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

Setting Priorities

Recent confirmation of frosty pod rot in Mexico and the discovery of cocoa pod borer (CPB) in Papua New Guinea (PNG) together with the (re-)emergence of cocoa wilt in new and revived production areas in the Democratic Republic of Congo (DRC) and Uganda (all covered in the first two articles) highlight the threat to the world cocoa industry of invasive and emerging pests. Given overarching socio-economic changes – including increased trade and expansion of cocoa production into new areas – together with global warming and the possibility of bioterrorism, are such events inevitable? If so, what can be done to minimise the risks, or mitigate the impacts? With resources always limiting, what precautions and preparations can reasonably be taken?

The hierarchy of responses laid out in Article 8(h) of the Convention on Biological Diversity (www.biodiv.org), outlining how members should meet the threat of invasive species to biodiversity, applies equally well to cocoa: prevention, eradication, and control (in that order). For cocoa, in the first instance this means phytosanitary precautions and raising awareness about pathways of spread; next, early-warning systems based on surveillance together with emergency response plans for containment and eradication; and lastly should an exotic pest manage to establish (or a new pest emerge), management options and their dissemination to farmers.

In practical terms, governments cannot afford to cater for every eventuality, so what are the priorities? How far should they limit movement of cocoa material? The University of Reading Intermediate Quarantine Facility provides a stalwart service, but with increasing germplasm movement (not least because of international research programmes) should some justification be required? Should events in PNG sound a warning to other countries in the region, such as Vietnam: should they restrict entry of material? Is there a need for regional quarantine centres? In terms of screening, can you justify devoting scarce resources to perceived regional or inter-regional threats when there are problems closer to home to contend with? For example, the new *Phytophthora megakarya* resistance screening programme in Ghana (see third article) is taking a rare and on the face of it laudably serious attitude to potential inter-regional pest movement by including the neotropical *Moniliophthora* diseases, but would efforts be better devoted to problems closer to home such as cocoa swollen shoot virus? And if you do find material with resistance or susceptibility to pests not yet present, should this limit what varieties you release to farmers?

Some pest invasions are perhaps inevitable. In such instances a country's preparedness and the swiftness and magnitude of the response are critical, as illustrated by recent events in PNG. Once a pest is present, farmer awareness and knowledge are vital. *GRO-Cocoa*'s policy of featuring programmes that promote these continues here with the article on Central Africa which describes the synergistic effect of two-way communication between farmers and Global Plant Clinic (GPC) scientists, and how this could be exploited to provide an early-warning system for emerging problems. We also feature a new publication aimed at disseminating information directly to farmers: a newspaper for cocoa farmers in Ghana.

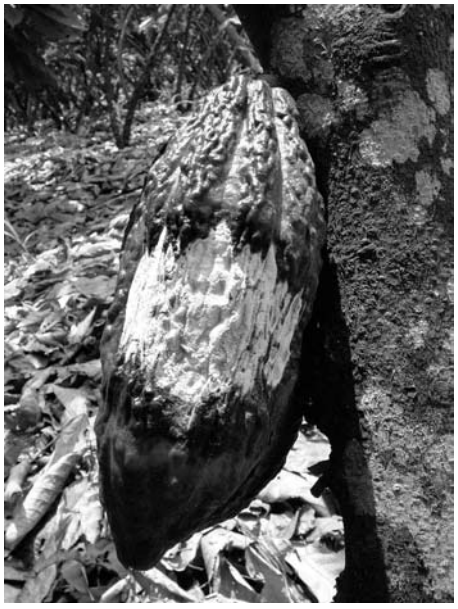
Diversification is often touted as a means of making cocoa farming sustainable, and tourism is one possibility. But this is a completely new area for cocoa farmers who may wonder what it involves and if it is for them. To answer some of their questions and also to provide food for thought, we end this issue with a series of articles on cocoa tourism schemes: a project in Ghana to develop community tourism, and two initiatives in the West Indies, one in the development stage and one up-and-running.

Wake Up to Invasives

The arrival of two feared pests in new countries highlights some widespread concerns about invasive threats and how they can be met.

Frosty Pod Rot in Mexico: Not the End of the Road?

The confirmation of frosty pod rot in southern Mexico, where cocoa has been grown for centuries (since the era of the Mayan civilisation), means that the disease



Frosty pod rot is highly invasive and can destroy crops. Now in Mexico, where will it spread to next? (Keith Holmes)

which is caused by *Moniliophthora roreri* has now reached the northerly limit of cocoa growing in the Americas. This may sound a warning message for places it has still to reach – and the cocoa community as a whole. First formally identified as causing a cocoa disease in Ecuador in 1919, *M. roreri* has spread gradually through South and then Central America, inflicting 25–100% crop losses and causing, directly and indirectly, the ruin of

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dragonprints

Frosty Pod Distribution

Current distribution of frosty pod rot of cacao in Latin America (indicated by the bold line).

