

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

About Farmers

At the 14th International Cocoa Research Conference (ICRC) in Ghana in 2003, farmers called for researchers to deliver results they could use. The Cocoa Producers' Alliance (COPAL), the organiser of the conference, listened to their plea and in a round of meetings that began this year (see below) identified research results ready to be transferred to the field; the next phase will identify the best ways of communicating the recommendations to farmers.

Picking up the baton, this *GRO-Cocoa* includes articles that address issues from the farmers' perspective. Farmers' greatest production constraints are frequently pests and diseases, and in extreme cases can lead them to abandon cocoa growing. Although non-chemical, sustainable pest and disease management is a desirable goal for the cocoa sector, Roy Bateman argues that in some cases there may currently be no effective (or economic) alternative to chemicals. He suggests what can and needs to be done is to provide farmers with the knowledge to spray effectively, economically and safely, to safeguard their livelihoods, until science produces alternative control measures. Farmers also need high-quality planting material. Rob Lockwood describes how Ghana's seed gardens provide a model that could be used to provide good, affordable seed in other countries. Still in West Africa, another article describes how the Sustainable Tree Crops Program (STCP) is exploring a range of methods and tools for farmer participatory training and research. The focus is on improving communication between trainers and farmers, a two-way process to optimise development and uptake of improved crop production methods.

Given the farmers' implicit criticism that much research fails to deliver usable results, it is nice to report a success, and a successful international collaboration too. Biopesticides are difficult to produce to a high specification and on a large scale. However, Brazilian, US and UK collaboration means a high-quality biofungicide for easy application against witches' broom disease (*Crinipellis perniciososa*) is now produced on a commercial scale in Brazil, and is available to farmers. With the continued threat of international movement of

diseases such as witches' broom, we also have an article that underlines the pivotal role of intermediate quarantine at Reading to the world cocoa community.

We include information on some new and forthcoming publications. Last but not least, the venue and date for the 15th ICRC has now been set, and details of how to find out more are given on p. 8. If you have a cocoa publication or meeting coming up, let us know.

COPAL Champions Technology Transfer

It may be an old chestnut to some, but it rings true with others: research results do not easily translate into recommendations for farmers. It certainly rang true with some participants at the 14th International Cocoa Research Conference (ICRC) in Ghana in October 2003.

Presentations made at the conference indicated how research covering all aspects of cocoa production was providing plenty of results that were suitable for transfer to cocoa farmers. The President of the International Organizing Committee, in keeping with tradition, gave an appraisal and summary of the Conference at its conclusion and emphasised the significant advances that had been made. However, some participants expressed concern that, while they could see from the presentations that research results were effective in generating technological breakthroughs, a mechanism was needed to transfer the developments to the farmers. The criticisms were accepted as constructive and the Secretariat of the Cocoa Producers' Alliance (COPAL) volunteered to ensure that effective transfer of technology would be made to cocoa growers.

As a first step, the Scientific Research Committee of COPAL met on 9-13 August 2004 in Ilheus, Brazil. This meeting was well attended by about 40 participants representing seven COPAL countries, with observers from Peru and CABI, UK. The object was to take stock of recently generated results in all aspects of cocoa cultivation, post-harvest operations and diversification-associated added-value activities, focusing on those that would have potential to be applied in the field.



Transfer of information to farmers; the key to sustainable cocoa production (Janny Vos)

Delegates from each country made presentations on current practices and recommendations within each of the following topic areas:

- Planting material
- Agronomy: appropriate planting systems
- Protection against harmful insects, diseases, rodents and plant parasites
- Post-harvest operations: harvesting, pod opening, fermentation, drying, storage, protection against harmful insects, transportation

The Chairman of each topic area then collated the information presented. The information was reviewed and presented as recommendations by the Scientific Research Committee to the COPAL General Assembly, who met in São Tomé on

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30 August - 3 September 2004. Activities agreed then, for the coming year, include a 'Workshop on the transfer of technologies to cocoa farmers in Alliance countries'. The objective of this meeting will be to "Identify and propose effective mechanisms to cocoa farmers to render cocoa growing more rational in the Alliance countries, given the demands for diversification, judicious farming of land that can be cultivated and environmental ethics". This will involve assessing the most appropriate means of ensuring effective transfer and uptake of research-generated knowledge by farmers. The date for this meeting is tentatively May-June 2005, at a venue yet to be decided.

By following up on the commitment made in Accra, COPAL is demonstrating its determination to provide the missing link between 'lab and field' and to turn scientists' results into improved methods of cocoa production that are implemented by farmers.

