Impact Evaluation Report

Integrated Management of the Coffee Berry Borer

Project: CFC/ICO/02

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Cover photos (by G. van de Klashorst)
Top row from left to right:
Coffee Berry Borer (CBB) burrowing into coffee berry. Infested coffee berries with naturally occurring *Beauveria*. Artisanal " alcohol trap" made from soft drink bottle – Guatemala.
Second row from left to right:
Artisanal "alcohol trap" made from disposable cups – Colombia. Coffee Berry Borer larvae on dissected coffee berry. *Beauveria* biopesticide for use against CBB, Indonesia.

Table of Contents

ACRONYMS

AEKI/AICE	Association of Indonesian Coffee Exporters and Industries
ANACAFE	National Coffee Association of Guatemala
ASIC	International Scientific Coffee Association
CABI	CAB *International* (UK)
CARDI	Caribbean Agricultural Research and Development Institute
CATIE	Centro Agronómico Tropical de Investigación y Enseñanza (Costa Rica)
CENICAFE	Centro Nacional de Investigaciones de Café (Colombia)
CIBOJ	Coffee Industry Board of Jamaica
CIRAD	Centre de Coopération Internationale en Recherche Agronomique pour le Développement (France)
CBB	Coffee Berry Borer
CFC	Common Fund for Commodities
EIAR	Ethiopian Institute of Agricultural Research
EMBRAPA	Empresa Brasileira de Pesquisa Agropecuária (Brazilian Agricultural Research Corporation)
EU	European Union
FAO	Food and Agriculture Organization of the United Nations
ICA	International Coffee Agreement
ICB	International Commodity Body
ICO	International Coffee Organization
ICCRI	Indonesian Coffee and Cocoa Research Institute
IIBC	International Institute of Biological Control, now part of CAB *International*
JARC	Jimma Agricultural Research Centre, EIAR, Jimma, Ethiopia
MASL	Meters above sea level
MRL	Maximum Residue Level
NCRS	National Coffee Research Systems
PEA	Project Executing Agency
PROMECAFE	Programa Cooperativo Regional para el Desarrollo Tecnológico de la Caficultura
RRF	Rural Rearing Facility
SB	Supervisory Body
USP	University of São Paulo

1. EXECUTIVE SUMMARY

The specific objective of the evaluation is to assess the development impact of the above project and the extent to which the project's objectives and targets have been achieved. This should include an assessment of the lessons that can be drawn from the project and its implementation to serve as a guide for future projects financed by the Common Fund. The evaluation was conducted by independent consultants, one of which carried out a fact-finding mission to three of the original project countries (Colombia, Guatemala and Jamaica) and to three other countries (Brazil, Ethiopia and Indonesia) as indicated in the Terms of Reference (see Annex 1). This Summary includes sections covering the main findings including impact assessment, lessons learned and major recommendations.

1.1 Main findings

1.1.1 The project

Implemented between April 1998 and May 2002, the Project Executing Agency was CABI Bioscience with PROMECAFE playing a coordinating role with respect to its four member countries. The central objective of the project was to benefit coffee producers through improved yields and coffee quality by controlling the coffee berry borer (CBB). It comprised the following components:

- Improvement and testing of mass rearing and delivery systems for natural enemies (pathogens and parasitoids) of the CBB;
- Provision of natural enemies to participating countries;
- Integration of biological control technologies and other methods for cultural and chemical control to develop Integrated Pest Management (IPM) systems;
- Dissemination of IPM technology/information and associated training to participating and other countries.

1.1.2 Principal results

The evaluation has found that in general the project had a positive impact, particularly in disseminating information on the nature of IPM using the very successful Farmers' Participatory Method. The outcome was increased take up of improved cultural practices which significantly reduced losses that otherwise would have arisen from CBB infestation. On the other hand, in spite of the weight given to this component in the project, the successful use of biological control was disappointing, since this technology proved to be insufficiently developed to be adopted easily by farmers. Nevertheless some cases of success were found and indicate that further efforts here, particularly in view of technical advances in mass-rearing technologies, should be continued. The comments below apply to the principal project components.

- **Improvement and testing of mass rearing and delivery systems for natural enemies[1] (pathogens and parasitoids) to combat the CBB**

The evaluation concluded that considerable advances had been made in the mass-rearing of biological control agents, although means for their practical application did not become available within the project time period. However, these were at too early a stage of development to be taken up by farmers. This is particularly the case with parasitoid wasps, although some positive results have been achieved with *Cephalonomia stephanoderis* in Guatemala. Technology for cost-effective automated mass-rearing of parasitoids only became available at the end of the project and requires substantial investment, which was not forthcoming at the time of the worldwide coffee price crisis of 2000-2004. In the case of the fungus *Beauveria bassiana,* during and after the project some of the difficulties in its cultivation and application were overcome, and at the present day it is much more commonly used than before.

- **Provision of natural enemies to participating countries**

After successful rearing, the natural enemies were transferred to participating project countries. Cultures were then established there, and the biological control agents (natural enemies) were subsequently released in the field to combat the CBB during the project period. After the project terminated this was not vigorously continued in most project countries, although Jamaica and Colombia are continuing to rear parasitoids for research. The field mission found that the only country where *Cephalonomia stephanoderis* is continually mass-reared was Guatemala, where over 50 larger farmers are financing and using Rural Rearing Facilities (RRFs). They have been releasing *C. stephanoderis* for over 12 years now. The combination of cultural control with release of *C. stephanoderis* is proving more effective for CBB control than either of these methods singly.

