*).

These two diseases pose a special threat to livelihoods in Latin America and their management remains problematic. Chemicals such as copper fungicides, have nontarget effects, limited efficacy and a long-term impact on the environment (although currently permitted for restricted use in organic agriculture). While biological control agents may offer the most sustainable long-term solution, there are many technical, commercial and conceptual issues of development yet to be resolved. What both synthetic and biological pesticides have in common currently is an inadequate standard of application to crops: poor formulation, spray droplet size and coverage substantially affect their efficacy. Techniques used by smallholder farmers for tree crops such as cocoa are often especially poor. In practice it is common to encounter farmers who use knapsack sprayers, fitted with cone nozzles, to 'squirt' the tank mixture onto higher branches; most of the liquid then falls back onto the ground and is wasted.

The CABI-CATIE-USDA project aims to improve delivery systems (especially formulation and application techniques) for promising microbial control agents (MCAs), such as isolates of hyperparasitic fungi in the genus *Trichoderma*. However, the techniques may also be used for application of conventional chemical fungicides, which are being used as standards in the field-testing programme. Ultimately, the goal is to assemble a 'toolkit' of practical, efficient and safe solutions to key problems, and encourage farmers to adopt them. This will have multiple benefits through improving both the efficacy of control and operator safety, while reducing control costs and adverse environmental impact.

At Turrialba in Costa Rica, where frosty pod is the main preoccupation, lab tests to assess the toxicity of chemical fungicides to MCAs were complemented by factorial field trials to evaluate practical disease control, including interactions between control agents and their delivery systems. Field trials also took place at CEPLAC (Comissão Executiva do Plano da Lavoura Cacueira) and Almirante/Mars field sites in Bahia, Brazil, where witches' broom is the greatest current constraint. The project is working with the two types of equipment most commonly used for spraying cocoa trees:

- Motorised knapsack mistblowers were originally developed for obtaining good droplet coverage in mirid control in the tall cocoa trees of West Africa. The most common nozzle design is of the air-shear type, in which thin layers of liquid are introduced into the airstream and thus produce fine sprays. They may be supplied, or retro-fitted, with rotary atomisers to improve spray quality.
- Side-levered knapsack (hydraulic) sprayers are a lower cost alternative (and are argued by many to be the only viable alternative for smallholder cocoa farmers). Tall trees are sprayed by using extended booms. Many locally available sprayers are fitted with variable cone nozzles that produce an infinitely variable range of droplet size spectra and flow rates, and these are arguably a contributory factor to reported poor or variable fungicide efficacy.

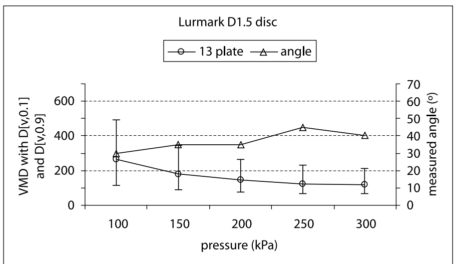

Figure 2. Example of a summary of droplet size spectra and cone angles (for a D1.5-13 plate-disc combination over the 100-300 kPa range). The line with bars (left hand scale) represents the Volume Median Diameter (VMD) with the 10 and 90 percentiles of the droplet size spectra. The lines marked with triangles (right hand scale) represent the measured angle of cone.

The nozzle is a critical part of any sprayer. It regulates flow, atomises the mixture into droplets and disperses the spray. Research to reduce fungicide volume application rate and improve work rate has included an extensive survey of some components of hydraulic cone nozzles, testing combinations that led to a greater proportion of the spray cone hitting the biological target and less pesticide being wasted (Figure 1). Reproducibility can be improved with valves that control the hydraulic pressure and thus flow rate at the nozzle tip: this is especially important in field trials, but can also substantially lower farmers' pesticide costs.

A database on the DROPDATA website presents the results in diagrammatic form (Figure 2). Initial observations indicate that although optimum spray patterns (droplet spectra and cone angle) for droplet impaction are more likely to be achieved at high pressure, some nozzle component combinations give similar quality at lower pressure. Risk of blockage, a particular problem with particulate formulations such as MCAs, can also be reduced by some component combinations.