Adapted from; W.Philips (2005) Origin, biogeography and current situation of frosty pod disease in Latin America. Regional Workshop on Frosty Pod Rot, CATIE, Turrialba, Costa Rica, 21-25 February 2005.

cocoa industries in some countries (e.g. Peru, Costa Rica). The invasive capacity of *M. roreri* was underlined when the cordon sanitaire that has successfully kept witches' broom, caused by the related pathogen *M. perniciosa*, south of the Panama Canal, failed to arrest the northward spread of *M. roreri*. It seems inevitable that, having breached the Andean barrier in the 1970s to reach eastern Ecuador, it will eventually spread through eastern South America to the key cocoa-growing Brazilian state of Bahía, and it threatens Bolivian cocoa production from its base in Peru. And the rest of the world should not be complacent.

The dangers were highlighted in February 2005 with an International Workshop on 'Strategies to control the spread of frosty pod rot in the Americas' held in CATIE (Centro Agronomicó Tropical de Investigación y Enseñanza) at Turrialba, Costa Rica where the imminent threat of frosty pod rot to cocoa production, especially in Bolivia, Brazil – and Mexico – was discussed. Then in March, frosty pod symptoms (deformed and prematurely ripening cocoa pods) were spotted in northern Chiapas Province, Mexico, and it subsequently became apparent that 1000 ha were affected there and in adjacent areas of Tabasco Province. In January 2006 the identity of the disease was confirmed by colony morphology and DNA sequencing[1]. It is suspected that the disease had been present in the area for at least 2 years, but farmers had apparently no idea what to look out for; they were not alone.

Despite the wave of destruction that accompanied *M. roreri*'s advance, little attention has been paid to regional early-warning systems, and the inter-regional threat has been dismissed. Yet a report in the latest round of the FORESIGHT project[2], released in April 2006, notes:

"The disease may move more rapidly from its latest area of invasion (Belize and Chiapas, Mexico) into the Caribbean since viable spores have been collected up to 9 months after infection, demonstrating frosty pod's spore longevity. Furthermore, it would seem entirely possible, if frosty pod were to reach the east coast production areas of Brazil from its present movement in Peru, that this devastating disease could eventually arrive in West Africa where its social and economic impact could be tremendous."

The optimistic view is that African introduction is unlikely since spores will not be blown eastwards across the Atlantic Ocean and quarantine measures for germplasm movement are rigorously enforced. But deliberate transfer (bioterrorism) is a realistic possibility, and so is introduction via increased South–South trade.

The FORESIGHT report suggests that "given the potential impact, a national (or regional…) awareness campaign aimed at farmers, along with training on proper field identification and safe sample collection and transport for laboratory confirmation, could make the difference between early detection and the possibility of eradication or the decline of the cocoa industry in West Africa", which produces some 70% of the world's cocoa. Preparedness is crucial in the face of such a disastrous disease.

Examples in other sectors show how planning can make all the difference to mitigating the impact of an invasive's arrival through training, awareness and surveillance, and a rapid response when the pest or disease arrives (see Box, 'Planning a reception'). As we shall see next, the recent experience of PNG demonstrates how a rapid concerted reaction can be launched, and highlights the importance of raising awareness among cocoa farmers; this is further addressed in the subsequent article, 'Remote control: detecting cocoa diseases in Central Africa.'

CPB in PNG: Combating Inevitable Invasion

Cocoa pod borer (*Conopomorpha cramerella* – CPB) was detected for the first time in Papua New Guinea (PNG) (**1**, see map, page 3) at the end of March 2006, in East New Britain Province[3] (**2**). By early April the province had been placed under agricultural quarantine as the government attempted to contain the pest and the Minister of Agriculture allocated several million Kina for activities aimed at its eradication. Operations currently underway illustrate how an effective response to an invasive pest demands early warning of the invasion, containment measures, coordinated

Planning a Reception

An invasion may be inevitable, but the visitor can be made unwelcome. The pink hibiscus mealybug (PHMB – *Maconellicoccus hirsutus*) is native to Southeast Asia and attacks many ornamental and fruit trees (but not cocoa). First reported in the Caribbean from Grenada in 1994, it spread to other island countries over the next few years, wreaking havoc until effectively controlled in most countries through biological control using introduced natural enemies (under programmes involving international, regional and country partners).

It arrived in mainland South America (Guyana) in 1997 and it was inevitable it would eventually reach Central America. Plans, based on programmes implemented in Caribbean island countries, were made for its reception.