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A Place for Pesticides

This is a case for pesticides - there I have used the 'P' word, one that has become unfashionable nowadays, but a cocoa production issue that won't go away. It is becoming increasingly apparent that cultural control methods alone are inadequate for more intractable problems such as *Phytophthora megakarya* in West Africa, the Latin American *Crinipellis* diseases (witches' broom [*C. perniciosa*] and frosty pod [*C. roreri*]) and cocoa pod borer (*Conopomorpha cramerella*, CPB) presently limited to South East Asia. The development of highly effective, self-sustaining classical biological control agents remains the 'holy grail', but success will be serendipitous and require further investment for technical developments such as biopesticides (e.g. The Myco-Harvester: Improving Delivery Systems for *Trichoderma* p. 6). However, in most



Spraying pesticides without the use of protective clothing (although ear defenders were accepted). The product in the spray tank was a class IV (unlikely to be hazardous) fungicide (Roy Bateman)

cases biological control, like genetic improvements should be considered as 'highly experimental' at present - to be implemented several years hence. In the meantime we need *true* Integrated Crop Management (ICM, see Box 1).

So do cocoa farmers use pesticides, and if so where? The answers I suggest are 'where they are perceived to work' and 'where they are available and affordable'. [Also see Box 2 for two recent analyses of pesticide use in West Africa.] Looking down the list of eight or so major cocoa pest problems, a few stand out including: *Phytophthora* black pod rots (the diseases that probably cause the greatest worldwide crop loss), mirids (capsids) and cocoa pod borer.

Unfortunately, chemical control for the invasive *Crinipellis*-type diseases is imperfect. For example, I have had the privilege of working with a team of scientists based at CATIE (Centro Agronómico Tropical de Investigación y Enseñanza), Costa Rica over four seasons (see below). Our trials have shown that 8-10 targeted sprays of copper hydroxide will nearly double the number of healthy pods (from a low level of production caused by very high disease pressure). Other experimental agents such as flutolanil or certain *Trichoderma* species have recently shown promising field activity, but not as cost-effectively as copper. Cultural controls such as sanitary harvesting give the greatest increase in proportion of healthy yield and are the mainstay of ICM, but with frosty pod rot in Costa Rica this means from practically nothing to some 20% healthy pods. So where does this leave us in the short to medium term?

Filling Knowledge Gaps with Pesticides

Many farmers will continue to use pesticides, at least for the time being, so what can be done to make sure that the most appropriate ones are used, at the minimum effective dosage, in a way which is safe for the farmer and the environment? During my travels it seems to me that the things that cocoa farmers wish to know about pesticides are (in approximate order of importance):

- Does it work?
- How much does it cost?
- Is it safe to use? ... perhaps, and...
- ... A few enlightened farmers may also express interest in environmental impact

Safety to operators and safety to the environment are two separate issues, both frequently emphasised by international scientists, aid workers and

Box 1. Integrated Crop Management (ICM)

Cultural techniques, such as pruning and sanitary harvesting, give the greatest proportional increase in healthy yield in cocoa under pressure from cocoa diseases and are often most straightforward to implement. However, there are many reasons, besides pest control, for such measures - hence the use of the term ICM. Integrated Pest Management (IPM) can be considered rather too specialised and has come to mean different things to different people (and organisations). Rational pesticide use (RPU) is the sub-set of ICM which aims to maximise efficacy and mitigate the problems associated with agrochemicals; but I emphasise that it is *not necessarily* about promotion of pesticides. Put another way, the World Cocoa Foundation "... endorses the minimal, safe use of appropriate agrochemicals ... and will support projects that move the sector towards low-input cocoa production systems requiring minimal use of approved agrochemicals, and research which makes these conventional pest and disease control measures more effective." Notable initiatives for investigating the role of RPU in cocoa include: participatory research with STCP (Sustainable Tree Crops Program) collaborators in Cameroon and Nigeria and CPB trials that will shortly take place in Sulawesi under the auspices of Prima Cocoa (see *GRO-Cocoa* No 3).

others. Members of the cocoa processing industry will also be concerned about (and monitor diligently) pesticide residues. The various safety issues are an enormous subject and cannot be dealt with here, but in my field, operator safety raises an important point. I was recently criticised at an international meeting for showing a picture of (trial) spraying by an operator who was not wearing personal protective equipment (PPE: gloves, masks, etc.). I leave it to the reader to estimate how many unorganised smallholder cocoa farmers in rural areas wear PPE as a matter of course, or are likely to in the next 5 years. The primary safety measures have to be washing after work and product selection. But how many available products (especially insecticides) are slightly hazardous (WHO class 3) or safer?

There are also serious problems with the current methods of application, and I suggest that one of the most effective short-to medium-term ways to reduce the use of pesticides is to help farmers to spray more efficiently. It is not widely appreciated just how wasteful 'normal' pesticide



Box 2. Pesticide use in West Africa

Two recent articles in *Crop Protection* give useful insights into current pesticide use in West Africa, where pesticide application on cocoa by smallholders has largely replaced the wider-scale operations of plantation owners or governmental campaigns.

The paper by Akrofi *et al.* focuses on black pod (*Phytophthora*) control practices using metalaxyl and copper fungicides. They discuss associated issues that affect the profitability of fungicide application and emphasise the role of farmers in successful disease control. The benefit/cost ratio of fungicidal treatments clearly depends on externalities such as operational costs and cocoa prices, and they suggest that ratios between 1 and 2 should be classed only as 'break even'. They found that fungicide use was often very profitable: a majority of farmers (in two districts) achieved ratios of >2 and in one particularly high yielding farm the ratio approached 20.