- **Integration of biological control technologies and other methods for cultural and chemical control to develop IPM systems[2]**

This was investigated through Farmers Participatory Research with varying degrees of success in the different project countries. However where correctly used it proved of outstanding value. Although biological control lagged behind, there seems to have been a substantially improved awareness of the benefits of IPM and in many cases the successful use in particular of improved cultural control methods such as “re-re”. Re-re (for recoleccíon and repase) is the most common cultural control (it encompasses the complete removal of all ripe and over-ripe berries from the trees and the ground after the harvest and during the inter-harvest period, thus reducing vital sources of re-infestation by the CBB). The results in avoiding losses have been highly positive, according to Colombian officials, who estimated a benefit in excess of US $200 million a year in the last year of the project compared to the first year, a result that could substantially be derived from the project[3].

[1] Natural enemies are specific natural agents that are introduced to combat the pest – in this case the Coffee Berry Borer.

[2] IPM or Integrated Pest Management is the use of one or several compatible control methods to combat a pest species. These can be cultural methods, biological methods and as a last resort synthetic pesticides.

[3] However improvements may also derive from other factors such as work undertaken prior to the project and occurrence of climate conditions less suitable for the CBB. For instance 1997/98 is classed as a bad year, thus giving a high initial reference point for infestation.

- **Dissemination of IPM technology/information and associated training to participating and other countries**

Although not emphasised in the final project reports, there has been a large number of officially published documents produced by the project, which are useful for other countries wishing to use the techniques and methods developed during the project. Moreover the dissemination process has been assisted through the successful use in many cases of the Farmers' Participatory Method (FPM) for extension.

1.1.3 Impact assessment

In view of the time (7 years) since the completion of the project, the large number of relevant factors and unavailability of data it proved in many areas to be quite difficult to establish meaningful quantitative indicators. Nevertheless enough material was obtained to allow a reasonable vision of the project's impact in the three countries studied.

- **Overall economic and social impact**

  The project had a favourable economic and social impact through the introduction of IPM and FPM. For instance in Colombia the project is credited with **benefits of over US$200 million a year** in reduced losses due to CBB infestation. However it should be noted that there was a marked preponderance of improved cultural practices in the IPM mix and many obstacles to successful implementation arose from the coffee price crisis of 2000 to 2004, which caused farm prices to drop some 50 per cent in many countries. Moreover the crisis also reduced funds available to coffee institutions which were essential to introduce biological control methods. On the other hand improved cultural practices could more easily be seen as an extension of normal farm management and thus easy to adopt as well as effective. This was particularly the case where coffee growers had strong institutional support, such as in Colombia. The point was made specifically for Guatemala that the favourable impact of IPM measures, albeit continued on a very small scale and on certain estates able to absorb temporary losses, was largely nullified by their abandonment during the crisis although they have now been restarted in several areas with success. In most project countries when successfully introduced the **Farmers' Participatory Method (FPM)** for extension has had **an important social impact** in motivating and getting coffee farmers to work together.

- **Impact on farmers**

  On the basis of the figures given above farmers in **Colombia** may have **benefited by up to US$163 million** from the project by the time it terminated with subsequent continued gains from reduced incidence of CBB. In **Guatemala** the introduction of IPM **reduced CBB infestation by nearly 70 per cent** where implemented although the use of IPM was severely reduced during the period of the coffee price crisis and its resumption is uneven. In **Jamaica** the introduction of IPM has made available potential alternatives to chemical control, which will need to be phased out in the longer term.

- **Impact on extension services**

  In the three project countries visited by the Mission, the Extension agents were well versed in IPM techniques communicated by the project, and commonly transferred these to farmers. However, the top-down approach for extension was still prevalent, which is less effective in empowering the farmers compared with the participative model.

- **Impact on research institutions**

  In **Colombia** the project has contributed significantly to the efforts of CENICAFE in combating the CBB. After the project ended, research has continued in areas such as CBB behaviour, trapping/monitoring by “alcohol traps”, and the use of *Beauveria.* The use of parasitoid wasps has not taken off largely because of high cost and lack of donor support, and cultures of three wasp species have been transferred to private enterprise. In **Guatemala** the project has given support to biocontrol with *Cephalonomia* and could be seen as instrumental in maintaining the momentum of this work as well as stimulating interest and work on *Beauveria*, which is presently being accelerated. Research efforts in **Jamaica** have continued after the project, albeit in a different form. Recent work has emphasised trapping and cultural control methods and the economics thereof, but data analysis has not yet been finalized and published. A maintenance culture of two parasitoid species is kept.

- **Impact on coffee sector profitability**

  In **Colombia** the IPM emphasis is on cultural practices easily integrated with normal coffee tree maintenance. Costs of CBB IPM are estimated at an affordable 6 per cent of total costs. At normal or high price levels **IPM enhances profitability** in view of the improvements achievable in both quantity and quality. In **Guatemala** IPM costs based on the use of two or three components are estimated at 295 Quetzals/ha equivalent to US$35.80, which is not high. With a potential reduction in infestation of up to 70 per cent **profitability is increased.** By facilitating a greater choice of control options the project has enhanced **potential** profitability in **Jamaica** although growers are at present seemingly slow to relinquish the use of endosulfan.