Belize was the first Central American country to find PHMB, and this was through an active surveillance programme. The Belize government had trained personnel in the identification, field recognition and management of PHMB, and established a PHMB task force. Because the task force was in place, implementation of an emergency action plan was immediate and comprehensive:

- The pest was detected on Friday 24 September 1999 and identified the same day.
- By the following Monday, just 3 days later, an emergency action plan was presented to the Ministry of Agriculture and Fisheries. This included public awareness, internal quarantine, surveillance, eradication (cut and burn) and biological control (with initially imported, later in-country reared, biocontrol agents).
- The first biocontrol agents were imported and released on 13 October.
- Less than 4 months later, PHMB densities in study sites had fallen by some 93%.

Source: Rapid response to mealybug invader. *Biocontrol News and Information* 21, 27N–28N (June 1997).

www.pestscience.com

Cocoa pod borers reduce the quality and value of the beans (Keith Holmes)

initiatives aimed at eradication, and surveillance of surrounding areas for spread and new outbreaks. Speedy identification of the invader and rapid intervention are vital, and these have been achieved. So are awareness and vigilance among the cocoa farming population, which are where the next thrust is needed.

CPB is the most serious insect pest of cocoa in Southeast Asia. It is the main limitation to cocoa production in Indonesia and Malaysia and caused the collapse of the Philippines' cocoa industry. Although moth flight allows local dispersal, there is no indication that they can fly long distances; long-distance spread is almost certainly facilitated through movement of infested pods by humans[4].

In PNG, an immediate threat was perceived as the pest spread eastwards through Indonesia's Papua Province (**3**) towards the countries' land border. The influx of Indonesian transmigrants into the border area together with the commonplace cross-border movements of local people whose families are split between the two countries made the eventual arrival of CPB in PNG seem inevitable. Experience in western Malaysia suggested that even stringent quarantine regulations would only buy time. In December 2004, with CPB only a few miles from the border, the Chairman of the PNG Cocoa Board highlighted the danger to the country's cocoa industry, and at the same meeting the Minister of Agriculture demanded a nationwide farmer education awareness programme on the pest. In the event, CPB came not by the land bridge into mainland PNG but into New Britain in the heart of PNG's cocoa-growing area. But this was also not unexpected as sea traffic had been identified as a potential invasion pathway.

If CPB manages to establish in East New Britain it will threaten a cocoa industry which provides the main livelihood for thousands of smallholder farmers. A provincial emergency team from the National Agricultural Research Institute (NARI), the Cocoa Coconut Institute (CCI), the National Agriculture Quarantine and Inspection Authority (NAQIA) and the local authorities was tasked with devising the response plan.

Latest information from intensive surveys by the emergency team across East New Britain suggests the pest may be confined to the Keravat area. A massive eradication effort, which began in May, focused on an area some 10 km long, running through five plantations. The aim is to create a cordon sanitaire of 1.5 km around the infestation and eliminate the pest within this. Some 2000 workers, together with 100 sprayers and five diggers are working from the outside inwards, undertaking a massive programme of spraying, pod burial and removal of branches/leaves to prevent pod formation. Logistically, the emergency team has the situation under control. Pods suspected to be infested from outside this area have so far proved not to harbour CPB, giving rise to cautious optimism that this first incursion of CPB may be short-lived. Nonetheless, there may be as-yet unidentified pockets of CPB, and in any case the Keravat invasion has underlined the vulnerability of PNG to the pest.

If eradication of CPB from Keravat is successful, it will be in no small part due to the speed and scale of the response. Will it be recognised so early next time? If not, the outlook may not be so bright. Knowledge of invasion pathways together with surveillance and early detection are key elements in combating invasive pests and diseases at an early stage, before they have chance to establish. There is an urgent need for raising awareness about the pest amongst the many smallholder cocoa farmers who are the mainstay of cocoa production throughout PNG. They have a pivotal role to play: unless they know about CPB – the possible pathways of introduction, and what it and its symptoms look like – they may unwittingly carry it to new areas, and may not recognise an outbreak before it is too late for eradication.

There is also an urgent need for training in practical management. If CPB does eventually become established in PNG, now or in the future, the structure of the smallholder cocoa production sector will make its control a challenge. The current emergency spraying operations are an essential part of the eradication effort, but in the long term, more sustainable, environmentally friendly means of CPB control, such as the use of pheromone traps and the development of parasitoids and microbials, are required and farmers enabled to make best use of them.

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1 Phillips, W., Coutiño, A., Ortiz, C.F., López, A.P., Hernández, J. & Aime, M.C. (2006) First report of *Moniliophthora roreri* causing frosty pod rot (moniliasis disease) of cocoa in Mexico. The British Society for Plant Pathology, New Disease Reports, January 2006. www.bspp.org.uk/ndr/jan2006/2006-04.asp

2 Quinlan, M.M., Phiri, N., Zhang, F. & Wang, X. (2006) The influence of culture and governance on the detection, identification and monitoring of plant disease: a comparative assessment of the United Kingdom, China and sub-Saharan Africa. Foresight, *Infectious Diseases: Preparing for the Future*, Report D4.1. Office of Science and Innovation, April 2006. www.foresight.gov.uk/

3 World Cocoa Foundation Research Update, January 2005. www.worldcocoafoundation.org/Library/Research/usda_Jan_2005.asp

4 Singh, S.P. & Rethinam, P. (2006) Cocoa pod borer threatening the sustainable coconut-cocoa cropping system in Papua New Guinea. *Cord* 22(1).