Matthews *et al.* provide a survey of pesticide application in Cameroon. Cocoa farmers there use fungicides (again, mostly copper fungicides and metalaxyl, representing a relatively low hazard), insecticides (many of them hazardous) and herbicides (including hazardous paraquat). Operators do not generally wear protective clothing, and under such circumstances the authors stress the need for better training in pesticide selection and maintenance of sprayers, most of which are manual knapsack type.

Akrofi, A.I., Appiah, A.A. & Opoku, I.Y. (2003) Management of *Phytophthora* pod rot disease on cocoa farms in Ghana. *Crop Protection* 22, 469–477.

Matthews, G., Wiles, T. & Baleguel, P. (2003) A survey of pesticide application in Cameroon. *Crop Protection* 22, 707–714.

These articles are available on www.sciencedirect.com

application really is (e.g. only approximately 0.02% of the active substance mixed in spray tanks is thought to actively control cocoa mirids). In *GRO-Cocoa* No 1, I described a 'cocoa nozzle' which may more than double the dose transfer efficiency and thus the cost effectiveness of spray operations against pod diseases (and possibly CPB). For approximately US\$10, it would obviate the need for some of the decision making in spray application, allowing farmers to concentrate on other aspects of better crop management. Technical improvements *may* have a role, but

successful implementation will depend on farmer knowledge of the underlying issues and well-maintained sprayers on which to attach the cocoa nozzles! Smallholder spraying equipment is in variable states of repair and much could be done rapidly to improve matters, but unfortunately this rarely happens.

So several questions then: Which pesticides are efficacious and safe to use? How best to apply them? The honest answer very often is that we don't know. A senior donor has described cocoa as an orphaned crop, with little funding devoted to field testing over the past quarter-century. Much of our known cocoa pesticide science therefore dates from when copper and lindane were sprayed in plantations, or as part of government campaigns. The 4-year series of pesticide trials on frosty pod rot, funded by USDA (US Department of Agriculture) and described above, represents the exception rather than the rule (and, ironically, were started partly because they were to provide baseline data for evaluation of 'environmentally sound' biological agents). There are a number of 'new chemistries' that have been developed in recent decades, but the infrastructure for evaluating new chemical products on cocoa is diminishing rapidly, a trend that must be reversed.

This article is therefore a plea for really integrated crop pest management and a strengthened research-training infrastructure for Rational Pesticide Use (RPU). Failure to engage with pesticide issues *may have perverse consequences* resulting in:

- Untrained farmers 'squirting on' pesticides (inefficient dose-transfer)
- Use of hazardous or even banned compounds
- Poor pest control

Without an ICM strategy that is robust and credible to farmers the cocoa sector will continue to be reacting to the whims of single-issue campaign groups, which will not necessarily improve the lives of cocoa farmers or the sustainability of the crop. That's better, I have now used the 'S' word...

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Seed Gardens Deliver Quality in Quantity

Supplying farmers with improved planting material is fundamental to the improvement of farm incomes. In cocoa, farmers can plant seeds or use

Language of Breeding

A **clone** is a group of plants derived from a single individual by asexual (vegetative) reproduction and they are thus genetically identical. A **mono-clonal block** is an area planted with just one clone.

A **hybrid** is a progeny of genetically distinctly different parents.

Inbred plant lines come from self-fertilisation or crossing related individuals; the progeny are less genetically diverse than those from random crosses.

Self-compatible plants can fertilise themselves, creating **selfed progeny**.

Self-incompatible plants are prevented from self-fertilising by an adverse (incompatibility) reaction between the tissues of the pistil and the pollen. However, this reaction is not always 100% effective.

The **direction of cross** refers to controlled (manual) pollination, and the decision about which parent to use as the **female parent** and which as the **pollen parent**.

clonal material, both rooted cuttings and grafted plants. Clonal material has major advantages because it is the most efficient way of using genetic variability and the change to the 'fan' (plagiotropic) growth habit in well-selected clones brings agronomic opportunities. However, the technology is more demanding on the farmer. Throughout West Africa, almost all farmers use seedling planting material and will continue to do so for many years. Selection of clones is only now beginning.

The idea of cocoa seed gardens goes back at least to the early 1940s. Peter Posnette selected Amelonado and local Trinitario seedlings on smallholder cocoa farms and experimental stations in Ghana. He tested them as selfed progenies and as clones at the Cocoa Research Institute at Tafo. Although one of these selections, TF1, was close to being com-



Don Edwards reported an average of 126 pollinations per hour and 20% recovery of pollinations as ripe pods, so seed production by manual pollination of freshly opened flowers need not be costly (Megan Fenn)



Manual Pollination

The success of seed gardens in Ghana, which rely on this technique, have demonstrated its benefits:

- Better seed yield
- Seed true-to-type
- Better timing of seed production to meet demand
- Simplified management through adoption of mono-clonal blocks for seed production
- Identification of crosses for better yield and tree structure, reduced losses from black pod diseases and cocoa swollen shoot virus resistance
- Bulk distribution of seed to farmers
- Good uptake of new varieties

mercialised by distributing seed from a mono-clonal block it was superseded by 'hybrid'¹ material.

