CROP PROTECTION PROGRAMME

Implementation of Cocoa IPM in West Africa

R8313 (ZA0583)

FINAL TECHNICAL REPORT

1 April 2003 – 31 March 2005

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CABI Bioscience

Date FTR completed: 30 March 2005

"This publication is an output from a research project funded by the United Kingdom Department for International Development for the benefit of developing countries. The views expressed are not necessarily those of DFID." *[R8313, ZA0583]*

FINAL TECHNICAL REPORT

Executive Summary

This project evaluated and disseminated outputs from previous DFID-CPP - funded projects on cocoa IPM in a farmer participatory training and research programme carried out in four West African countries in collaboration with the Sustainable Tree Crops Programme (STCP). The project was implemented in partnership with STCP. Research activities included the development of a tailor-made farmer participatory learning curriculum for the extension of cocoa IPM in West Africa. The project played a major role in facilitating the start-up phase of Farmer Field School (FFS) activities and contributed a range of technical IPM bulletins and field guides, for use by farmer facilitators and master trainers. Models for optimising management inputs to cocoa production were adapted for cocoa production in West Africa. Additional modules relating climate to leaf flushing and to a variable range of shade were included, as these are critical parameters affecting incidence of the major West African cocoa pests, black pod and cocoa mirid. Farmers and trainers, including scientists from national cocoa research institutions, were trained and involved in farmer participatory research processes, using these to evaluate and adapt research outputs. The so-called Farmer Field Research (FFR) concentrated on black pod and mirid management. In Nigeria, FFR focused on improved spray application of fungicides, or Rational Pesticide Use (RPU) against black pod. In Cameroon, FFR evaluated biological control agents to manage black pod, alongside RPU of standard chemicals. In both cases, farmers highly appreciated the cost savings that could be made using more targeted (bio)pesticide application methods. In Ghana, FFR groups initiated the evaluation of use of pheromone traps in the search for improved management of cocoa mirids. The STCP regional team was supported through the facilitation of quality control of the farmer training and research activities. The STCP national teams supported the project through on-the-ground liaison with the national institutions and the field school facilitators and farmers. Moreover, the enthusiastically collaborating national scientists were instrumental in engaging the national institutions. Although formalising institutional agreements caused a delay in initiation of some FFR activities, the national institutions generally turned out to be highly supportive of the project concept and activities. Added value was achieved through the establishment of partnerships to pilot participatory video production, which is currently being implemented in Ghana with an industry co-funded DFID-CPP extension until January 2005. Although final impact data are not available yet, it is likely that the project contributed significantly to the sustainability of cocoa production by smallholders in West Africa. The project contributed to two of the DFID development goals. Poverty is reduced by improving the profitability of cocoa production in West Africa with reduced cost of inputs through minimised and more effective application of pesticides. Environmental sustainability is promoted through minimising and moreover replacing chemical pesticides with cultural and bio-rational methods for controlling the major cocoa pests in the region.

Background

Farmer participatory learning for cocoa IPM implementation
In 2002, a paper on more efficient knowledge transfer was prepared for the Global Cocoa Co-ordination Group. The paper (Vos *et al.*, 2002) concluded that more efficient transfer of technologies, or rather, knowledge transfer is needed to achieve higher efficiency of research efforts into sustainable cocoa production. It stipulated that the classical "top-down" manner of transferring blanket recommendations is being largely discarded with growing attention for farmer participatory models of knowledge dissemination and described examples of successful extension programmes following novel approaches to knowledge transfer in cocoa. The examples showed that farmer training should take a holistic approach to the farming system and that research needs to be focused on farmer problem-solving and developing effective research – extension – farmer partnerships.

Modelling of management inputs for cocoa production
In previous project work, funded by the DFID CPP and the cocoa industry, models of cocoa pest and disease management were produced for SE Asia and for Central America. These models are climate-driven, fruit-age-dependent cocoa production models in which cultural and other crop protection management practices can be tested to determine robust extension messages for farmers. Outputs are expressed in crop production cycles, damage levels, financial returns and marginal grower effort. The models are stochastic and allow dynamic risks due to pests, climate and prices to be assessed. The SE Asian cocoa model has been used as an extrapolation tool to convert intensive field experimental results into broad extension guidelines. It has also been the key tool for financial evaluation of a large-scale, field training programme using data from extensive monitoring of training sites. The Central American model was under evaluation for similar use in S America. Both models had common general features applicable to cocoa production in West Africa, but needed parameter values specific to West African conditions and could be adapted to specific management specifications relevant to the unique West African pest and disease problems and control options.

Spray application against black pod
In a previous DFID-CPP project (R7326), surveys showed that the recommended spray regime of metalaxyl + cuprous oxide was too expensive for typical smallholder cocoa growers and that many did not possess suitable equipment. Potassium phosphonate was shown to be a viable alternative that could potentially be cheaper. An important further finding was that spray equipment and procedures typically used for fungicides in Ghana resulted in huge wastage of material. With more toxic agents this could present health hazards to operators and significant environmental effects, and in all cases it means effective control is much more expensive than necessary. Simple modifications to equipment and procedures to avoid this wastage were developed. Similar work would be needed in other cocoa producing countries in the region where similar pesticide abuse was observed.

Biological control agents against black pod
At the West African Regional Cocoa IPM Workshop held in Benin in November 2001, several participants called for the use of biological control as part of an integrated approach to controlling black pod as has been done in other cocoa countries (Krauss and Soberanis, 1998) especially using locally isolated antagonists (Holmes & Flood, 2002). Investigations of indigenous biocontrol agents were taking place in 2003 in Cameroon (Tondje et al, 2002), in Cote d'Ivoire (Kebe et al , 2002) and in Ghana (Padi et al, 2002) with a view to augmentative biological control. Collections and surveys had been conducted throughout the region and a number of antagonists

including *Trichoderma* species have been isolated. Also, in vitro and in vivo trials were initiated and successful agents needed to be tested by farmers as part of an integrated management approach.