Data to date bear out the need for alternatives to chemicals, which must always be seen as imperfect stopgap methods. However, this project is presently focused on providing rapid solutions. It is well on the way to defining guidelines that maximise chemical performance and minimise costs and adverse impacts. Provisional recommendations have been made on operational settings for both common types of application equipment. Work on optimisation continues to further reduce volume application rates for hydraulic sprayers, and more field evaluations are aimed at minimising dosages of chemical fungicides and maximising the potential of MCAs.

Website: http://www.dropdata.net

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African Designs for IPM

Regional collaboration and a participatory approach were the key ingredients and messages of a meeting of cocoa scientists held in Benin in late 2001. The meeting led to the formulation of a proposal for a regional cocoa IPM initiative in West Africa. This calls for regional expertise to be focused on the most pressing pest problems, for gaps in knowledge to researched, for inclusion of farmers in

Cocoa pod infected with Phytophthora megakarya, *Cameroon (H.C. Evans)*

testing and refining IPM technologies, and for dissemination of these locally developed and validated methods by scaled-up farmer training.

The West Africa Regional Cocoa IPM workshop held on 13-15 November in Cotonou was organised jointly by CABI *Bioscience* and IITA (the International Institute of Tropical Agriculture). It was sponsored by STCP (the Sustainable Tree Crops Program) and BCCCA (the Biscuit, Cake, Chocolate and Confectionery Alliance, UK), and brought together scientists from the various West African cocoa-producing countries in an innovatory review and planning process. The STCP is a joint public-private partnership between European and American chocolate manufacturers, bilateral donors (such as the US Agency for International Development; USAID), NARES (National Agricultural Research and Extension Systems) and IARCs (International Agricultural Research Centres) in West and Central Africa.

West Africa produces some 60% of the world's cocoa, and by far the majority of this is grown by smallholders. At the moment, cocoa production in Africa is falling. Farmers find it increasingly difficult to make a living from the crop, in the face of pest and disease constraints and poor prices, and are abandoning their trees (ironically, cocoa prices took a recent upswing owing to fears over production declines). The organisers of this workshop, however, described this bleak picture as a window of opportunity to steer IPM towards a biologically based system for high quality cocoa production, in response also to ever-louder calls for environmentally friendly solutions to pest problems in these areas of high biodiversity where cocoa is grown.

The workshop's participants included three cocoa IPM scientists from each STCP member country (Cameroon, Côte d'Ivoire, Ghana, Guinea-Conakry and Nigeria) together with others from the host country Benin, CABI *Bioscience*, CRIG (Cocoa Research Institute of Ghana), NRI (Natural Resources Institute, UK) and IITA. The workshop programme was developed in consultation with the participating countries, and provided a platform for scientists to exchange ideas on cocoa IPM research and implementation. Each country outlined its pest and disease problems, past and current control measures, and the status of its cocoa IPM research and implementation. Together, these presentations provided an up to date summary of the status of pest and disease problems, and research and its implementation in West Africa.

A series of workshop sessions formed the powerhouse of the meeting. These provided a mechanism for identifying key constraints to cocoa production in the region, and capacities and gaps in regional capabilities for tackling them, and defined options for regional collaborative research and implementation by piloting new methods for cocoa extension.

The three key constraints to cocoa production in the region were agreed to be black pod disease caused by *Phytophthora* spp., the mirids *Distantiella theobroma* and *Sahlbergella singularis*, and the cossid moth stemborer *Eulophonotus myrmeleon*. Diseases currently devastating South American production, witches' broom (*Crinipellis perniciosa*) and frosty pod (*Moniliophthora roreri*), were also recognised as looming threats. Interestingly, swollen shoot virus (transmitted largely by mealybugs in the genera *Planococcus* and *Stictococcus*) was (along with mistletoes, termites and weeds) considered a threat, but it was not accorded the priority it has sometimes been given.