The first crosses between Upper Amazon and unrelated material were made at Tafo in 1951. They showed such great early promise that soon after they commenced bearing consideration was given to their mass production for farmers' use. As one and in some cases both the parents were self-incompatible (SI), and the incompatibility reaction was thought to be absolute in effect, the idea of bi-clonal seed gardens was born. When both parents were SI they were planted in double rows, when one was self-compatible (SC) it was planted in a 1:5 ratio with the SI parent (to minimise the number of trees that would not produce useable seed pods). About 300 ha of seed gardens were planned, with the bulk of them planted between 1960 and 1962. It was intended that the seed pods from several seed gardens would be mixed at central points and that the pods would be issued to farmers as mixtures. Similar seed gardens were planted in several countries including Brazil, Cameroon, Côte d'Ivoire, Indonesia, Malaysia and Papua New Guinea. Poly-clonal seed gardens were planted in Nigeria in the late 1960s, with the intention that the seed pods would be produced by manual pollination.

The yields of the Ghana seed gardens were found to be very low when they were reviewed in 1969. The Amelonado and local Trinitario parents, mostly first generation inbreds, established poorly, were vegetatively weak and shy flowering. Further, pod production peaked in November, which is the time of the natural peak in Ghana, whereas farmers required seed pods in the January-May period for nursery planting

¹ Strictly speaking, these were bi-parental crosses as the parents were not inbred.

and a little later for sowing as seed at stake.

Don Edwards showed that if naturally set young pods ('cherelles') are removed from Upper Amazon trees they flower profusely and that mass manual pollination of freshly opened flowers was effective provided that the operators were properly trained. This was a cheap way of increasing yields of seeds, and it gave a measure of control over the time of seed pod production. Use of a morphological marker, the axil spot gene², showed that contamination with extraneous pollen was minimal except during periods of the year when flowers were scarce. In cocoa, there is no evidence that the direction of the cross affects the performance of the resulting seeds.

The introduction of mass manual pollination brought further benefit. Review of the long-term performance of the Ghana hybrids showed that the Upper Amazon x Amelonado crosses were higher yielding than the Trinitario ones, had lower black pod (*Phytophthora palmivora*) losses and formed smaller and more uniform trees. All the seed gardens were converted to the production of Amelonado crosses. A new breeding programme tested large numbers of potential pollen parents for the seed gardens supplying the area of Ghana affected by cocoa swollen shoot virus (CSSV) in the hope of identifying more resistant crosses that could be produced in bulk in the existing seed gardens. This programme was successful: not only were the crosses more resistant but they were higher yielding under farmers' management and maintained the Ghana cocoa quality profile. These crosses are now produced in seed gardens throughout the country.

Adoption of manual pollination allows use of mono-clonal blocks for seed production, greatly simplifying the management of the programme. The breeding strategy is to identify parents to use as females and, once chosen and while being established in the mono-clonal blocks, to identify a suite of four to six pollen parents. The better pollen parents are evaluated as females for the next cycle of seed garden planting.

Manual pollination brought another unexpected benefit. Claire Lanaud's pioneering work with isozyme markers showed that a large proportion of the seeds produced in the seed gardens in Côte d'Ivoire and Cameroon arose from self fertilisation, even on supposedly SI trees. This

² The axil spot gene is dominant and does not occur in Upper Amazon cocoa. It shows as a red spot on the tip of the radicle of a germinating cocoa bean.



Heavy crop resulting from synchronised mass manual pollination of a tree that had under-cropped over a long period. When all the young pods are the same physiological age, the natural mechanism for limiting the crop fails, and trees will over-bear. However, if this is repeated too many times, the pods ripen prematurely, the canopy weakens and the tree starts to die back. If these warnings are ignored and the pollinations continue, trees die (H.C. Evans)

explained Malaysian plantation observations that yields were higher if seeds were produced by manual pollination.

Ghana's experience that high quality seeds can be produced cheaply and in bulk by mass manual pollination was confirmed in Malaysia and Papua New Guinea. However, Ghana is unique in that no other major producing country produces high quality seed for bulk issue to farmers. Constraints include government policy towards the release of improved seeds and the management challenge of the day-to-day operation of the seed garden programme over very long periods of time. Training of pollinators and rigorous removal of natural sets are two key success factors that are not always fully recognised.

In 2003 Ghana produced more than 4 million seed pods by manual pollination for distribution to farmers. There is high uptake of new varieties in the traditional cocoa-growing areas but not in the more recent developments in the West. One of the reasons for this is that seeds are not always available in the place and at the time when they are needed. Work is in progress to use supplementary irrigation in seed gardens to improve control over the time of seed production, but there is no doubt that a cheap and easy way of storing seeds for several weeks would be invaluable. This would give further control over the time they can be sown, but more important, allow them to be transported to the places where they are most needed.