Pheromones of cocoa mirids
In a previous project (R7249), evidence was obtained for production of sex pheromones by both of the main mirid species in Ghana, *Distantiella theobroma* and *Sahlbergella singularis*, in that traps baited with virgin females attracted males of the same species (Padi *et al*., 2000). Analysis of volatiles produced by the females led to isolation, identification and synthesis of two components that elicited electroantennographic (EAG) responses from the antennae of males of the same species. Apparently both compounds were produced by both species, but the amounts present were extremely small, and it was not possible to determine the relative amounts of these. In field testing, males of *S. singularis* were attracted to traps baited with blends of the two components. Some *D. theobroma* males were caught, but populations of this species were too low in the trial areas to obtain significant results (Padi *et al*., 2002). An effective trap design was developed and trap height optimised, but trap catches were still very variable. Further work was needed to optimise and evaluate the use of pheromone traps at farmer level.

Partnership of programmes
The Sustainable Tree Crops Programme (STCP) was created in 1998 by USAID and industry to achieve a shared vision for sustainable tree crop development. It is a Public-Private Partnership between industry, producers, researchers, government agencies, public sector institutions and conservation groups. The STCP program started with pilot implementation activities early 2002, which almost coincided the start of this project. The collaboration was sought for the project to assist STCP with their curriculum development and participatory technology development work and for the project to be part of a larger framework allowing for a unique cooperation and coordination of field activities among all partners involved.

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Project Purpose

The purpose of the project was the promotion of strategies to reduce the impact of pests and stabilise productivity of tree crops important to livelihood security of poor people in Forest Agriculture systems. The new knowledge sought concentrated on innovative ways of facilitating uptake and adoption by farmers of cocoa IPM measures in West Africa.

Research Activities

1.1 Compile, validate and adapt participatory exercises relevant to black pod and mirid management

A wide range of participatory exercises was compiled and validated with master trainers and farmers during curriculum development workshops and in pilot farmer field schools. Many of these were written up in straightforward protocols and included in the Discovery Learning about Cocoa manual, which was agreed to become the base curriculum for the STCP master trainers. From there local adaptation and expansion of the curriculum has taken place, which have been documented in workshop reports as well as in the recently disseminated STCP cocoa manual (also see under 1.3).

1.2 Prepare and validate model for optimising management inputs for cocoa in West Africa

A model was prepared to develop a virtual 1 ha cocoa grove into which the population dynamics and epidemiology of pests can be introduced. Several modules of the finished model were developed including a shade module that will allow the user to explore how the intensity of the shade (3 levels) and gappiness (2 levels) impact on three primary pests of Ghanaian cocoa; mirids and two *Phytophthora* species. The gappiness aspect of shade allows the mirid population model to be compartmentalised for an improved description of population dynamics and management. Shade intensity has impacts on all three species but most importantly for the two *Phytophthora* species. This module will allow the user to simulate shade management and to assess the costs and benefits that shade manipulation may have to farmers. Climate-based vegetative flushing models have been developed which are relevant to the population dynamics of pest populations. Flush initiation is simulated by the model at the cessation of inhibitory climatic factors based on historical weather data. The most important inhibitory factors to vegetative flushing are drought and low temperatures and the model regulates the size of the flush that is proportional to the time since the last flush. The flush model also interacts with flower setting and cherelle wilts in the age-structured pod model that interacts with the flush model when large numbers of rapidly growing pods (90 days to 120 days old) inhibit the size climate-induced flushes. “Crazy” flowering is generated by the same rules as for the flush module while “normal” flowering is initiated by the production of metabolites generated from new flushes. The model simulates this start of “normal” floration as occurring at a fixed time after a leaf-hardening period following a new vegetative flush. It is expected that, by including these phenological aspects, different varietal responses to climatic and phenological cues will improve the value of the model.

1.3 Compile training modules into West African cocoa IPM training manual with STCP
The project developed IPM technical bulletins for the major cocoa pests in the region, to be translated into French and handed out to farmer trainers as information leaflets. The project also contributed to exercise protocols and advisory documents, especially on rational pesticide use and testing biocontrol agents. Through workshop participation and facilitation, further documentation of participatory training processes and methods were realised and made available to trainers within STCP. All these guidelines will be bundled into the STCP manual (in English and French) ‘Learning about sustainable cocoa production: a guide for participatory farmer training’ which is being disseminated through internet (posted on website www.treecrops.org in March 2005). The manual has technical bulletins, discovery learning exercises, and field guides, many of which were delivered to STCP by the project.

2.1 Backstop the STCP regional knowledge transfer specialist to assure quality in training process and content
Through active participation and facilitation of workshops as well as e-mail contact, the STCP knowledge transfer specialist was supported in the first phase of initiating farmer participatory training activities in awareness raising, planning and curriculum development workshops, as well as over the course of the project in advising on initiation of participatory research activities as well as feeding information on impact assessment, self-financing field schools, simplified statistics, etc. The project also made a start working on documenting farmer innovations and experiences within the STCP context and with various other stakeholders through participatory video production, so that these experiences can be disseminated more widely than only to farmers participating in field schools.

2.2 Backstop the STCP in participatory technology development with farmers setting the research agenda
Farmer field research activities were supported in Nigeria, Cameroon and Ghana, on issues of interest to both the farmer and scientist communities. This collaboration was channelled directly through Cocoa Research Institute Nigeria (CRIN) in Nigeria, Institute of Agricultural Research for Development (IRAD) in Cameroon and Cocoa Research Institute Ghana (CRIG) in Ghana. In a 2004 workshop in Ghana, STCP master trainers were trained to facilitate Farmer Field Research (FFR) and from then an action plan was agreed for activities in those three countries. In Nigeria, the focus was on black pod control using rational pesticide use to seek an improvement on the current situation of self-made fungicides applied with trombone sprayers, in Cameroon farmers were involved in the evaluation of biological control agents in the search for more effective management of black pod, in Ghana farmers worked with scientists to evaluate the use of mirid pheromones to look for innovative ways of avoiding mirid damage during peak seasons.

3.1 Backstop STCP in participatory technology development for spray application techniques

Spray application techniques were investigated in participatory research with scientists and farmers in Nigeria and Cameroon. In Nigeria, working with CRIN, the focus was on making improvements to the conventional spray equipment to improve the targeting of fungicide and to reduce fungicide waste, thereby reducing environmental pollution. Twenty farmers over four sites collaborated in the Nigeria FFR that concentrated on testing pressurised knapsack sprayers fitted with 'cocoa-nozzles' versus the conventional trombone sprayer, using 100 trees divided over 2 experimental plots per site. As learnt through the FFS, farmers used spot application in both treatments rather than the full field application that they used to do prior to the FFS. In Cameroon, working with IRAD, the focus was on applying a biological control agent, and comparing this to improved application methods of regular fungicides. Six farmers were trained up as research-partners and took the lead in setting up field trials and gathering data. Three experiments were done using 400 cocoa trees for each experiment. Both scientists and farmers have reported enthusiastically about the scientist-farmer collaboration. The work resulted in improved farmer understanding of the importance of spray equipment in securing impact of their pesticide applications, and improved scientist understanding of real farmers' needs.