1.2 Lessons learned

The evaluation identified the following main lessons:

- The design of the project was complex, in terms of the wide range of activities and the number of countries involved, which probably made project management more difficult.
- The economic malaise in coffee from 2000 to 2004 greatly reduced the interest of coffee farmers in investing in their farming systems, which had a significant impact on the project
- While farmers developed a stronger understanding of the IPM concept during the project, it could be useful to separate out the individual contribution of each component to the reduction of pest populations. When coffee prices are low farmers could then choose the component(s) with the most impact if economic resources become scarce.

- Poor money management skills of farmers and lack of access to financial services have had a negative impact on the use of necessary management practices for coffee farms. This element was not sufficiently addressed in the original project. The development of a basic easy-to-apply economic model to help farmers choose the optimal IPM component mix would be very useful.
- Work with farmers should be focused on small coffee producers because they are facing more difficulties with CBB management. In the future much effort needs to be made towards community strengthening, learning and empowerment with emphasis on participatory methods such as Farmers' Field Schools.
- Cultural control is sustainable, effective and environmentally sound, but the cost of labour (and its availability) make its use difficult to maintain under adverse market conditions where labour costs are high and coffee market prices are low.
- IPM strategies as implemented in this project should help to develop organic coffee production in these countries.
- The existence of an inter-country structural working party or group on CBB IPM would have enhanced the project's sustainability.

1.3 Recommendations

The following are the principal recommendations arising from the evaluation:

a) Farmers' participatory methods should be central to any further projects to be conducted.

b) Continued but carefully focused testing of biological control agents in the field should be encouraged.

c) CBB Monitoring systems can be established by using locally produced "alcohol traps".

d) Priority should be given, within an IPM framework, to minimizing the use of chemicals for CBB control.

e) Small farmers in Central American countries that have not participated in the original project could benefit from its results and the advances that have been made since.

f) Farmers in certain parts of Indonesia need to be organized in farmers' groups and be empowered to understand and apply sound IPM techniques against CBB.

g) Greater price incentives to farmers for quality need to be adopted.

h) Future initiatives, such as new projects, should assess the possible impact of climate change in areas where such initiatives are proposed.

i) The formation of an international consultative group or working party on CBB research should be encouraged. A number of priority research topics are identified.

2 INTRODUCTION

The Coffee Berry Borer (*Hypothenemus hampei* (Ferrari)) is the most important insect pest of coffee, first described from trade samples in 1867. The Coffee Berry Borer (or CBB) has spread all over the world during the last couple of centuries, following the spread of coffee cultivation. It spends most of its life cycle inside the developing coffee berry, which makes it extremely difficult to control. Specifically, losses from the CBB arise from loss of coffee beans falling prematurely and through lower quality caused by damage to the bean (Le Pelley 1978). In the late 1990s production losses in Colombia alone attributable to CBB were estimated at some US$100 million per year (Duque 2000). Worldwide they have been estimated at least at US$500 million per year (Vega 2009).

The incidence of CBB can vary considerably within countries, with significant social disruption in heavily affected areas. The re-emergence during the late 20th century of CBB in countries of the Caribbean, Central and South America, Africa and Asia, poses a major threat to the millions of small farmers who depend on coffee production for their livelihood.

2.1 Period and places of the impact evaluation

Details of the methodology used and Terms of Reference of the Evaluation are given in Annex 1.

The exercise was divided into three phases:

Phase I (after the assignment was approved, May-June 2009)

Project objectives were reviewed and relevant existing data material generated, with contacts set up. This was followed by consultations with CFC, ICO and Dr Peter Baker of the Project Executing Agency (CABI, UK). Guideline questionnaires were prepared for the field mission to evaluate availability of and obtain further relevant and up-to-date data. In this phase both consultants were involved in planning and preparation.

Phase II (missions, data collection, preliminary analysis June-August 2009)

Eight weeks of missions and travel to the three project countries and three other countries proposed in the TOR to collect data on specific IPM and socio-economic parameters. This phase was mainly implemented by Dr Van De Klashorst. The details of persons and places visited as well as meetings conducted are given in Annexes 2 and 3.

Phase III (post missions, period June-September)

In this phase both consultants were involved in preparation of the report, comprising analysis of country data and development of conclusions and recommendations. Discussions and further development of the study through interaction with CFC and other possible interested parties took place in London and Amsterdam, with a presentation of preliminary findings to the ICO Council in London, on 24 September 2009. Submission of the completed report to the CFC was scheduled for 30 September 2009.

2.2 Composition of the Evaluation Team

The field data collection, IPM component and travel were implemented by Dr. Gerrit van de Klashorst, international consultant, entomologist/IPM specialist, who has extensive experience on all aspects of development projects, IPM training, research and evaluations (e.g. CFC/ICO coffee wilt disease project) in tropical environments. Mr. Pablo Dubois, economist/coffee specialist, formerly Head of Operations at the ICO, who has wide-ranging experience in this area, carried out the socio-economic component of the assessment.

3. MAIN ELEMENTS OF THE PROJECTS

3.1 Problems addressed by the project

The central objective of the project as stated in the project appraisal report was to benefit coffee producers by reducing yield losses and coffee quality deterioration caused by the Coffee Berry Borer. Details of CBB impact are reviewed in detail in section 4.1.