There is no technical reason why other



cocoa-producing countries that use seedling material should not have seed garden programmes like Ghana's. Using better varieties will improve farm incomes and if over-production is a concern, land can be released for other forms of biological production. A concerted programme to deliver existing improved varieties to all cocoa farmers would be a highly effective intervention in sustaining cocoa production and reducing rural poverty.

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The University of Reading Intermediate Cocoa Quarantine Facility

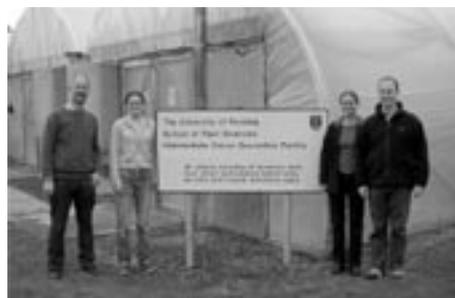
The movement of cocoa germplasm is often essential in providing material for improvement programmes but is also associated with the risk of spreading pests and diseases. Intermediate quarantine can minimise this risk. Failure to apply appropriate quarantine measures can have disastrous consequences; for example, it is thought that illicit movement of germplasm resulted in the spread of cocoa swollen shoot virus (CSSV) to Sri Lanka.

The University of Reading, UK began its cocoa quarantine operation in 1983 when it inherited a small germplasm collection from the Royal Botanic Gardens at Kew. The UK is ideally suited as a location for such a facility because it is not a cocoa-producing country so the risk of economically significant pests or diseases entering the greenhouses is minimal.

Over time, there has been an expansion in the facility, which now occupies 1000 m² of greenhouse space and houses a collection of over 350 accessions; a further 100 are currently passing through quarantine (the list of accessions available is located at www.icgd.rdg.ac.uk/quarantine.htm).

Safety First

Plant culture within the quarantine greenhouses involves a semi-hydroponic system, whereby the cocoa is grown in an inert medium and fed with a nutrient solution.



The Reading quarantine team: Paul Hadley, Helen Binns, Megan Fenn and Andrew Daymond

This arrangement has the benefit of both reducing the amount of labour involved in plant maintenance and minimising the risk of insect pests entering the soil.

Approximately half of the accessions at Reading have been received from the International Cocoa Genebank, Trinidad (ICG,T), the remainder coming from the original collection at Kew, from CIRAD (Centre de Coopération Internationale en Recherche Agronomique pour le Développement), France and germbanks in Costa Rica, Ecuador, Brazil, Colombia, Malaysia, Peru and the USA. Material is often imported as budwood, although over the past 2 years we have been receiving clones as micro-grafted plants from ICG,T, a process that has greatly increased the success rate of establishment of new material.

The quarantine procedure lasts for 2 years, during which time accessions are indexed for viruses. This is achieved by grafting buds from a mother plant onto rootstocks of the Amelonado variety, which is subsequently checked for visual symptoms of viral infections (Amelonado is used since it is particularly susceptible to Badna viruses). Virus indexing is particularly important since, without this process, viral symptoms are not always easily seen on the mother plant. We are currently developing a PCR (polymerase chain reaction) detection system, in conjunction with the Cocoa Research Institute of Ghana (CRIG), that could potentially enable a shorter quarantine period.

Budwood from accessions held in the quarantine collection has been exported to over 20 institutes covering all of the main cocoa-growing regions. These include all the principle cocoa-growing countries and also newly emerging producers such as Vietnam and Tanzania. The project has also played a major role (alongside CIRAD) in providing material for the International Clonal Trial established as part of the CFC/ICCO/IPGRI (Common Fund for Commodities/ International Cocoa Organization/ International Plant Genetic Resources Institute) project on cocoa germplasm utilisation and conservation.

The Way Forward

In the last few years we have adopted an active management policy for maintaining and increasing the genotypes held at Reading. We are engaged with the main national and international germplasm collections to select genotypes, which have known desirable traits or are genetically distinct, for the quarantine collection. The establishment of the 'CFC collection',

Intermediate quarantine at Reading for:

- Safe international movement of germplasm
- Provision of germplasm for international projects
- Development of new virus detection techniques
- Better awareness and delivery of what is available

115 genotypes known to have superior yield, quality and disease resistance traits, has been a particular recent focus for the quarantine facility at Reading. We are also assessing the volume of germplasm that we are holding in our established collection. Whilst there has been a high demand for many accessions, a minority have received very little interest. In some cases, this may be due to a general lack of awareness of them. We are therefore planning in future to circulate to centres that import material from Reading detailed information concerning these genotypes to encourage adoption into cocoa breeding programmes. On the other hand, we also wish to determine 'redundancy' in the collection since there is no need, in a working collection such as this, to have genotypes that have no practical use to the end-user. To this end, accessions that have been shown, using genetic fingerprinting, to be duplicates have been removed and the practical value of all the accessions in the collection is being actively assessed. It is hoped that the development of cryo-preservation techniques at Reading will make such decisions easier in that material currently considered of little value or demand could be cryogenically stored and re-activated if needed in the future.

In terms of the broader programme of cocoa-related activities, the quarantine facility initially came to Reading because research on cocoa physiology was underway here during that period. Over time, the situation has turned full circle so that the quarantine facility itself now provides material for a wide range of research on physiology, genetics, pathology and somatic embryogenesis.