3.2 Advise on quality control and field testing of biological control agents and participatory evaluation for black pod control

Advisory visits were made to support the planning and design of protocols to test biological control agents with IRAD in Cameroon. Field application was carried out by technical assistants, using full protective clothing, whilst evaluation was done in close consultation with farmers. Farmers were most interested in the biological control methods, which scientists clarified using various participatory exercise protocols. Advice was given on mass production and quality control of efficacious agents and lab facilities needed. A future bottleneck in scaling-out biocontrol technologies could be encountered in the registration of successful biocontrol agents, as has been experienced before in West African countries. IRAD has been made aware of this potential obstacle.

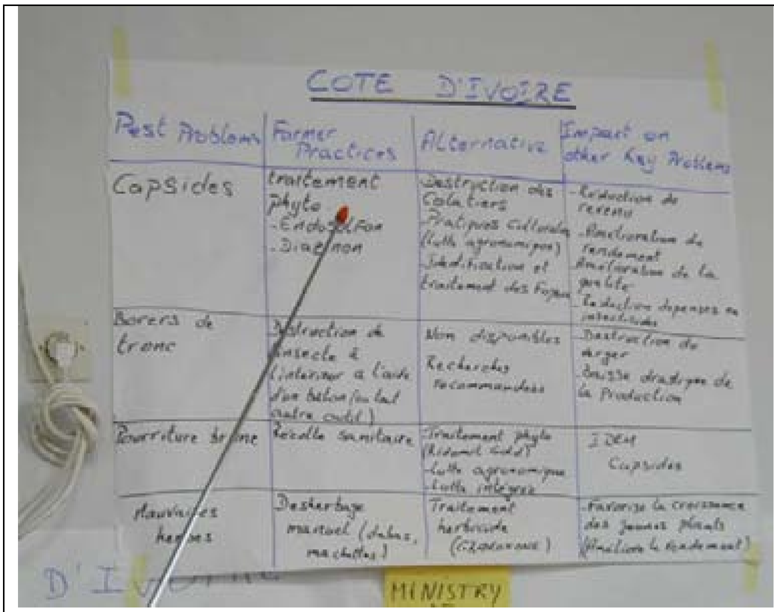
3.3 Optimise mirid pheromone lures and carry out farmer participatory evaluation of pheromones in management of cocoa mirids

Lures and materials for traps were sent to CRIG for further validation experiments. Lures included 2,500 standard lures, lures for two pheromone blend experiments, lures for a pheromone loading experiment and a new type of controlled release device for the pheromone developed at NRI. Trap materials included 100 sheets of corrugated plastic sheet and 50 tubes of polybutene adhesive, as well as 50 standard delta traps. Experiments were set up by CRIG staff on the CRIG station and included comparison of five different pheromone blends, comparison of three different pheromone loadings, an experiment to investigate the effect of lure ageing an a comparison of six different trap designs. Traps were spaced 20 m apart and there were five replicates of each treatment. An experiment was also set up to examine the effect on catches of trap density using 0.25 acre plots with 20, 40 or 60 traps per acre. Farmer field research was initiated rather late in the project life-time due to the delay in formalising the CRIG collaborative agreement. However, this has now been secured and is in progress in collaboration with the STCP and also at two other sites regularly used by CRIG for farmer extension.

Outputs

1. Farmer participatory learning curriculum for cocoa IPM in West Africa developed

Two field school planning and curriculum development workshops were facilitated by the project to raise awareness on the preparation needs prior to starting farmer field schools and to guide exercise development. An awareness raising paper was presented at an international workshop to summarise training experiences and highlight the needs for appropriate training methods in cocoa IPM.



Problem analysis during awareness raising and planning workshop, Cameroon, photo J. Gockowski

Validating spray dye exercise during curriculum development workshop, Cameroon, photo J. Vos

The recently (March 2005) web-posted STCP training manual contains 8 technical bulletins that were contributed by the project:

- Black pod disease
- Swollen shoot virus
- Mirids
- Stem borer
- Termites
- Rodents
- Mistletoe
- Rational pesticide use

The STCP training manual also contains at least 18 validated discovery-learning exercises that were derived from project delivered base material:

- Cropping calendar
- Ballot box
- Agro-ecosystem analysis
- Pruning and shading
- 4 black pod exercises
- 4 insect zoo exercises

- 6 rational pesticide use exercises

The project has also contributed comments to further STCP manual elements, such as the curriculum for training cocoa farmer field school facilitators that will be added in due course.

The participatory technology development work by the project was re-named Farmer Field Research (FFR) to emphasise the process of farmer participatory training being followed by farmer participatory research. In other words, the FFR was implemented as a post-Farmer Field School follow-up activity with FFS graduated farmers capable of systematic observing and monitoring. Case studies covering the experiences in the three countries where FFR was implemented (Cameroon, Ghana, Nigeria) are under preparation. It is planned that these will be written up collectively into a scientific paper on FFR for sustainable cocoa production. A further 2 papers will be produced on the Nigeria FFR work by the Cocoa Research Institute Nigeria for publication in national journals and the same can be expected in Cameroon and Ghana.

Farmer Field School farmers and Farmer Facilitator in Ghana, photo J. Vos

A model for cocoa production has been prepared. The model contains modules that relate weather conditions, particularly the onset of rains, to flowering and thus to subsequent fruit development. Other components of the model include shade effects on fruit production and harvesting impacts, both on the physiology of the tree and on the economics of production. Overall the model is aimed at providing a basic framework to produce representations of the dynamics of the age structure of pods and leaf flushes throughout a season based on immediate weather inputs and long-term weather values for the remainder of a season. The pod and leaf dynamics drive the ecology of pod and leaf pests and diseases. Two important cultural management options, harvesting (intensity and frequency) and the degree of shade, can be manipulated to show direct effects on pod and leaf dynamics and indirectly effects on pod diseases and leaf/pod insects. Some varietal factors, such as fruit carrying capacity and flowering response to rain can also be examined. The model has been validated logically, but will need field verification, which will require data from several seasons and locations in W Africa. In the meantime, it can be used for hypothesis generation on control relationships and control economics. The model will be available on CD-ROM to the four project partner institutions in West Africa. Field validation will be undertaken with interested collaborators. Papers will be presented at an international cocoa conference and an international cocoa meeting later this year.