Three regional groups, with one member from each STCP member country, each focused on one prioritised pest or disease; they considered current status, available and developing IPM options, and expertise in member countries, and came up with suggestions for regional collaboration to alleviate impact. Lastly, participants came together as national groups to evaluate cocoa IPM extension and expertise in each country and how current methodology could be improved to reach more farmers or improve impact.

This information was synthesised into an inventory of on-going and potential regional cocoa IPM research and implementation, and a menu of possible solutions to achieve sustainable and cost-effective reduction in cocoa yield losses. Core components of the menu are:

- biological control using indigenous microorganisms
- rational pesticide use
- host plant resistance
- cultural controls including habitat management and tree pruning

Strengthening quarantine was added to this list, to address the need to prevent diseases from other regions of the world gaining access to West Africa's cocoa-growing areas.

Moves are now underway to formulate projects and secure funding. The goal is to develop sustainable farming systems in the forest zone with cocoa as the main cash crop and farmers in the driving seat. The solutions have to be based on what is acceptable to farmers, and a basket of options that alleviate cocoa farmers' major pest problems is needed. These will be evaluated and implemented in 'best-bet' trials using farmer participatory methods.

The English version of the proceedings* is now available from the CABI *Commodities* website. The French version is in preparation, and both will shortly be available on-line and in print.

*Vos, J.; Neuenschwander, P. (2002) West Africa regional cocoa IPM workshop, Cotonou, Benin, 13-15 November 2001. Egham, UK/Cotonou Benin; CABI *Bioscience*/IITA, 77 pp.
Download from: http://www.cabi-commodities.org/Acc/ACCrc/ACCrc.htm

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Indonesian IPM Trainers & Scientists in Malaysia

In South East Asia, recent country visits gave cocoa IPM trainers and scientists an opportunity to exchange information on

Participants checking for cocoa pod borer (S. Soetikno)

how they are tackling the region's pest and disease problems.

The cocoa pod borer, *Conopomorpha cramerella*, (CPB) is the most obdurate pest in the region. In Indonesia, the world's third largest cocoa producer, it was estimated in 1998 that as much as 100,000 ha (~20% of the country's cocoa) could be infested. CPB is present on most of the larger cocoa-growing islands of Indonesia, except Java, and is also found in Malaysia and the Philippines. Chemical and cultural control measures have been developed, although the latter (based on crop hygiene) is labour intensive. Cocoa mirids (*Helopeltis* spp.) are also problematic, although the black ant, *Dolichoderus thoracicus*, shows promise as a biological control agent.

Vascular streak dieback (*Oncobasidium theobromae*) is generally regarded as the most serious disease problem in this region, and is particularly damaging to young seedlings.

Indonesia has a distinguished history of IPM implementation. The National IPM Programme began in 1989 with the goal of increasing the capacity of farmers and field workers to make sound field management decisions based on IPM principles. Indonesia has also been a key player in the FAO Intercountry IPM Programme.

The IPM Smallholder Estates Crops Project is financed by the Asian Development Bank (ADB). Its main purpose is crop rehabilitation with a target of reaching

Releasing Trichogramma. *Although the wasps can reduce cocoa pod borer losses substantially, this technology has not been widely adopted by farmers in Malaysia (S. Soetikno)*

Farmer Field Schools

Since the late 1980s, farmer participatory training has gained increasing acceptance as an effective means of promoting farmer uptake of sustainable methods of production, and a number of models have evolved around the world. The Farmer Field School (FFS) approach was developed in the rice sector in SE Asia and has been adapted for other crops. It is based on regular farmer group training sessions over a crop season that focus on discovery-based learning and make use of non-formal education approaches.

FFSs help farmers to discover and learn about field ecology and integrated crop management. The training is 'hands on' and is carried out almost entirely in the field. The four major principles are:

- Grow a healthy crop
- Observe fields weekly
- Conserve natural enemies of crop pests
- Farmers understand ecology and become experts in their own fields

A cornerstone of FFS methodology is Agro-Ecosystem Analysis (AESA). This involves regular (usually weekly) observations of the crop. Participants, in subgroups of 4-5, learn how to make and record detailed observations including the growth stage of the crop, pest and beneficial insect numbers, weeds and disease levels, weather and soil conditions, and overall plant health. Another important aspect is helping and encouraging farmers to conduct their own experiments to test out ecological crop management methods and to interpret the results.