Different control methods against the CBB applied so far have proved difficult and outdated for various reasons (see Damon 2000). The chemical pesticides used during the 1950s and 1960s (chlorinated hydrocarbons) caused harmful side effects and they were largely abandoned in favour of another chemical of the same group (endosulfan), which was then considered the most effective insecticide. However, this product was also found to be hazardous to humans and the environment, and has been banned in more than 60 countries. In fact one of the main producers of endosulfan has recently announced that the compound will be taken out of production by 2010, so that it is likely to be phased out completely.

Other control methods employed earlier have found little following of late. These include methods involving the reduction of shade and complete harvesting of all fruit from the coffee trees and collection of fallen fruit from the ground at the end of the harvest season.

Biological control of CBB - the introduction of parasitic wasps - was pioneered in the 1920s and 1930s, but although potentially promising, never found great success. The use of fungi was still under investigation and their effectiveness was planned to be assessed.

No single technology for the control of CBB has been found effective in all places at all times. Neither the application of chemicals, nor cultural or biological methods have proved to be sufficiently effective by themselves. Each of these methods may provide a significant amount of CBB control, but it was concluded that several of these methods need to be combined in an Integrated Pest Management (IPM) system to give satisfactory results. Thus, through the development and transfer of IPM technologies for the borer via on-farm pilot and demonstration plots, the project aimed to provide cost-effective tools with wide application not only in the countries directly involved but also in other affected coffee-producing countries worldwide.

3.2 Means applied to solve the Problems

At the onset the project comprised the following components:

- Improvement and testing of mass rearing and delivery systems for natural enemies (pathogens and parasitoids) of the CBB;
- Provision of natural enemies to participating countries;
- Integration of biological control technologies and other methods for cultural and chemical control to develop IPM systems;
- Dissemination of IPM technology/information and associated training to participating and other countries.

3.2.1 The development of cost-effective mass rearing systems for natural enemies

This would involve:

- The development of a cheap and effective artificial diet for CBB production which substantially reduces the use of coffee beans and other costly elements and
- The automation and scaling-up of production systems in order to achieve true mass-rearing. This is a substantial research and development activity, which is central to the success of the project. In undertaking this activity it will be necessary to determine the optimal scale at which production can be carried out.

Some progress had already been made towards this end: a semi-artificial diet had been developed in Mexico and was being improved in Colombia. Research in Colombia was also developing ways to mass-rear parasitoids from CBB larvae.

Systems for the mass production of insect pathogens have existed for some time, from very simple on-farm methods to sophisticated two-stage liquid phase systems requiring substantial investment. The problem lies in assessing their effectiveness and economic feasibility under a wide range of conditions in the participating countries. This was to be addressed by a workshop to ensure that advantages and limitations of these methods are clearly understood.

The project aimed to develop automation and scaling up of production systems to determine the optimal scale of mass rearing of natural enemies of the CBB. CENICAFE also desired to develop an improved diet for CBB rearing in close collaboration with PROMECAFE. CENICAFE was to expand its rearing capacities and to carry out intensive laboratory studies on CBB, the parasitoids *Cephalonomia stephanoderis, Prorops nasuta* and *Phymastichus coffea*, to develop new rearing systems to replace the current one based on parchment coffee, which can produce up to 2 million *Cephalonomia* per week.

Complementary development of an artificial diet was to be undertaken in Mexico by ECOSUR in a project funded by the USDA with expert inputs from their laboratories in Texas.

Mass-production, formulation, application and evaluation techniques for the fungus *Beauveria bassiana* were available from IIBC and other institutions.

To achieve these goals, the following activities were planned:

Activity 1: CENlCAFE to develop an improved diet for CBB and rearing systems for its parasitoids in collaboration with PROMECAFE and Ecuador by month 24.

Activity 2: Research on artificial diets in Mexico with support from USDA-ARS.

Activity 3a: *Prorops nasuta* and *Phymastichus coffea.* Rearing, field release and field evaluation methods transferred from CENICAFE and CIRAD to India, PROMECAFE and Ecuador by month 12. Scientists from PROMECAFE, India and Ecuador to travel to Colombia for training in the field release and evaluation of parasitoids, by month 12.

Activity 3b: *Cephalonomia stephanoderis*. Rearing, field release and evaluation methods transferred from PROMECAFE to Jamaica by month 12. Jamaican scientists receive training in Honduras on *Cephalonomia* rearing by month 12.

Activity 4: *Beauveria bassiana* mass production, formulation, application and evaluation techniques transferred from IIBC and CENICAFE to India, Ecuador and PROMECAFE by month 18.

Activity 5: Methodologies for sampling, economic thresholds, and predictive modelling transferred from IIBC, CENICAFE to India, Ecuador and PROMECAFE by month 24. Scientists from PROMECAFE, India and Ecuador to travel to Colombia for training in IPM techniques. This training should provide them with techniques to develop on-farm IPM trials.

3.2.2 The supply of parasitoids and their establishment in participating countries which presently do not have them.

This is an essential first step for establishing mass rearing systems. The introduction of parasitoids and the establishment of laboratory cultures is a technology transfer exercise.