The propagation compartment of the University of Reading Intermediate Cocoa Quarantine Facility



In conclusion, the University of Reading Intermediate Cocoa Quarantine Facility has been, and continues to be, pivotal in international germplasm movement as well as being central to much of the cocoa-based research at Reading.

By Andrew Daymond and Paul Hadley

Funding for the quarantine facility is primarily from BCCCA (Biscuit, Cake, Chocolate and Confectionery Association) and Masterfoods with co-funding from CFC.

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The MycoHarvester: Improving Delivery Systems for *Trichoderma*

The search for pest control solutions includes working with fungal agents that antagonise fungal pathogens in various ways but may have characteristics that are novel to mycopesticide developers. A number of isolates in the fungal genus *Trichoderma* show promise for the management of intractable cocoa diseases such as witches' broom and frosty pod rot (caused by *Crinipellis pernicioso* and *C. royeri*, respectively). In *GRO-Cocoa* No.4, Gary Samuels (*Trichoderma*: a taxonomist reports) described how, although the genus *Trichoderma* is widely known, a number of the species appear to be specific and previously unknown to science, and amongst the potential biological control agents for witches' broom disease are a number of isolates of *T. stromaticum*. The exploitation of these fungi will require intelligent manipulation between field and laboratory (or production facility), but there are an increasing number of 'enabling techniques', which have been placed in the public domain, which will assist with the exploitation of these organisms.

A commercial formulation of *T. stromaticum*, 'Tricovab', has been developed by the Biocontrol Unit of CEPLAC (Comissão



The project team included (from left to right): the author; Prakash Hebbar, Masterfoods/USDA; Givaldo Niella, Director, CEPLAC Biocontrol Unit; Uilson Lopes, Director CEPLAC and Alan Pomella, Masterfoods, Almirante Cacau. The newly installed MycoHarvester behind shows the substrate agitating drum (left) and the extractor fan unit (right)

Executiva do Plano da Lavoura Cacaueira), Itabuna, Brazil, and is available for control of witches' broom disease. Research is ongoing to optimise isolates and delivery systems for the hyperparasite, some isolates of which are known to be endophytic. Tricovab is typically sprayed onto cocoa as a mycopesticide to achieve what has been called 'biological broom pruning'. Unfortunately, as its name suggests, spores of *T. stromaticum* are clumped together as 0.5-2 mm stromata, which do not distribute evenly in spray droplet spectra. The existing formulation also contains ground-up substrate (rice) which may cause nozzle and filter blockages. A further problem has been difficulty in controlling the moisture content of the formulation (rice is hygroscopic) and this factor is known to influence the storage stability of mycopesticide products.

The 'MycoHarvester' is a device designed to harvest fungal spores safely and efficiently from a solid substrate. It is suitable for a number of powdery fungi used in mycopesticide products, concentrating conidia in a form that is easy to desiccate and package. Experience in the successful international LUBILOSA (Lutte Biologique Contre les Locustes et les Sauteriaux) programme, where *Metarhizium anisopliae* is used for locust control, has shown that this is a key process in the development of commercially acceptable mycopesticides. CABI Bioscience has distributed around 35 laboratory-scale machines throughout the world, and we know that research groups have used them to extract spores of at least five *Trichoderma* species.

Using 'Diclone' technology developed by ACIS R&D of Devon, UK, the MH3 is a large-scale version of the MycoHarvester, developed for pilot/commercial production. With generous funding from Masterfoods and USDA (US Department of Agriculture), a unit was installed at the Tricovab production facility at CEPLAC early in 2004. The work included fabrication of a drum for churning the rice substrate at a local metal works (Itametal). The feasibility of this technique had been assessed previously at IPARC (International Pesticide Application Research Centre) in the UK, using a pilot-scale machine. Subsequent particle size analyses showed that scale-up resulted in little loss of particle quality. The stromata are broken up into individual conidia (median particle size = 7µm) ready for formulation and trouble-free application. Unlike the laboratory-scale models, the MH3 can process 0.5 tonnes of grain substrate per day, as a two person operation. Further technical information is available on www.mycoharvester.info



Trichoderma stromaticum as a fine powder product showing MycoHarvester Diclone units in the background (Roy Bateman)

Reducing *T. stromaticum* to a pure powder creates a number of opportunities including accurate dosage control, improved packaging and improved control of product moisture content, leading we hope to enhanced shelf-life of the product. Conversion of stromata into a single-spore preparation also enables the development of improved, 'user friendly' formulations that can be applied in a similar manner to - and thus complement better - conventional pesticides. The new Tricovab formulation is already available, packaged in 40 g sachets, which is a suitable amount for treating 1 ha. It has been further validated in commercial cocoa, located at CEPLAC's experimental station, *Joaquin Bahiana*. This trial, conducted by Almirante Cacau and CEPLAC, is partially funded by FAPESB (Fundação de Amparo à Pesquisa do Estado da Bahia) and FINEP (Financiadora de Estudos e Projetos), which are respectively the state and federal government agencies for supporting research. Following four sprays of the product, brooms colonised by *T. stromaticum* increased from 0% to 63% in treated plots.