The farmers then take management decisions based on their observations, becoming independent and confident decision makers.

250,000 farmers in 12 provinces, who between them grow six crops including cocoa. Project objectives also include upgrading the Plant Quarantine Service, and applied and basic research in IPM. The most important function, though, is farmer training using methods derived from the Farmer Field School [FFS, see Box] approach pioneered by the National IPM Programme

The ADB funded two study visits, arranged by CABI-SEARC (CABI South East Asia Regional Centre), which took 25 Indonesian IPM trainers plus a number of scientists from national research institutions to Malaysia from 30 September to 8 November 2001, and from 20 January to 6 February 2002. The visits enabled participants to acquire theoretical information, practical knowledge and hands-on experience in the labs as well as in the field on pest problems and their management in cocoa and other plantation tree crops in Malaysia, with emphasis on IPM and the use of biological control.

In Malaysia, smallholder cocoa now accounts for 70% production, up from 37% in 1980. However, this increase is illusory, for the change reflects a falling area of estate cocoa while the smallholder area has remained relatively unchanged. Recognising the central role smallholder cocoa farmers now play in the country's cocoa industry, the Malaysian Cocoa Board (MCB) launched the Smallholder Development Programme in Sabah, to help farmers rehabilitate their cocoa with the aim of increasing production from 0.5 to 1.5 t/ha/year, largely by promoting side-grafting of high-productivity cocoa clone materials into mature cocoa trees.

Study visit participants had the opportunity to visit the Pahang R&D Centre of FELDA (the Federal Land Development Authority, long involved in smallholder settlement) and the MCB in Kota Kinabalu and Tawao, and they also met with cocoa farmers involved in the MCB cocoa rehabilitation project.

The observations of the Indonesian visitors concerned the impact of economic forces, the successes of plant breeding and grafting, and the continuing need for appropriate insect pest control:

- In Peninsular Malaysia the area of cocoa plantation has been dramatically reduced over the last 20 years due to high costs, labour intensiveness and low prices. Almost 80% of the cocoa area in Malaysia is now concentrated in Sabah, and is mostly under smallholder cultivation.
- Diseases problems in cocoa have been controlled through breeding techniques.
- The Cocoa Rehabilitation Programme of MCB using side-grafting technique of different clones has proven successful in increasing production from 0.5 to 1.7-2.5 t/ha/year in Sabah.
- Although approaches have been researched in pest management, especially for CPB and *Helopeltis*, no suitable (i.e. economically viable and sustainable) biological control method has been implemented on a large scale in farmers' fields in Malaysia. Insect control still relies on insecticides such as Nurelle and Decis.

The visits provided participants, organisers and hosts with much food for thought, and underlined the importance of developing IPM options to fit local needs and economic circumstances.

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SUCCESS in Sulawesi

A project in Sulawesi, Indonesia is using Farmer Field Schools (FFSs, see Box) to demonstrate IPM practices in cocoa to farmers and showing that the extra effort is financially worthwhile. The SUCCESS (Sustainable Cocoa Extension Services for Smallholders) project is funded by the US Department of Agriculture (USDA) in partnership with the World Cocoa Foundation (WCF) and the Biscuit, Cake, Chocolate and Confectionery Alliance (BCCCA) in the UK. It is implemented by ACDI/VOCA (an international NGO) in collaboration with the local governments of three provinces in Sulawesi. WCF is a US-based organization, launched in 2000 by the Chocolate Manufacturers Association, the American Cocoa Research Institute (ACRI) and the Cocoa Merchants Association of America.