By the end of year 2, the project would have developed a mass-rearing system sufficiently advanced for it to be considered for transfer to other countries as a prototype mass-production system. It was envisaged that for *Prorops nasuta* and *Phymastichus coffea,* rearing, field release and field evaluation methods were to be transferred from CENICAFE and CIRAD to India, PROMECAFE and Ecuador by month 12. Scientists from PROMECAFE, India and Ecuador were to travel to Colombia for training in field release and evaluation of parasitoids, by month 12. For *Cephalonomia stephanoderis,* rearing, field release and evaluation methods were to be transferred from PROMECAFE to Jamaica by month 12. A Jamaican scientist was to receive training in Honduras on *Cephalonomia* rearing by month 12.

Beauveria bassiana mass-production, formulation, application and evaluation techniques available at IIBC and other institutions were to be transferred through IIBC. Scientists from PROMECAFE, India and Ecuador to be trained in Colombia in entomopathogen production, formulation and application. This would enable participating countries to produce and apply small quantities of good quality fungus in order to test it in their IPM experiments and to evaluate its efficacy and methodologies for sampling, to determine economic thresholds.

To achieve these goals, the following activities were planned:

Activity 1: Transfer of *Phymastichus coffea* from laboratory culture in Colombia to laboratory culture in India and Ecuador, by month 12 with follow-up visits to target countries by month 18.

Activity 2: Transfer *of Cephalonomia stephanoderis* from Honduras to Jamaica, by month 18.

Activity 3: Shipment of *Beauveria bassiana* isolates to participating countries by CENICAFE, IIBC, CATIE and CIRAD as requested, to all countries requiring them by month 18.

3.2.3 Integration of biological control technologies and other methods for cultural and chemical control to develop IPM systems;

A principal problem facing all IPM projects is to make them work convincingly and economically in the field and in such a way that they can be readily taken up by farmers with a wide range of abilities. This was to be addressed in the project by intensive work on farm plots involving farmer participation. These pilot IPM plots would be set up no later than 6 months after the start of the project in all participating countries.

The different IPM elements would also be tested in various combinations and timings in joint field-station trials in Guatemala (with Mexican and Honduran participation) where large replications and more elaborate experimental designs would give accurate quantitative evidence on the effectiveness of various combinations of IPM elements. The CBB model developed by IIBC and CENICAFE would be used extensively to test different combinations and timings of the IPM elements.

Predictive modelling to be transferred from IIBC, CENICAFE to India, Ecuador and PROMECAFE by month 24. Scientists from PROMECAFE, India and Ecuador to be trained in Colombia in IPM techniques. This training should provide them with techniques to develop on-farm IPM trials. Provisions were made for a total of 25 to 30 scientists from participating countries to be trained in the technical areas indicated above through a wide range of laboratory and field techniques by workshops, bench training and field plot exercises.

To achieve these goals, the following activities were planned:

Activity 1*:* Setting up on-farm pilot IPM plots at two sites in Ecuador, three sites in Colombia, three sites each in Mexico, Guatemala and Honduras and three sites in India by month 9.

Activity 2: Setting up on-station pilot IPM plots at one site in Guatemala (ANACAFE) by month 9.

Activity 3: Audit by PEA of national IPM activities at 18 and 36 months in each region in relation to farmer needs.

3.2.4 Dissemination of IPM technology/information and associated training to participating and other countries.

An intensive programme of dissemination was envisaged for both national and international participants. Staff of the participating countries, who are competent in mass rearing natural enemies, would implement CBB IPM at farm level, and train others in CBB IPM implementation. Documentation and presentation material to be prepared and disseminated to participating and other interested countries. Trainers to be educated in field pest incidence and natural enemy impact assessment through centralised training activities in each of the three regions. In-country training of trainers in IPM techniques to be for a minimum of ten trainees per country per year. More significantly, on-farm IPM trial plots to serve as demonstration plots and provide a practical training basis. Evaluations of IPM impact to be an on-going activity at each of the field sites to determine the success and integration of IPM technologies.

A final workshop in year 3 was to be held to assimilate information on CBB control and to discuss the development and future dissemination of CBB IPM technologies within participating countries and other affected countries. The workshop was to be held with a full evaluation of the outcome and questionnaires to determine the level of success.

To achieve these goals, the following activities were planned:

Activity 1: Training of trainers in the components of IPM technologies through centralised training activities in each of the three regions, to be carried out twice (preferably during the mid points of years 2 and 3) during the course of the project.

Activity 2: Training of trainers in the field assessment of pest incidence and natural enemy impact through centralised training activities in each of the three regions, to be carried out twice (preferably during the mid points of years 2 and 3) during the course of the project.

Activity 3: Evaluation of pilot IPM plots by farmers, researchers and extension officers as an ongoing activity at each of the field sites, to determine the success and integration of IPM component technologies.

Activity 4: A workshop in year 2 and a final workshop in Year 3 to assimilate information on CBB control, and to discuss the development and future dissemination of CBB IPM technologies within participating countries and in other affected countries.

Activity 5: Production of annual progress reports from the projects by regional implementing institutes and their collection and publication by the PEA.

Activity 6: Publication of research results in scientific journals.

3.3 Stated beneficiaries

The project was executed in seven countries, Colombia, Ecuador, Guatemala, Honduras, India, Jamaica, and Mexico.

The ultimate target beneficiaries are the coffee farmers, who are mostly smallholders. Unless the CBB is brought under control, over ten million smallholders now producing coffee will suffer major production losses and consequently a significant reduction in their family income.