2. Farmers trained and involved in participatory technology development

Over the project period, STCP implemented Farmer Field Schools in pilot areas using the jointly developed curriculum in Cameroon, Cote d'Ivoire, Ghana and Nigeria. In 2003, a total of 160 FFS were implemented, training 3734 farmers. In 2004, 127 FFS were conducted for 3780 farmers. In total, 132 farmer facilitators were trained in the region, although not all received certificates of performance. Preliminary STCP impact data show that in Cameroon, inputs costs pre- and post-FFS remained unchanged but shifted from being used for pesticides and application to labour for pruning, phytosanitary harvest and shade adjustments. In this respect it needs to be noted though that the cocoa farms subject to FFS were relatively old and poorly maintained groves. In such a situation, any first year of proper pruning requires significantly more labour than the so-called maintenance pruning of properly maintained cocoa groves. Therefore it is expected that in the long run, overall input costs will come down. Final production data for evaluation of outputs are being awaited.

Farmer Field Research farmers and CRIN scientists in Nigeria, photo J. Vos

In an effort to explore options for piloting a scaling-out method, capturing farmer field school graduates' experiences and lessons from FFS on film – a start-up meeting was organised and facilitated in Ghana. This led to successful buy-in by a range of project and non-project partners and subsequent, separately funded project activities were implemented. It is expected that many more cocoa farmers will be reached using such extension videos than through FFS alone.

To support the development of participatory technology development / FFR, an orientation workshop for STCP master trainers was facilitated. Master trainers thereafter were equipped with the tools to facilitate FFR implementation in each project country.

FFR work plans were developed by the national cocoa research institutions in Cameroon, Ghana and Nigeria. This consultative process, within which STCP as the facilitating platform on-the-ground was to play a prominent role, took much longer than expected causing a delay in implementation of work plans. Notwithstanding, there has been particularly good progress in Cameroon and Nigeria, where two sets of guidelines and two discussion papers were prepared jointly with collaborative national cocoa research institutions to support the work on rational (bio-)pesticide use to manage black pod (specifically implemented in Nigeria and Cameroon). Unfortunately in Ghana, work started late due to a delay in the cocoa authorities' approval of the institutional agreements that needed to facilitate the work. Implementation is however still expected under the project extension.

In both Cameroon and Nigeria, national scientists and farmer groups have expressed the desire to continue the FFR work for another season for two reasons: (1) combining the tested technology with rigorous implementation of cultural practices, especially pruning – i.e. further farmer participatory research; (2) involving more farmers so that more farmers will start using the tested technology – i.e. further farmer participatory training. Funds are being sought to facilitate this activity.

3. New IPM knowledge from previous research effectively evaluated by farmers and disseminated

A scientific paper was presented at an international cocoa IPM workshop outlining the state-of-play regarding the development of cocoa mirid pheromone traps in Ghana, being the basis for the Farmer Field Research planned under the project.

Priming a trombone sprayer prior to application, Nigeria, photo by R. Bateman	***Testing the trombone sprayer, Nigeria, photo by J. Vos***

Pesticide use and application was documented in two project visit reports (one on Cameroon, one on Nigeria), which complemented available STCP survey information on pesticide use in the project countries.

In Nigeria, discussions with farmers led to the following ranking of lessons learnt through the FFR:

Lessons learnt	**Ranking**		
	Lloro village (1 FFR site)	**Bamikeme village (2 FFR sites)**	**Wasimi village (1 FFR site)**
Reduced amount of pesticide needed	1	3	5
Higher income	2		
Pruning	3	4	2
Sanitary harvest of infected cocoa pods & burying those	4	6 & 7	1 & 9
Less run-off of pesticide – more efficient application		1	6
Reduction of black pod incidence		2	
Reduced labour costs		5	
Reduced negative impact of spray application on cocoa roots (less run-off)		8	
Reduced incidence of epiphytes and mosses on tree trunk		9	
With knapsack sprayer can't reach high up in the canopy			3
Interval of spraying 2 weeks			4
Reduced amount of water needed			7

Appreciate need to have good aeration of farm up until high into the canopy (combination of pruning and shade management)			8

Whilst unrealistic to average these ranking data, the above table shows what farmers have learnt from implementing RPU (in no specific order):

1. They have saved input costs (reduced amount of pesticide needed, labour costs, amount of water)
2. They have learnt specific skills (pruning, sanitary harvest and burying of black pod diseased pods, interval spraying 2 weeks, get good aeration in farm)
3. They have achieved improved impact on the biological target (less run-off of pesticide, reduced incidence of black pod, reduced negative impact of pesticides on the ecosystem)

The table also includes a problem with the adapted spray technology, namely that the black pod infected pods high up in the cocoa canopy could not be reached. Simple extension lances would mitigate this problem, however it is a fact that cocoa farms where the FFR took place were not well pruned nor thinned in the past. As a result, the cocoa tree architecture is too lanky, which would need addressing in any follow-up. Yield data are currently being analysed by CRIN and shared with farmers to complete the evaluation and build a work plan for continuation of FFR (pending availability of additional funding sources).

In Cameroon the FFR work contributed to the development of RPU protocols mentioned under (1) and used by STCP in farmer field schools. Participating farmers were able to improve the efficacy of black pod management through optimised pesticide application. Farmers could reduce the number of fungicide applications from the conventional range of 8 – 12 applications to a mere 4 applications in one season, achieving comparable black pod control. Using extension lances, locally available, fitted to conventional knapsack sprayers, allowed farmers to achieve similar protection from black pod when compared to application using expensive motorised mist blowers that are known to achieve most effective protection.