The whole project (described as the *Plataforma Cacau* in Brazil) has also been an excellent example of international collaboration, involving a number of institutions from both the public and private sectors.

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Methods Make a Difference

Recognition of the need for effective communication of research results to farmers has highlighted the importance of methods. In June, a Sustainable Tree Crops Program (STCP) Master Trainer Workshop was organised by Sonii David at Kumasi in Ghana. It examined the potential of a number of innovative tools and mechanisms for sharing knowledge across cultural and educational barriers. STCP is managed by the International Institute of Tropical Agriculture (IITA). Participants from STCP pilot projects in Ghana, Côte d'Ivoire, Nigeria and Cameroon considered both FFS (Farmer Field School) and post-FFS activities.

Addressing Perennial Issues

The FFS approach was introduced to Africa in the mid 1990s, and currently there are pilot FFS programmes in over a dozen countries throughout the continent. However, there is relatively little experience worldwide with conducting FFS on perennial crops such as cocoa. During the workshop, participants discussed how to adapt the conventional FFS approach and training methods to cocoa. Training master trainers for FFS with annual crops typically involves sessions spanning several seasons, not feasible when dealing with a perennial crop. An important output of the workshop was developing approaches for training cocoa FFS master trainers. Participants endorsed a two-session 30-day training period for new master trainers followed by practical training that consists of conducting one full cycle of FFSs supervised by an experienced master trainer.

Models to Follow

Although sections of the cocoa community are familiar with participatory activities in the form of FFSs and FPR (Farmer Participatory Research), it is often not clear how these might be coordinated to optimise the quality of farmer training. At the workshop, a session facilitated by Janny Vos (CABI Bioscience) focused on introducing and explaining the essential steps of FPR. Following from this, she developed a conceptual and methodological connection between FFS methodologies, with which the master trainers already were familiar, and post-FFS activities focusing on unresolved problems, which FPR is essentially aimed at. FFS thinking and implementation characteristics were portrayed as a learning process which can be carried on post-FFS as FPR, a valuable concept which can help other organisations trying to develop such activities.

Moving from theoretical to real models, Nick Nathaniels (CABI Bioscience) demonstrated a practical 3-D cocoa modelling tool, which helps researchers/facilitators and farmers/community members understand and share insights on specific crop management actions and options. Participants practised building and using the model to show (i) how crowded heavily shaded trees can be altered to let in more light and minimise blackpod (*Phytophthora*) and improve general yield and (ii) how sudden gaps in the cocoa canopy encourage suckering (chupons), and associated mirid 'hotspots'; these can be spot treated with insecticides but can also be rapidly shaded again by planting quick-growing temporary shade plants such as plantain.

Wide Field Focus

The workshop included an excellent field visit to Sri Boso village close to Kumasi, where participants met with STCP's FFS-trained farmers and practised using modelling and other tools to explore the reasons and requirements for FPR. Andrews Akrofi and Joseph Sarfo from the Cocoa Research Institute of Ghana (CRIG) facilitated the field visit which focussed on the use of pheromone traps for mirid control, an activity being undertaken in Ghana by STCP, CRIG and NRI (Natural Resources Institute, UK) with funding from DFID (UK Department for International Development).

The visit underlined how farmers' views and understanding can best be drawn out by using a range of methods.

Transfer of technology from the lab to the field is not a one-way process, and Peter van Grinsven of Masterfoods (one of the chocolate companies that supports STCP) emphasised the importance of feeding back information. Sharing his extensive knowledge of cocoa pod quality and health status, he explained the scope and kind of cocoa tree production performance data needed to document the quantitative results of cocoa FFS.

Caught on Camera

A critical obstacle to a participatory approach is scaling up. One idea introduced by Janny Vos and Nick Nathaniels to STCP was whether an award-winning participatory video knowledge-sharing approach used by CABI Bioscience for rice farmers in Bangladesh could be applied in smallholder cocoa. Discussions with STCP and chocolate industry resource people led to a project being formulated to develop participatory videos on key cocoa management problems, initially for Ghana, and start-up funding was subsequently secured.



Workshop participants practised using the 3-D model to explore cocoa management options (Sonii David)

Since then, a team of two local media organisations in Ghana, STCP and Nick Nathaniels have met and identified an interested cocoa farming community, farmers who have taken part in active 'hands on' learning activities in the FFSs facilitated by STCP. The team has invited them to consider whether and how a video made by the community could assist them and other farmers to improve their lives. The next step is to train the selected farmer video team. They will then go on to play leading roles in making and editing the videos, each of which will address one topic, also drawing on other farmers' testimonials as well as that of various resource people from within and outside their communities. The initiative is fully supported by CRIG who will be providing technical advisors for the productions. The videos will be pre-tested in several cocoa-growing communities before final editing, and then made available through existing programmes and channels from TV to DVD machines owned by chiefs and other local leaders, NGOs, and development programmes.