The participating countries are the direct beneficiaries, with first access to the benefits of the project, including enhanced export earnings. They would be provided with technology and assistance in strengthening their capacity for developing and testing IPM systems as well as disseminating the application of the methodology among farmers and extension workers.

At the end of the project these countries were expected to be equipped with the necessary technological capability to deal with the CBB, thereby reducing their cost of production by minimizing the use of chemicals and raising their incomes by improving the quantity and quality of their coffee. Research institutions, extension services and the staff whose skills are upgraded through training would also be beneficiaries of the project.

The secondary beneficiaries are other countries and farmers to whom the advantages of IPM and the methodologies applied would be transferred under the project's dissemination programme.

3.4 **Results achieved** (as reported by the project)

The results of the project as given in its Completion Report (Baker et al. 2002) are represented in Table 3.1. For each of the four project components a number of activities were planned (see Section 3.2 of the present report). In the Completion Report they were numbered differently as shown in the table below. There seem to be fewer activities than given in Section 3.2 but this is largely due to pooling. Nevertheless, some activities have been omitted or cancelled for various reasons, which will be discussed further below.

Table 3.1. RESULTS as presented in the COMPLETION REPORT of the CBB project

PLANNED ACTIVITIES	***TARGETS SET***	***FINAL STATUS***	***REMARKS***
Activity 1.1			
Develop diet and rearing systems	Develop mass rearing for CBB and C. *stephanoderis*	Mass rearing of *Cephalonomia* abandoned in favour of *Phymastichus*	Clear evidence that *Cephalonomia* is not economic. All resources should be channelled to *Phymastichus*
		Artificial diet and CBB breeding work stopped at CENlCAFE due to lack of progress.	Significant progress by USDA on continuous CBB rearing on diet (20+ generations) with good quality.
		All diet work at USDA Starkville with new co-financing	Initial "ball-park" feasibility of the method undertaken with positive results
Activity 1.3			
Training course on *Phymastichus*	1st year training course	Took place in August 1998 in Colombia	Successful course. All country participants subsequently reared P. *coffea*
Activity 1.4			
Training course on farmer participatory research	2nd year training course	Took place in May 1999 in Colombia	Moderately successful course, from later interactions it became clear that many participants did not fully understand the concepts
Activity 1.5			
Training course on IPM of CBB	3rd year training	Took place in May 2000 in Mississippi	Successful course Participants exposed to the concepts of true mass rearing.
Central American training course on participatory research		Took place in August 2000	Central American course by Bentley more successful
Training for 3-member Indian team		Took place in October 2001	Indian training undertaken in Nicaragua
Activity 2 l			
Transfer of parasitoids to	Shipments of parasitoids by end	All designated countries have received shipments	*Phymastichus* released into the field in Honduras,

PLANNED ACTIVITIES	***TARGETS SET***	***FINAL STATUS***	***REMARKS***
recipient countries	of Year 1	of *Phymastichus*	Guatemala, Mexico, Ecuador
		Jamaica has received *Cephalonomia, Prorops* and *Phymastichus* Jamaica has also received training in *Phymastichus* rearing	India now has strong culture
Activity 3			
On farm plots	Initiation of IPM plots and participatory work with farmers by month 9 of Year 1	Preliminary surveys carried out in all countries and areas for plots identified On farm activities in all countries, a wide range of activities.	Valuable baseline data on farmers collected. Evidence of a significant impact of the project in India and Ecuador as extension exercises. Some true progress on participatory work in Colombia and Mexico. Less in other countries.
Activity 3.3			
Audit by PEA of IPM activities	Audit of countries IPM activities in relation to farmers needs	Fieldwork carried out in all countries	Reports available for Ecuador, Mexico, Honduras, India
Activity 4			
Training	Informal training only in Year 1 Training courses for extensionists	Training undertaken in all countries. Courses in Ecuador, India carried out.	Indian training in January 2000, Central America (Honduras) in August 2000
Information and dissemination	Project meeting	April 1998, Mexico May 1999, Colombia May 2000, Mississippi, October 2001 Costa Rica, December 2001 India Farmer participatory manual produced	Ecuador and India have produced many posters, flyers and folders on IPM aimed at farmers

3.5 The main players involved

In accordance with standard practice for commodity projects financed by the Common Fund for Commodities (CFC) the project was sponsored by a CFC-recognized international commodity body (ICB) which also acted as the project's Supervisory Body (SB). Overall management of the project was undertaken by a Project Executing Agency (PEA) with the cooperation of national institutions in the countries involved. The principal organizations involved in the CBB project are described below, followed by relevant institutions in the three non-project countries reviewed.

International Coffee Organization (ICO) – SB

The ICO is the main intergovernmental organization for coffee, bringing together producing and consuming countries to tackle the challenges facing the world coffee sector. It makes a practical contribution to the world coffee economy and to improving standards of living in developing countries through international cooperation on coffee matters, including initiating coffee development projects to address issues and problems affecting the commodity such as fighting pests and diseases, adding value and improving marketing. The ICO was set up in London in 1963 under the auspices of the United Nations. It has administered six International Coffee Agreements (ICAs), the most recent of which entered into force provisionally on 1 October 2001 and definitively on 17 May 2005. Its 77 Members include 45 coffee exporting and 32 importing countries, and it functions through the International Coffee Council, the Executive Board, the Private Sector Consultative Board, the Executive Director and a small Secretariat.