Demonstrating run-off with a conventional, high volume, variable cone nozzle, Cameroon, photo by R. Bateman

Targeted spray without run-off using the 'Cocoa Pod Nozzle', Cameroon, photo by R. Bateman

The biocontrol development work in Cameroon highly enthused farmers. Data are being analysed by IRAD, but from visual observations both farmers and scientists seem convinced that the biocontrol agent protects cocoa pods better than the chemical standard. In fact, the farmers' impression is that the biocontrol agent effectively stops black pod development on pods, having a major impact on slowing down the epidemic of this devastating disease. Towards the end of the FFR season, participating farmers (unlike in Nigeria or Ghana, FFR farmers in Cameroon had not previously been involved in FFS and had to be trained over the course of the FFR using specific black pod training exercises) urged STCP to conduct FFS in their community, indicating that indeed this kind of work addresses the cocoa farming community's needs and priorities.

Both CRIN (Nigeria) and IRAD (Cameroon) have expressed their appreciation for the FFR processes used. Both CRIN and IRAD saw the FFR as a great stride towards more effective farmer take-up of research outputs. IRAD has indicated that in fact this project has functioned as a bridge between farmers and the STCP pilot project for the implementation of biological control agents in the upcoming cocoa season. Scientific papers are being drafted on the experiences of FFR evaluating pesticide application in Cameroon and Nigeria, but can't be completed until all data have been analysed and evaluated with farmers (still on-going). The aim is for IRAD and CRIN respectively to present these case studies at a future international cocoa conference. In both countries, there is a felt need to extend the FFR for another season to secure more reliable data and extend the work to more farmers, eventually leading to increased uptake of the new technologies and methods used.

In collaboration with CRIG in Ghana, pheromone blends and trap designs were optimised for the main mirid species in Ghana, *Sahlbergella singularis* (Appendix 1). Comparison of the attractiveness of a range of blends of the diester and monoester pheromone components showed no significant differences in catches between any of the blends containing the diester with varying amounts of the monoester ($P>0.05$), although catches with the monoester alone were lower. Comparison of six different trap designs showed no significant differences in catches because of the great variability in catches with time and location ($P>0.05$). Highest catches were obtained in the locally made white "new rectangular trap" and the commercially available white delta trap. Experiments to investigate the effect of pheromone loading and the longevity of the lures were set up in October 2004, and results are being awaited from CRIG.

In the course of these experiments it was shown that lures last for at least six months in the field and traps can be used for several seasons with little maintenance. Monitoring with these traps showed that significant populations of mirids are present well outside the generally perceived 'mirid season' of August-December, which will be an important finding for farmers as this will change the farmer perception that management is only needed during the 'mirid season'.

CRIG scientists explaining about mirid pheromone traps with farmers, Ghana, photo J. Vos

Preliminary trials were set up to investigate using the traps for mirid management through monitoring and mass trapping in farmers' fields at three different trap densities. Significantly fewer ($P<0.05$) mirids were caught per trap in the plots with 60 traps per acre relative to plots with 40 traps/acre or 20 traps/acre. This result suggests that there was indeed some trapping out effect or communication disruption at the higher density. However, results showed little evidence for reduction in mirid numbers or damage, probably due, at least in part, to the small scale of the experiments.

Contribution of Outputs to developmental impact

This project has contributed towards two DFID developmental goals: Poverty alleviation and sustainable environment. The exercise development work promotes cultural practices and alerts farmers regarding the negative side-effects of chemical pesticides on their health as well as the environment (especially on the natural enemies). Although thus far only preliminary survey cost-benefit analyses are available from STCP, farmers appear to be saving costs on chemical pest management once they have been trained in FFS. Preliminary results show, e.g. in Cameroon, a significant decline in input costs of fungicides purchase and applications. Cost reduction improves smallholder livelihood security, provided that production outputs remain the same or are improved. STCP is currently in the process of gathering, analysing and publishing these important impact data. In terms of environmental impact, FFS promotes a shift from calendar-based application of chemical inputs to a crop-need-based regime of inputs. From experience, this tends to translate into reduced use of toxic chemicals and a reduced negative impact on the environment. The STCP will shortly produce a paper on the impact of FFS in the region.

The modelling work will in due course also contribute to saving costs, both in terms of smallholder inputs as well as in terms of the environment. Once the pest modules are incorporated, it will be possible to estimate net returns of various management activities not only for single pest species but also to help resolve IPM issues associated with managing a complex of pests (e.g. mirids and black pod) where management of one pest may have conflicting effects on the other.

The FFR work resulted in additional cost savings on chemical pesticide use and labour. In Nigeria, farmers argued that, as a result of FFR, they reduced their pesticide costs even further to another one-third. According to farmers, the impact of their changed application methods goes beyond the more efficient and improved pest management as there is far less run-off or 'waste' of pesticides into the environment. Farmers are expecting improved cocoa production and as such an improved income from cocoa production – final data are expected and will be used for publication.

The FFR work in Cameroon and Ghana resulted in farmers' appreciation of biorationals, giving them another tool in the basket to choose from rather than lean on chemical pest management alone. Using biocontrol in the management of black pod and pheromones in the management of mirids is expected to increase farmers' profit margins by reducing the use of chemical pesticides as well as improve ecological balance and biodiversity in the cocoa agro-ecosystem. In general, farmers and scientists involved in the FFR were enthusiastic about the approach and are planning follow-up activities with more farmers (pending availability of funds to support implementation). Project collaborators will produce various publications on the impact of FFR as well as look into scaling-out options using media in Nigeria, following results of the Ghana video initiative started by the project.

More farmers will be reached when the project extension will deliver the Ghana video episodes for wider extension use, beyond the STCP pilot areas. This extension project "Implementation of Cocoa IPM in West Africa" (R8313; April 2005 – December 2005) will follow up on the activities hereby reported. Taking the achieved outputs of R8313 thus far as its starting point, the extension project focuses specifically on exploring participatory video as a tool for consolidation and sharing of IPM lessons from cocoa FFS, and on making the benefits of cocoa mirid pheromone research available to a wider cocoa growing public. In addition, video productions will be made on other pests and management issues. The videos will be used in extension and further Farmer Field School work in collaboration with the STCP.

The project extension will also seek to make the pheromone traps and lures locally available. This will be carried out in collaboration with CRIG and has been endorsed by MASDAR consultants carrying out an EU-funded programme attempting to improve the translation of CRIG research results into benefits for cocoa growers in Ghana and the Region.