Remote Control: Detecting Cocoa Diseases in Central Africa

Recommendations for control are only as good as the accuracy of a diagnosis. Most diagnoses are based on visual examination of symptoms. Few samples get sent to laboratories. Witches' broom is clearly different from frosty pod rot, but is everyone familiar with the difference between frosty pod rot and black pod? If a smallholder cocoa grower did have doubts or came across a problem which was new to her, where would she go for advice?

Extension workers try hard to assist growers in often difficult circumstances. Many work independently, either by default or because extension has been privatised. All extension workers share a common difficulty in getting adequate technical support. What role do scientists have to play in changing this? How can scientists help extensionists help growers?

This is one of the main challenges that the Global Plant Clinic (GPC – see Box) has set itself. A recent visit by Eric Boa and

Global Plant Clinic

The Global Plant Clinic (GPC) provides a comprehensive diagnostic and advisory service for disease problems on all (particularly tropical) crops. The GPC, unique in terms of global operation and range of plant diseases covered, is an alliance of CABI (fungi, bacteria and nematodes), Rothamsted Research, UK and the Central Science Laboratory, UK (viruses and phytoplasmas).

The GPC works closely with extension services, NGOs and farmer groups to create primary plant healthcare systems supported by diagnostic laboratories and the latest control technologies. We help to run mobile clinics, train plant doctors and organise courses on how to produce fact sheets and other advisory information for farmers.

We provide a rapid response for new diseases in developing countries, including short term research support. Practical help includes field surveys and assessment of diseases, collaboration with quarantine services, risk assessments and advice on seed health.

A free service is available to developing countries. For conditions that apply, please go to our website.

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Paula Nash of the GPC to the Democratic Republic of the Congo (DRC) and Uganda, to investigate the death of cocoa trees, provided an opportunity to review methods and approaches that have proved successful for other crops.

A decisive response is needed to new diseases and pests. Is a problem new to a region or resurgent? That means getting the right samples quickly, in the right condition, to a laboratory able to identify all pathogen and pest groups. There is no point in sending a wilted branch and dead leaves if the disease is best detected in roots or stems. What is the history of the crop? That requires good access to the scientific literature and gathering useful information from local growers.

Dead trees are what concerns Hassan, a cocoa grower near Beni, North Kivu. The GPC wants to examine early symptoms. These reveal much more about the potential cause of the wilt disease (Eric Boa)

The GPC has developed training courses for extension workers, new methods for mass extension (e.g. Going Public – see Box) and created mobile plant clinics that gather demand from farmers and supply appropriate technologies. Applied more widely, they could contribute to an early-warning system for new disease and pest threats to cocoa production and improve understanding of the constraints that cocoa farmers face in all parts of the world.

Uganda has long grown cocoa without ever being a notable producer. Bundibugyo, nestling in the northern edges of the Ruwenzori, has perhaps the most promising potential, one that a local exporter (ESCO) has done much in recent years to encourage. A notable feature of this region is the lack of serious pests and diseases.

Just across the border lies North Kivu, an agriculturally rich region of the DRC. North Kivu has escaped many of the direct effects of strife in eastern Congo but has suffered along with a much wider coffee-producing region from coffee wilt disease (also known as 'tracheomycosis' and caused by the fungus *Fusarium xylarioides*).

The decline of coffee in North Kivu and Bundibugyo has given an added stimulus to other crops, with cocoa, vanilla and papaya (for papain) proving popular – and profitable. Beni in North Kivu is a centre for cocoa producers and ESCO are a major buyer of the beans. Production is small by comparison with other African producers but the importance of the crop to the local economy and livelihoods is high.

The Beni producers benefit, like their nearby neighbours in Bundibugyo, from having few major pests and diseases. Despite the relative isolation from other cocoa producing areas and their major pests and disease, problems can lurk unreported or quiescent for many years. Or someone can bring in infected material.

In 2004 the GPC went to investigate a wilt of cocoa. With the kind assistance of Masterfoods and Philip Betts of ESCO, we went to examine the dead and dying trees. The eagerness of extension officers in Bundibugyo to tell us what was happening was impressive but also made it difficult to talk to farmers and learn their stories. Decide on a limited range of key questions and say as little as possible. Listening carefully reveals a lot.

Slowly we picked our way through the snippets of information and busied ourselves collecting samples and taking photographs. We had established beforehand that the most likely cause of the wilt was the fungus *Verticillium dahliae* but we were aware that mirid feeding in West Africa, for example, also results in wilting. It is important to examine all parts of the plant, looking for internal symptoms such as necrosis as well as the more obvious external symptoms. This is a standard instruction in textbooks but it is surprising how few people look under the bark or examine roots.