CABI Bioscience – PEA

Formerly the International Institute of Biological Control, CABI Bioscience is part of CAB International, a UK-based not-for-profit science-based development and information organization providing services worldwide in the areas of agricultural information, pest identification and biocontrol. CABI was established by a United Nations treaty level agreement between 40 countries to: "promote the advancement of agriculture and allied sciences through the provision of information and scientific and related services on a world-wide basis." Development and management of agricultural development projects is a priority area of work.

National institutions

The project involved a series of activities in 8 countries: Colombia, Ecuador, India, PROMECAFÉ Group (Mexico, Guatemala, Honduras and Jamaica) and the USA. However this evaluation concentrates on Colombia, Guatemala and Jamaica, involving the following institutions:

Colombia: Federación Nacional de Cafeteros

The National Federation of Coffee Growers of Colombia is a non-profit and non-political cooperative of coffee farmers that tries to stabilize the market for Colombian coffee and undertakes research, social assistance and promotion programmes on behalf of small, independent farmers. The Colombian government has designated the Federación as its agent for national coffee policy. Supported by a tax on coffee exports, the Federation has succeeded in protecting the growers against falling coffee prices. When prices fall below an established minimum, the Federation steps in and buys the crop, storing it in central locations and putting it on the world market in times of shortage.

The Federation has an extensive social programme and provides help to farmers in areas such as low-cost loans, company stores and cooperatives, and training in managing and diversifying his crops.

The Federation also establishes and maintains high standards for Colombian coffee. In addition, it invests heavily in research through CENICAFE, the national Centre for Coffee Research, to improve the product and farming and processing methods, and in training growers.

Guatemala - Asociación Nacional del Café (ANACAFE)

ANACAFE, the Guatemalan National Coffee Association, is a non-profit organization that represents the interests of about 90,000 producers. Anacafé is involved internationally in promoting the quality of the product. It also provides services in the fields of research and extension as well as grading, statistics and storage and in general promotes all agricultural and economic activities related to coffee.

Jamaica - Coffee Industry Board (CIB)

The Coffee Industry Board (CIB) is a statutory body that regulates the coffee industry through its core processes of licensing, certification and advisory services. It establishes and monitors the standards by which the industry's affairs are conducted, defining quality standards, growing areas and recommending specific plant varieties. It certifies quality via taking custody of all green coffee for shipment, sample testing of same and handling all export documentation and preparation. It monitors and forecasts crop conditions and provides technical advice to farmer groups on planting, pre- and post-harvesting techniques, pest and disease control and environmental management. Finally it owns the Jamaica Blue Mountain® and Jamaican High Mountain Supreme® coffee trademarks and is responsible for the integrity of the brands.

Central America and Caribbean PROMECAFE

The Programa Cooperativo Regional para el Desarrollo Tecnológico de la Caficultura (Promecafe) is a dependency of the Inter-American Institute for Cooperation on Agriculture (IICA), a specialized agency of the Inter-American System, whose purpose is to encourage and support the efforts of its Member States to achieve agricultural development and well-being for rural populations. PROMECAFE, based in Guatemala, deals with coffee research and projects in the Central America and Caribbean region, emphasising initiatives with a regional impact.

NON-PROJECT COUNTRIES

Brazil - EMBRAPA

The Empresa Brasileira de Pesquisa Agricola (EMBRAPA) is a government body dependent on the Ministry of Agriculture and grouping institutions dealing with agricultural research. Networking through 38 Research Centres, 3 Service Centres and 13 Central Divisions, EMBRAPA is present in almost all the states of the Union, each with its own ecological conditions. There are 8,275 employees in EMBRAPA, of which 2,113 are researchers, 25% with master's degrees and 74% with doctoral degrees. EMBRAPA coordinates the National Agricultural Research System, which includes most public and private entities involved in agricultural research in the country.

EMBRAPA coordinates the National Research and Development Programme for Coffee, which involves a Consortium of research institutes and private sector companies. The work of coordination is carried out through a special unit of EMBRAPA known as EMBRAPA Café.

The principal academic research institution for coffee is the College of Agriculture ”Luiz de Queiroz”, located within the University of São Paulo at Piracicaba. Within its Department of Entomology, Plant Pathology and Agricultural Zoology several professors and their students investigate aspects of biology and control of CBB.

Ethiopia - Jimma Agricultural Research Centre

The purpose of the mission was to obtain more information on the status of CBB and its natural enemy complex in the country. The Government is giving research support to the coffee industry through the Jimma Agricultural Research Centre, where a number of plant scientists are conducting research in various sub disciplines such as agronomy, breeding, entomology, plant pathology, weed science and documentation. The mission therefore visited Jimma and some surrounding areas.

Indonesia – Ministry of Agriculture, AEKI

In recent years the Indonesian Government has decentralized much implementation power to the Provinces. The Ministry of Agriculture in Jakarta has an Estate crops division with offices in the provinces that have to deal with the needs of the farmers there. The national Ministry of Agriculture is largely responsible for policy, but the provincial Ministry branches are implementing these policies, with funding from the central government and other sources.