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The field trip during the workshop was an opportunity to meet FFS-trained farmers and practise using modelling and other tools to enhance discussions on FPR (Sonii David)



Dates for your Diary

15th ICRC in Costa Rica

The 15th International Cocoa Research Conference (ICRC) will take place in San José, Costa Rica on 9–14 October 2006. Organised by the Cocoa Producers' Alliance (COPAL), the theme is 'Cocoa productivity, quality, profitability, human health and the environment.'

Contact: Cocoa Producers' Alliance, National Assembly Complex, Tafawa Balewa Square, PO Box 1718, Lagos, Nigeria

Email: 15icrc@copal-cpa.org

Fax: +234 1 263 5684

Web: www.copal-cpa.org

Malaysian International Cocoa Fair

This meeting, organised by the Malaysian Cocoa Board with the theme 'Sustainable cocoa economy through increase in productivity, efficiency and quality', will be held at Selangor on 15–19 July 2005, and is for all stakeholders in the cocoa sector. Meetings include the Malaysian International Cocoa Exhibition, Malaysian International Cocoa Research Conference, and Malaysian International Cocoa Dinner.

Contact: Secretariat, c/o Malaysian Cocoa Board, 5th & 6th Floor Wisma SEDCO, Locked Bag 211, 88999 Kota Kinabalu, Sabah, Malaysia

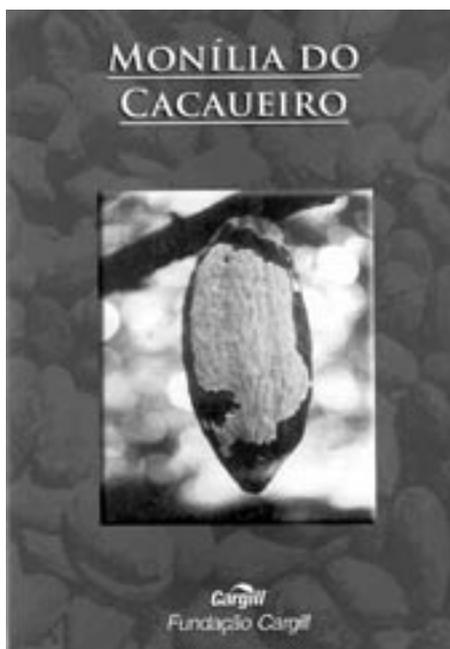
Email: micf05@koko.gov.my / norhaini@koko.gov.my [exhibition] / kelvin@koko.gov.my [conference] / omar@koko.gov.my [dinner]
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Publications

Frosty Pod Manual

This publication, in Portuguese, highlights the threat posed by *Crinipellis (=Monilophthora) roreri* - the causal agent of frosty pod rot disease, to cocoa cultivation in Brazil - in order to raise awareness about the disease. It addresses this through a technical bulletin aimed at both farmers and agricultural extensionists; and, thanks to the abundance of beautiful illustrations and clear diagrams, it will also find resonance with the relevant quarantine authorities, as well as the public in general. The taxonomy, biology and life-cycle of the pathogen are discussed, as well as the measures needed to keep the disease out, and to control it, if or when it arrives.

This handy, nicely-formatted publication achieves all the objectives outlined by the authors and, since the disease is on an extensive invasive front - threatening cocoa-growing countries in South, Central and North America, as well as in



the Caribbean - it would prove to be an even more useful document if a follow-up version were published in both English and Spanish.

Ram, A., Valle, R.R. & Arévalo-Gardini, E. (2004). *Monília do Cacaueiro*. Fundação Cargill, Sao Paulo, Brazil, 36 pp.

Contact: e.arevalo@ict.terra.co.pe

Also look out for:

Cocoa Futures

This source book of important issues facing the cocoa industry will be available in early 2005. To register interest, please email or write to the *GRO-Cocoa* editors. The book deals with major challenges facing stakeholders in the cocoa sector as they attempt to move the industry forward.

The 13 chapters cover genetics and breeding, crop production and protection, land and labour, training and diversification, and trade and market issues. While the book does not aim to be comprehensive, it does aim to stimulate discussion, with the ultimate objective of motivating the kinds of activities necessary to move towards a sustainable world cocoa economy and thus improve the quality of life for cocoa farming families.

Flood, J. & Murphy, R. (in press) *Cocoa futures*, CABI Commodities. 164 pp. Price UK£30.00.

The Genetic Diversity of Cacao and its Utilization

This book, due out in February 2005, provides a comprehensive review of our current knowledge of the diversity of *Cacao*, and discusses procedures for collecting and conserving it.

It examines the diversity and inheritance

of the characteristics of primitive populations in the Amazonian and Caribbean regions, then looks at the evolution of diversity within cultivated populations first in South America and around the Caribbean, and then beyond the Americas. It describes the inter-relationships between populations based on morphological and molecular markers. It also examines the conservation of genetic resources and how these genetic resources can be utilised to produce new cultivars

Bartley, B.G.D. (in press) *The genetic diversity of cacao and its utilization*. CABI Publishing, 368 pp. UK£75.00/US\$140.00.

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