We took lots of photographs so that we could show what appeared to be 'typical' staining associated with *Verticillium* to colleagues back in the UK. We carried out isolations in our hotel the same evening. Fresh material always yields the best results. We confirmed the presence of *V. dahliae* from Uganda and DRC courtesy of CABI mycologists. We were not surprised: the disease was first recorded in Uganda over 40 years ago when it caused major losses. The intro-

Going Public

It is a common frustration for agricultural departments: you have some good technical solutions to farmers' problems, but how do you reach your large population of farmers, particularly in remote areas? Ideally, you would have enough extension officers, but that is rarely if ever practical. Other methods can contribute (field days, demonstration plots) but still you cannot reach everyone.

Turning the problem on its head, the innovative 'Going Public', a mass extension method first developed in Bolivia, exploits ad hoc situations where people gather anyway (markets, bus and truck stops, even road junctions). Using a show-and-tell approach, extension officers describe key symptoms and control measures with the help of demonstrations, posters and photo-sheets. Working from the back of a truck, a market stall or a table, a varied group of people can be reached, including some who might never attend a field day. In Africa Going Public has been used successfully for banana bacterial wilt in Uganda and Tanzania and Napier grass stunt in Kenya.

Interactions at these events are two-way. On the one hand, the extension officers make sure they have things for people to look at, handle and discuss; on the other hand they ask questions and listen to what people have to say, then identify where support should be targeted. Listening can give more information in a few hours than obtained by several days of field work, especially as the farmers reached by Going Public come from far and wide.

The hunt for early symptoms of wilt includes an examination of roots and the lower stem. Philip Betts of ESCO and local extension workers look on. Near Beni, North Kivu (Eric Boa)

duction of new varieties and/or changes in cocoa management could account for the decline in importance of the disease. A similar disease was reported from the DRC around the same time as the 'first' outbreak in Uganda but local memories were hazy when we tried to take some 'crop histories'.

In April 2006 the first ever mobile plant clinic was run in North Kivu and we hope more can be established to improve routine plant healthcare and heighten surveillance. It took several years for decisive action to be taken on coffee wilt yet human disease such as SARS can be characterised in a matter of months and control and containment measures put in place soon after.

What price dead and dying cocoa in the western reaches of Uganda and, until more recently, the isolated regions of eastern Congo? It is tempting to say 'not much', but with better use of extension workers (an undervalued resource) and careful listening to farmers, it is possible to identify and respond to new disease outbreaks quickly. The GPC supports mobile plant clinics in Bolivia, Bangladesh, Uganda and Nicaragua (our largest scheme so far) where we also train extension workers and carry out scientific research.

A decline in technical capacity and poor coordination between extension and research is a serious problem in North Kivu and many other places in Africa. Reversing this decline and improving coordination will take a long time to achieve. In the meantime, as the GPC has learnt from other countries, there is nothing to stop you having a go at doing Going Public or running a mobile plant clinic. These do not need a lot of resources – only resourceful people.

It is still early days to say what effect cocoa wilt will have on producers in Uganda and DRC. We hope to continue working with ESCO and their network of growers, developing farmer fact sheets and using other rapid extension methods such as Going Public to convey key messages on control.

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Mabang Megakarya Selection Programme

Black pod disease caused by *Phytophthora* spp. is endemic throughout West Africa, but the particularly virulent form caused by *P. megakarya* has been spreading westwards from its supposed area of origin in the Cameroon/Nigeria border region. It was first identified in the Ashanti Region of Ghana in 1985 with losses of 60–80% of the crop reported. The pathogen continues to spread, threatening the country's cocoa production.

The new Mabang Megakarya Selection Programme at the Cocoa Research Institute of Ghana (CRIG) will select clones that are high yielding in the presence of *P. megakarya*. A 4-year establishment phase with a budget of Euro 976,720 is jointly funded by CRIG, Subsidieregeling duurzame ontwikkeling cacao- en chocoladesector (Dutch cocoa buffer stock fund) and the Ghana Cocoa Growing Research Association (GCGRA, a trust set up by the late John Cadbury) and is administered by the Biscuit, Cake, Chocolate and Confectionery Association, UK (BCCCA). The programme is managed jointly by CRIG and GCGRA.

About 5000 candidate clones will be planted in preliminary trials at the rate of about 500 per year starting in 2007. Clones will be selected from CRIG's germplasm collection, from existing trials and most importantly from farms in the area affected by *P. megakarya*, as heritability estimates suggest that on-farm selection for low incidence of disease would be more effective than random selection. It is expected that about 80% of the clones will be discarded within 4 years of planting, with the balance advancing to larger scale second stage trials at the same site. As clones show promise for yield, low incidence of black pod disease, low incidence of capsid damage, acceptable growth habit, appropriate vigour and Ghana quality of the finished cocoa they will be tested further on both farms and research stations in different agro-ecological zones within Ghana. This approach is modelled on rubber breeding and the highly successful selection of cocoa clones at the former Prang Besar Research Station in Malaysia (see Box, 'Breeding Success').