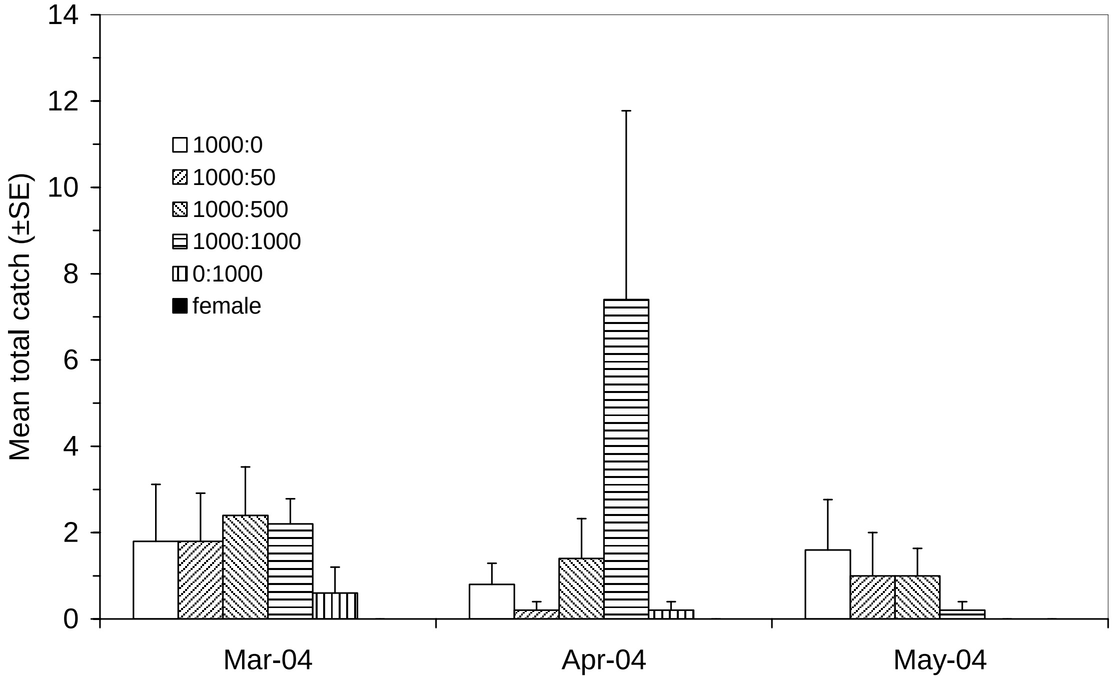
Biometricians Signature N.A.

Farmer field research studies were laid out using standard designs, which had been used before.

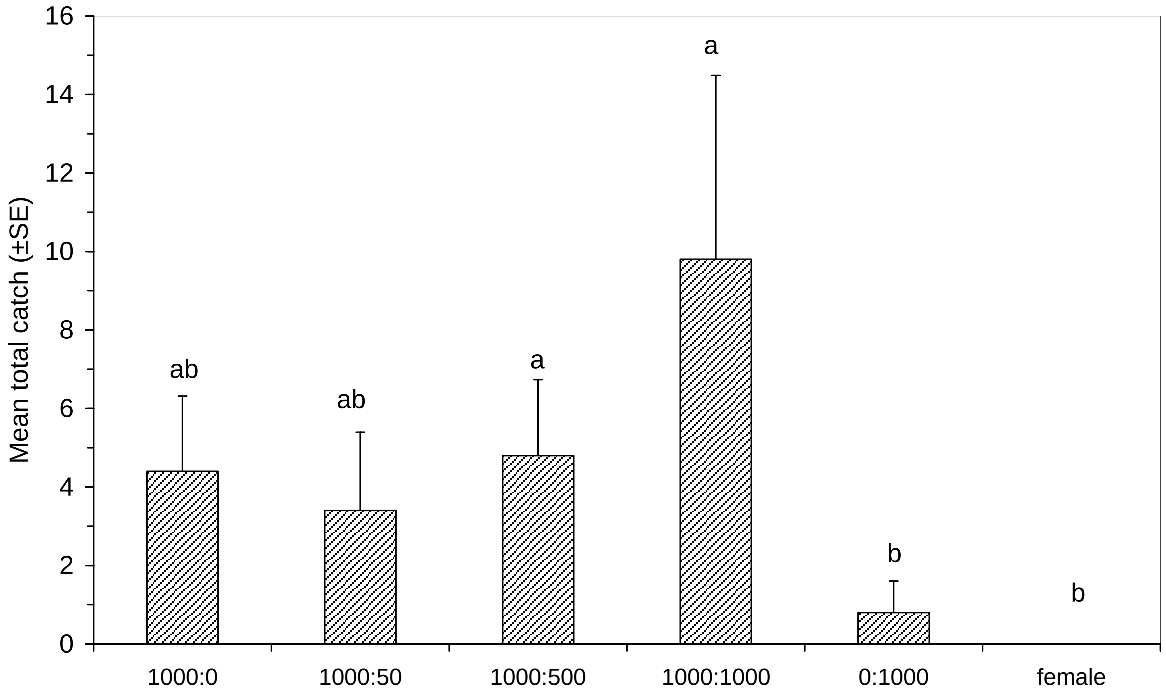
TRAPPING OF COCOA MIRID, *Sahlbergella singularis* IN PHEROMONE TRAPS AT CRIG, 2004

BLEND EXPERIMENT (21/2/04 – 31/5/04; 5 replicates)