SUCCESS's goal is to improve the income of cocoa smallholders in Sulawesi by reducing crop losses from the cocoa pod borer, *Conopomorpha cramerella* (CPB) through better pruning and frequent harvesting, and by improving fertilizer use. These methods are recommended as a result of previous research in Indonesia by Dr John Mumford of Imperial College, London, UK. Sulawesi is Indonesia's main cocoa-producing region, and CPB has an alarming and increasing impact on production. Last year, it slashed the country's production by 10-15% compared to the previous year, according to ASKINDO (the Indonesian Cocoa Association).

The project is targeting 20,000 farmers over a 2-year period, and in 2001 has

SUCCESS team and farmers in Sulawesi (B.K. Matlick)

SUCCESS means more healthy cocoa trees for farmers in Sulawesi (B.K. Matlick)

trained 8500 in FFSs. The SUCCESS extension message was built on 2 years of extensive field research conducted in Sulawesi by ACRI, BCCCA and ASKINDO, alongside provincial agricultural department staff. The combined approach by government and the producing and manufacturing industries ensured a solid foundation to establish a unified extension programme. Involving local extension staff in project development means the project has been designed to fit local constraints; extension staff can assure farmers that it is low cost and will take no more than 2 days per month to follow the Field School.

In each training village, a *Demplot* (demonstration plot) is set up where the FFSs are carried out on CPB. Farmers observe where the larva comes from; they learn about the behaviour of the moth by seeing where it rests, how it flies and where it lays its eggs; they find out what the pupa looks like and where to find it. In short, they become experts on the pest's life cycle. Armed with this knowledge, they learn how to manage the pest through frequent and complete harvesting, pruning and sanitation, and how to identify the right time for each intervention. However, this is not a passive learning process: farmers conduct research for themselves, either together at the SUCCESS training farm or independently. Farmers are also helped to improve and maintain productivity through understanding changing fertilizer needs, for example where shade has been decreased by pruning and where trees are growing more vigorously and productively.

Success has been swift for the SUCCESS project. Just one year into the programme, analysis of the 2001 results shows that not only are cocoa losses from CPB amongst the 8500 trainees down from an average of 40% to 15%, but quality has improved too. By following the practices they learnt at the Field Schools, farmers have not only seen reduced losses from CPB, but have also seen pod sizes improve through better crop management, and have benefited from decreased pressure from black pod fungal disease (*Phytophthora* spp.) as well as rodent problems.

The sustainability and further dissemination of the project message (key issues for farmer participatory training) look promising too. In some areas, trained farmers are being hired by untrained farmers to share their skills, which is both an indication of the confidence of trained farmers and a sign of growing business acumen that puts the spread of this technology on an entrepreneurial and more sustainable course.

Websites:
ACDI/VOCA: http://www.acdivoca.org/
WCF: http://www.chocolateandcocoa.org/WCF/wcfindex.htm

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Information Column

Accra Conference

The 14th International Cocoa Research Conference will be held in Ghana in October 2003 with the theme, 'Towards a Sustainable Cocoa Economy - What Strategies to this End?' One of the aims of the conference is to increase productivity and quality through production and distribution of improved planting material and promotion of IPM. It will include sessions on pests and diseases, agronomy and physiology, breeding, utilisation of cocoa by-products and extension-transfer and efficient utilisation of the results of cocoa research.

The conference is being organized by the Cocoa Producers' Alliance (COPAL).

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ICCO Moves to Côte d'Ivoire

By this time next year, the Headquarters of the International Cocoa Organization (ICCO) will have moved from London to Abidjan in Côte d'Ivoire. This historic decision, taken during the 25th Special Session of the Council held from 7-8 May 2002 in London, is expected to lead to considerable strengthening of the financial situation of the Organization. Negotiations on a Headquarters Agreement are now taking place with the Ivorian authorities.

Website: http://www.icco.org/

CABI *Commodities* Website

This newsletter can be downloaded from our website at:

http://www.cabi-commodities.org

The site has details of our cocoa projects, together with diverse resources on cocoa pest and disease management and farmer participatory training and research. These include briefing papers on developing sustainable cocoa production systems, reports of field research and training, practical manuals and information posters.

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