The best clones from three previous clone trials at CRIG will be used as controls. Data from one of these clone trials will be used to validate use of screening tests for low incidence of black pod disease.

The programme will collaborate with USDA and Mars Inc. in the use of quantitative trait loci (QTLs) to select a pool of material carrying resistance to witches' broom disease and frosty pod rot, as an insurance against either disease reaching Ghana. It is emphasised that selection will be done using molecular methods and that there is no intention of introducing either pathogen to Ghana.

Seedling trials will be established for family level selection. These trials will be integrated with the QTL work, with development of new bi-parental crosses for production in current and prospective seed gardens and with genetic investigations designed to improve understanding of cocoa breeding. One trial that will be linked to a major new clone × spacing trial will investigate the inheritance of yield and vigour in cocoa.

A new laboratory and housing complex will be established at Mabang on the Ashanti–Brong Ahafo border not far from Bechem. Mabang is in the centre of the *P. megakarya*-affected area. More than 150 ha of prime land is available for the field

The team plan a site visit at CRIG, Tafo (Martin Gilmour)

Breeding Success

Harrisons Malaysian Plantations Bhd (now Golden Hope Plantations Bhd) started their cocoa selection programme in 1965. They modelled it on their rubber breeding programme that began on Prang Besar Estate in 1921 and had led to the highly successful PB series of clones.

The cocoa programme began with selection of large numbers of promising seedlings ('ortets'). Ang Boon Beng undertook much of this work, spending months on end walking through cocoa in Trengganu State where most of the trees were severely affected by vascular streak dieback (caused by infection with *Oncobasidium theobromae*). Individuals that maintained their promise for low disease incidence, yield, freedom from defects and large enough beans (more than 5500 ortets) were taken into 'preliminary proof' trials at a single location. The usual experimental design was at least two replicates of 25-tree plots in a randomised block design. Promising clones were carried forward into larger scale 'further proof' trials, at increasing numbers of locations as confidence in them grew.

The selection scheme was as recommended by Simmonds (1979, p. 164) for clone selection: "select as weakly as possible at the beginning and only for characters known to be highly heritable; intensify selection only when substantial quantities of individuals are available to reduce the effects of environmental variation; rely for ultimate decisions on trials replicated over sites and seasons."

Further information: Chong, C.F. & Shepherd, R. (1986). Promising Prang Besar cocoa clones. In: Pushparajah, E. & Chew Poh Soon (eds) *Cocoa and coconuts: progress and outlook*. Kuala Lumpur, Incorporated Society of Planters, pp. 3–20.

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trials. A plant breeder has been appointed for the work and a new team of support staff is being developed.

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Does Tourism Pay?

Cocoa farmers are being encouraged to diversify, both to buffer them against the uncertainties of cocoa production and markets, and to supplement their income. Tourism is one option, but it is far outside the experience of most cocoa farmers and they need a lot of questions answering before deciding whether it is for them. What does cocoa tourism involve? Is there a market? What are the financial implications? The articles below describe ventures, which are at various stages of development, both to provide some answers and also to stimulate discussion.

Cocoa Farming and Ecotourism in Ghana

An Earthwatch and Cadbury Schweppes project is bringing potential benefits to cocoa communities in Ghana through a sustainable cocoa farm tourism initiative.

In early 2005, the Earthwatch Institute initiated a 3-year cocoa farming and biodiversity project in Ghana, which is also intended to lead to the establishment of the country's first cocoa farm tourism initiative. Designed in partnership with the Ghanaian based NGO, the Nature Conservation Research Centre (NCRC), the Cocoa Research Institute of Ghana (CRIG), the University of Reading and Cadbury Schweppes, who sources the majority of its cocoa from Ghana, this project aims to investigate the feasibility and potential of sustainable cocoa production in a biologically diverse environment, whilst increasing the income for farmers through tourism.

Earthwatch provides long-term support to research projects and recruits volunteers from diverse backgrounds to help scientists collect data in the field. Engaging volunteers in this way not only enables large amounts of data to be collected, but also provides a valuable educational experience for the volunteers through their direct, hands-on involvement with research activities tackling environmental issues. The interaction between the research staff, volunteers and host communities at the research site also contributes to enhancing local capacity and ownership as a foundation for effective biodiversity conservation beyond the project period.