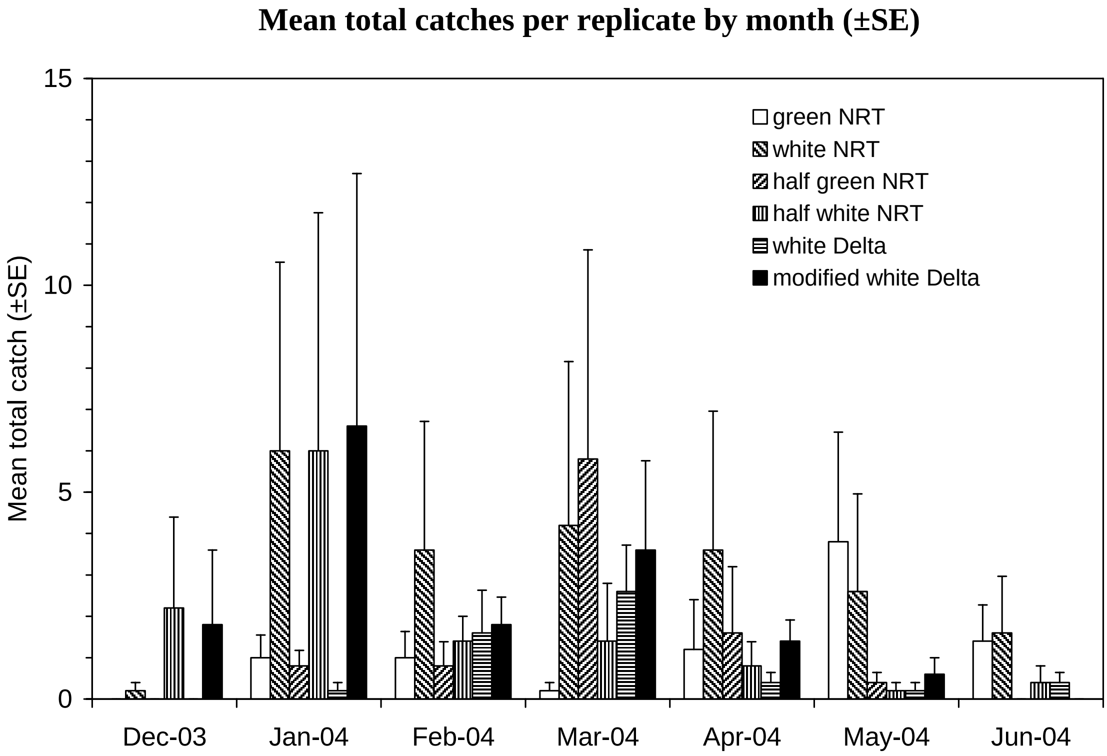
Mean total catch (±SE) per month

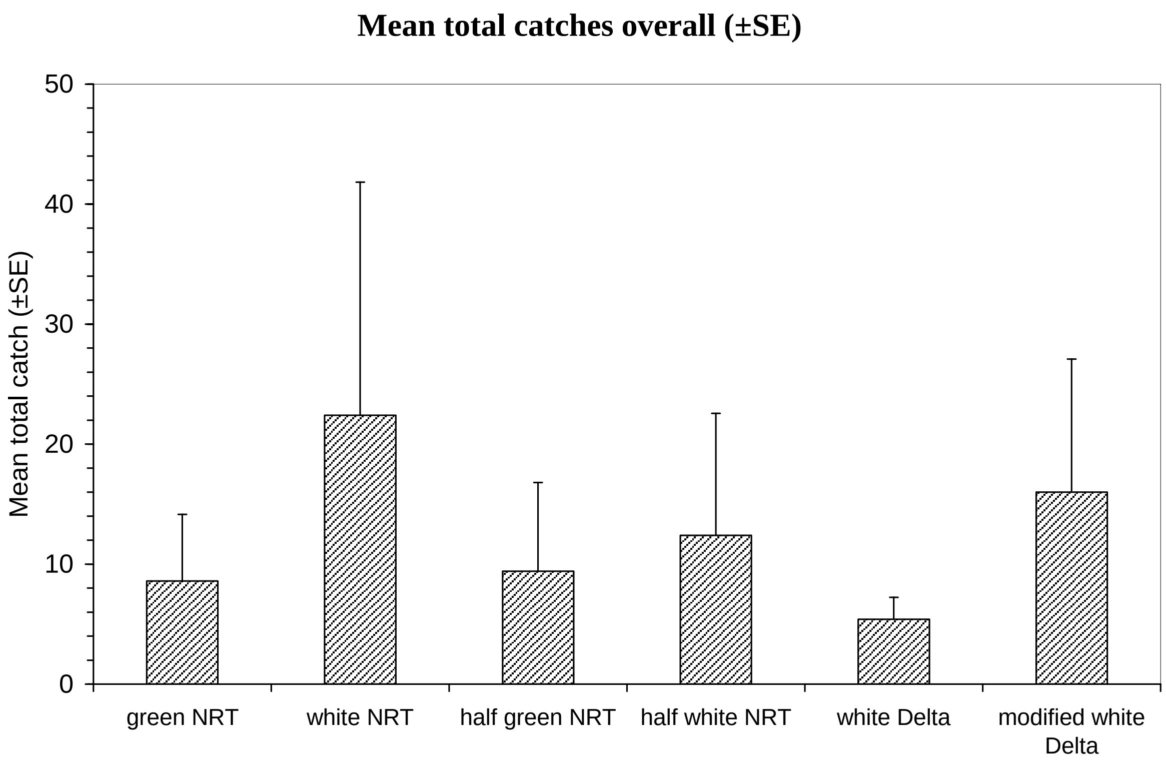


Mean total catch (±SE) overall



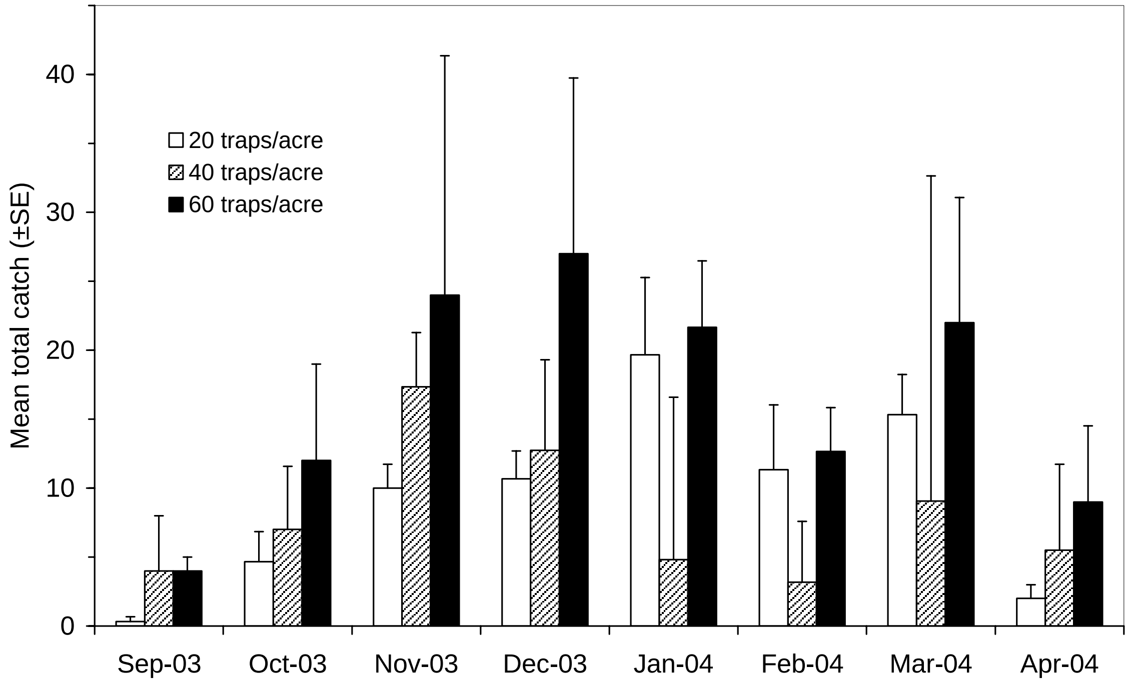
TRAP DESIGN (1/11/03 – 30/6/04; 5 replicates)