This field research project is based in the Fanteakwa District of the Eastern Region – the heart of cocoa growing in Ghana. In its first year, with assistance from 40 volunteers, including Ghanaian University students and Cadbury employees, baseline data were collected on cocoa farming practices and biodiversity under different land-use conditions: unshaded intensive farms, traditional shaded farms and areas of remnant native forest. In addition, crop monitors have been recruited from the community to collect data on the use of fertilisers and cocoa pod harvesting. From this data, a set of indicators will be drawn which can be monitored to document changes over time and, ultimately, inform cocoa farming practices.

Having established the research project and formed strong links with the farming communities during the first year of the project, work has now started on develop-

Initial planning of the layout of the 541-ha Mabang site (Martin Gilmour)

Newspaper for Cocoa Farmers

The Ghana Cocoa Farmers' Newspaper is a new initiative in knowledge transfer to farmers, and is a joint venture between CRIG, Cadbury Schweppes and CABI. The first issue is published in July.

The Chief of Adjeikrom village in traditional robes and holding dried cocoa beans (Caroline Campbell/ Earthwatch)

ing the community-based tourism initiative. The communities in the Fanteakwa District are situated close to the picturesque Kwahu Escarpment which is likely to be very attractive to tourists. Here, birds and butterflies are abundant and there are numerous species of small antelopes and other mammals. Visitors will have opportunities for hiking, bird watching, mountain biking and walking and will be able to observe the rich traditional cultures of the farming communities. Within this area, the Atewa Forest Reserve is designated as a Globally Significant Biodiversity Area, and an Important Bird Area by Birdlife International.

The success of rural tourism initiatives lies in the fact that they are set up and managed by the local communities. Indeed, empowerment of local communities and the necessity of benefits accrued by communities, as well as the environment, is stressed in a definition of sustainable tourism from the 1995 World Conference on Sustainable Tourism: *"Tourism is sustainable when its development and operation include participation of the local population, protection of the total environment, fair economic return for the industry and its host community, as well as a mutual respect for and gratification of all involved parties."* Thus the goal is to create sustainable income-generating ventures benefiting the community, whilst conserving local wildlife, environment and culture.

NCRC is a non-profit organisation formed in early 1996 as a result of inspiration from Dr Jane Goodall to John Mason to form a new conservation organisation in West Africa, where there were so few active groups. It is now the largest NGO conservation group in Ghana (and one of the largest in the sub-region). NCRC has successfully developed and implemented sustainable tourism schemes in over 100 rural communities at 20 locations throughout Ghana. The number of visitors and the amount of revenue generated at these rural tourism centres has surpassed all expectations. NCRC's successful community-based ecotourism model is being replicated at the Earthwatch project communities. It is expected that the cocoa farm tourism will draw a minimum of 4000 paying visitor days per year by the end of 2007, and that revenue generated will add at least US$36,000 per year of new income to the area.

From discussions with the communities to determine the tourism potential of their cocoa farms, NCRC staff and the research project team have started to draft an area Tourism Development Plan. This plan will be refined during the second year of the project in consultation with key community members who will also be facilitated in forming a Tourism Management Team (TMT) for overseeing the day-to-day implementation of the tourism plan. The TMT will be the backbone of the community-ecotourism initiative ensuring that it has the communities' support, that benefits accruing stay in the communities, and that ownership is retained locally.

Tourism facilities, such as a visitor centre, will be built during 2006; the local-styled lodges, which were originally built by local builders to house the research team, will be made available to visiting tourists. Tourist guides will be recruited from the community and will have the opportunity to visit other community tourism sites to enable them to learn from their colleagues and participate in training workshops covering financial management, bookkeeping, guiding skills and customer service. As the tourism initiative develops, the Ghana Tourist Board will help to produce marketing material for distribution throughout the country to promote the initiative.

Through this project, the cocoa farmers have a new opportunity to become involved in the growing number of farm tourism initiatives around the world, contributing to increasing financial security to the farmers and their communities. This is particularly important in Ghana where the tourism sector is growing at 15% per annum. Ecotourism has been identified by the Ministry of Tourism as the most important tourism product for the country during the next 5 years with cocoa related tourism, and cocoa farm tourism, in particular, being highlighted as an area that warrants new initiatives. Farm tourism will thus provide a new revenue source for cocoa farmers that is not linked to increasing cocoa bean productivity and consequent potential biodiversity degradation.

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Cocoa-linked Tourism in the West Indies

The West Indies is one of the world's premier tourist destinations and a source of some of the world's fine or flavour cocoa. Cocoa growing declined during the 20th century as prices fell, pest and diseases increased, and other industries – including tourism – became prominent. Nowadays restored cocoa plantations and houses are not uncommon tourist havens, not least because of the rich biodiversity they harbour (e.g. the world-renowned Asa Wright Bird Centre in Trinidad). An emerging trend is to exploit cocoa itself as an added-value component of the tourist experience.

Restoring Tobago's Cocoa Provides Tourism Potential

Cocoa was once one of Tobago's major exports but decline began in the late 1920s. By the end of the 20th century there were a mere 45 small-scale cocoa farmers (mostly elderly), one large estate, a single cooperative fermentary and one processor on the island. Since then, and in tandem with a similar programme in Trinidad, a cocoa revitalization programme has begun to rehabilitate Tobago's cocoa sector in the expectation that the cocoa's unique aroma and flavour will mean high demand and a premium price in the growing niche market. In recent years Tobago has also twice won the World Travel Foundation prize for 'Best Eco-Destination in the World'.

A new initiative is taking advantage of this combined excellence to restore Tobago's cocoa heritage, and both exploit its ecotourism potential and establish strategic relations with European chocolate compa-

Cocoa seedlings ready for planting as rehabilitation gets underway (Duane Dove)

nies, for whom single-estate fine or flavour lines are an emerging interest. Working with David Butler and colleagues at the Cocoa Research Unit of the University of the West Indies (St Augustine, Trinidad), Duane Dove has spent the last 2 years planning the revitalisation of part of the former Roxborough cocoa estate, preserving old Trinitario varieties and planting new TSH hybrids. Financing comes mainly from government agencies such as the ADB (Agricultural Development Bank) who are keen to support agrotourism projects, although private investment is also welcome.

The plan is to put Tobago back on the world cocoa map using environmentally friendly, organic farming methods and, at the same time, create a Cocoa Heritage Park in an area that is already a well-known tourist haunt. It also aims to help build the sustainability of the cocoa sector in Tobago by working closely with local schools, arranging visits to whet the appetite of the younger generation for cocoa farming.

The strategic location of the estate makes marketing easier than in countries without Tobago's highly developed tourist industry: tour operators, cruise ship agents, villa agents and hoteliers are a ready outlet for publicity (including displays of value-added products made from Trinidad & Tobago fine/flavour chocolate) and a source of customers. In terms of further development, relevant authorities such as the Tourism Development Corporation (TDC), regional and international tourism fairs, and the Internet provide support and opportunities. Cocoa tourism will become participatory and not just observational if one venture, special tours to assist during the cocoa harvest, comes to fruition. Beginning in May 2006, an online diary is charting progress (see website below).

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Grenada: From Pod to Prize-Winning Product

Cocoa is Grenada's third export (after tourism and nutmeg) although the impact of Hurricanes Ivan and Emily on the crop is still being felt. Some one-third of the population and one-tenth of the country's export earnings depend on cocoa.

The partnership between Belmont Estate and the Grenada Chocolate Company combines cocoa tourism and prize-winning chocolate. Belmont Estate is a 400-acre [160-ha] fully operational cocoa and nutmeg plantation which dates back more than 300 years.

"Inspired by history", Belmont Estate opened as a tourism attraction in 2002 to provide visitors with an opportunity to experience the operations of a traditional plantation, to observe and participate in the production and processing of cocoa and to learn about the estate's history. Closed to tourists following the hurricanes, it expects to re-open this December. The Grenada Chocolate Company is a cooperative founded in 1999 to produce high-quality organic fine dark chocolate where the cocoa grows – a rare example of single-origin chocolate that won a Bronze Medal at the Academy of Chocolate's 'World Chocolate Awards' in November 2005.

The tour of the Belmont Estate allows visitors to explore the cocoa fields and experience the entire processing of cocoa – planting, harvesting, fermenting, drying, polishing and bagging, all using traditional methods and equipment. As an agent of the Grenada Cocoa Association, Belmont Estate buys conventional cocoa from local farmers for export and visitors can witnessed the purchasing of the cocoa on buying days. In addition they have an opportunity to learn to 'dance the cocoa', a traditional way of polishing beans. Visitors can also watch an informational video on the exciting story of the cocoa bean from the tree to chocolate bar. A must-do for visitors is the sampling of 'cocoa tea' a local hot chocolate breakfast drink.

The heritage museum's exhibits illustrate the history of the plantation and cocoa production in Grenada. Conventional tourist attractions of good local food, beautiful grounds and abundant wildlife are present, but this tourist centre is essentially about cocoa.

Belmont Estate and the Grenada Chocolate Company are committed to sustainable farming and organic agricultural practices. By a joint venture relationship the companies produce high quality organic cocoa and dark chocolate using ecologically sound and fair labour practices.

Belmont Estate produces the organic cocoa that is used by the Grenada Chocolate Company for making fine dark chocolate. To allow small-batch chocolate production from the cocoa this land produces, the innovative Grenada Chocolate Company developed small-scale, solar-powered versions of industrial equipment (often based on machinery used in the early 20th century). The chocolate produced by this method from the traditionally processed beans is mostly sold locally but the limited amounts available for export command a high market price. There are plans to lease more cocoa land and have it certified for organic production, in order to meet demand, but this will take time.

Walking through the beans allows air to flow evenly through them and aids drying (Belmont Estate)

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