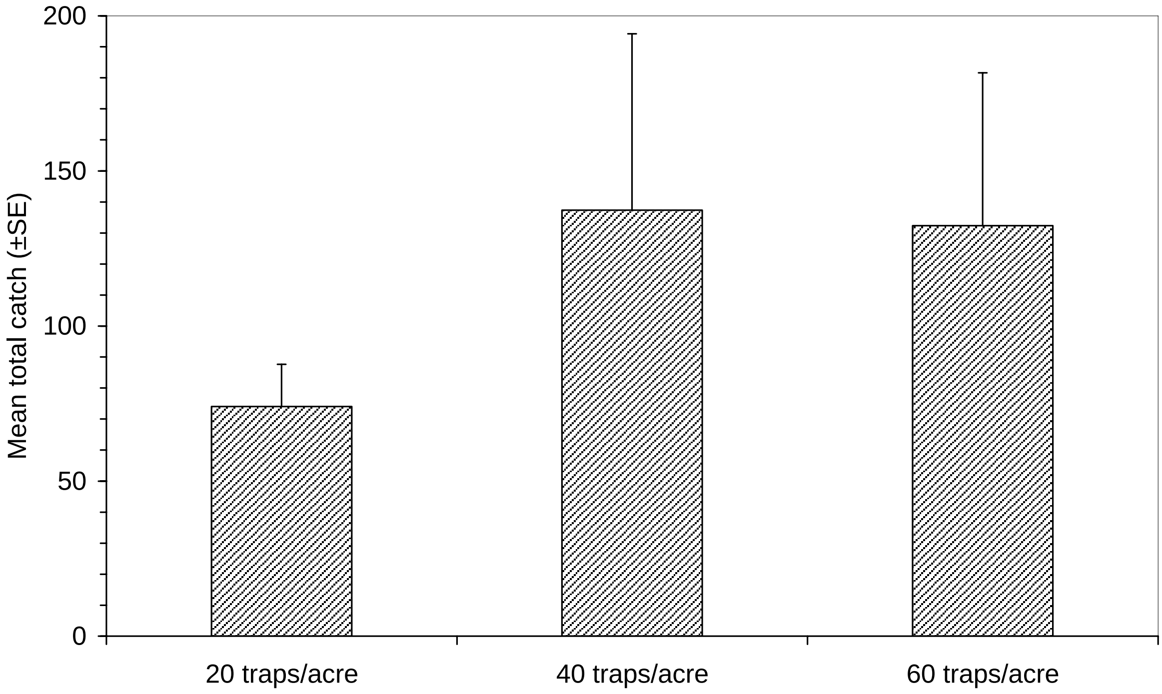


TRAP DENSITY EXPERIMENT (September 2003 – April 2004; 3 replicates)

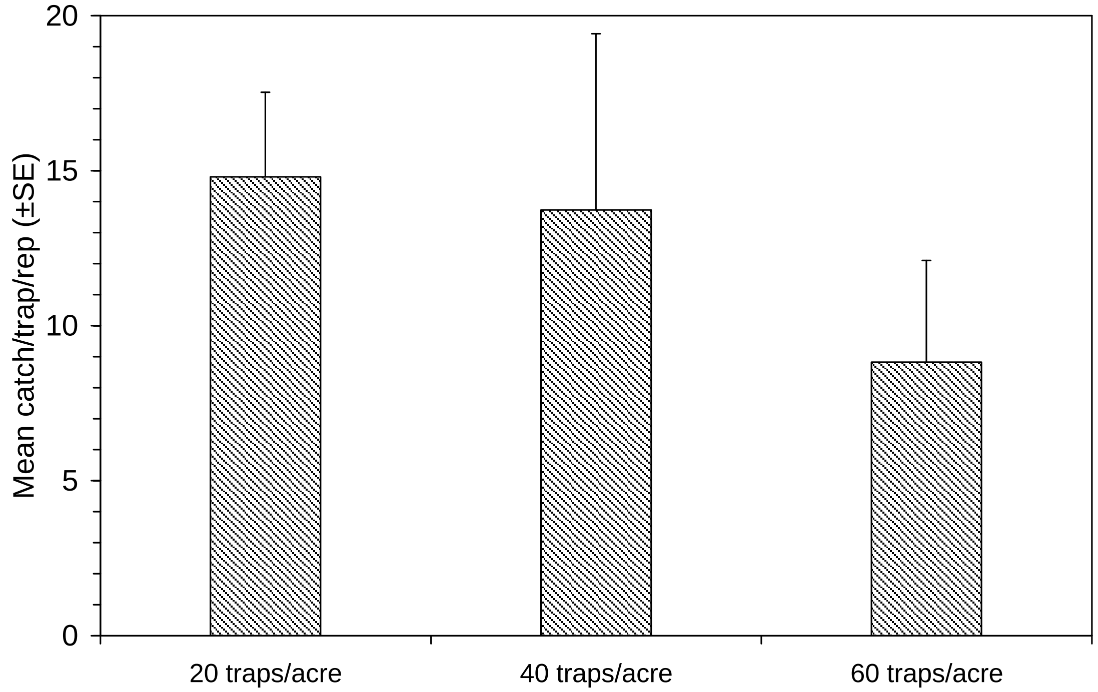
Mean total catches per replicate by month (±SE)



Mean total catches overall (±SE)



Mean catches per trap per replicate (±SE)



Mean catch/trap at 60 traps/acre significantly less than catches at other two densities ($P<0.05$ after ANOVA using log-transformed data)

Damage Assessment