The Estate crops division also has provincial experimental stations, which carry out the necessary research in their provinces. Then there is ICCRI, the Indonesian Coffee and Cocoa Research Institute a national unit under the Central Ministry of Agriculture in Jakarta; it has a national mandate to conduct research and development on coffee and cocoa. The activities cover agronomy, breeding, soil and fertilization, plant protection, physiology, post harvest technology, economy and statistics, and biotechnology. The institute is funded by three different sources, namely from state owned plantations for routine budget, Indonesian Agency for Agricultural Research and Development (IAARD) for research budget, and its own income from the sales of research products, planting materials of coffee and cocoa and other services. Funding may also come from different sources, national, international and commercial.

The coffee exporters are united in the Association of Indonesian Coffee Exporters and Industries (AEKI or AICE). The association headquarters in Jakarta supports 13 regional offices in major producing areas throughout the country. Branch offices are located in Banda Aceh, Medan, Padang, Jambi, Palembang, Bengkulu, Bandar Lampung, Jakarta, Semarang, Surabaya, Singaraja, Kupang and Ujung Pandang with liaison offices in London.

The association is actively cooperating with the government to help carry out government policy on coffee, both domestically and internationally. It was also taken steps to establish closer cooperation with other coffee organizations in both producing and consuming countries.

The export of coffee is mostly handled by government - Department of Trade - approved exporters from a large numbers of ports throughout the archipelago.

4 PROJECT OBJECTIVES

4.1 Importance of the problems addressed

The Coffee Berry Borer causes important losses in most coffee cultivation areas of the world. Since it spends most of its life cycle inside the developing coffee berry it is very difficult to control. Specifically, losses from the CBB arise from loss of coffee beans falling prematurely and through lower quality caused by direct damage to the bean as well as development of secondary organisms such as bacteria and fungi. In addition the conversion factor for cherries to parchment coffee increases due to CBB, meaning that CBB also causes a direct yield weight reduction.

In 2008 the ICO (ICO 2008) conducted a survey on the impact of pests and diseases that elicited responses from 20 Member countries responsible for nearly 75 % of world coffee production. The Survey showed that the CBB remains the most prevalent pest of coffee with 14 countries considering it a problem and 3 a major problem.

Control measures are considered to be effective in the Americas, with the exception of Mexico (ineffective) and Panama (non-existent). In contrast, four African countries see them as ineffective (D.R. Congo, Kenya, Tanzania and Togo) and four others state they are non-existent (Central African Republic, Côte d'Ivoire, Ghana and Malawi). Vietnam equally reported ineffective farmer measures. Similarly, knowledge about the pest is regarded as good or fair in the Americas, whereas it is seen as poor in all African countries and Vietnam, with the exception of Cameroon and Central African Republic, where it is classified as good, and Côte d'Ivoire and Togo, where it is considered fair. National coffee institutions in the Americas are believed to be coping well in half the countries, and not very well in Brazil, Mexico, Nicaragua and Panama. A similar picture comes across in Africa, where Cameroon, Kenya and Togo give a good rating to their local institutions, while D.R. Congo, Côte d'Ivoire, Ghana and Tanzania rate their performance as not very effective. When it comes to international cooperation, only five countries have a positive evaluation, whereas ten producing nations across all continents consider it as not very good or even poor. Of the top five producers, only Vietnam seems satisfied with international response to this problem.

With regard to the response of farmers after infestation, D.R. Congo, Côte d'Ivoire and Jamaica reported they were unlikely to take any measures to combat the disease, with Tanzania also informing that some farmers were likely to abandon coffee cultivation entirely once struck by CBB. Countries in the Americas have all adopted an integrated pest management (IPM) approach, with the exception of Brazil, which emphasizes the use of chemical controls.

The countries surveyed made specific recommendations on the need for further action to address the problem including:

- Increased research and technology transfer (Brazil, Costa Rica, El Salvador and Nicaragua)
- Capacity building, timely access to resources (Ecuador and Mexico)
- Increased use of IPM (Brazil, Cameroon, D.R. Congo, Côte d'Ivoire, El Salvador, Kenya, Panama and Tanzania)
- Use of pest-resistant coffee trees (Central African Republic and D.R. Congo)
- Improved coffee harvesting processes in order to reduce the number of coffee beans infested with the pest (Colombia)
- Greater emphasis on post-harvest sanitation (Jamaica)

- Dissemination of in-house agro-ecological pest control techniques (Togo)
- The use of *B. bassiana* (Honduras)

The ICO also organised an international Seminar on the CBB in March 2009 (ICO 2009). The Seminar emphasised that the CBB is very difficult to control, especially because of its small size and concealed lifestyle. **The economic losses to the coffee sector caused by this pest were estimated at around US$ 0.5 billion per year**, equivalent to more than 3% of the export earnings derived from coffee by producing countries in 2008. At a national level, in the late 1990s production losses in Colombia alone attributable to CBB were estimated at some US$100 million per year (Duque 2000). Incidence of CBB can vary considerably within countries, with significant social disruption in heavily affected areas.

Participants in the 2009 Seminar considered that the problem of the CBB is likely to become even more prevalent in the future, as the result of changing global weather patterns. Studies have already noted the presence of the CBB at altitudes at which it did not exist in the past (Jaramillo 2009, Mawardi pers. comm.).

4.2 Relevance to poverty alleviation and to ICB Strategy

By acting to reduce crop losses and to improve quality the project has a direct positive impact on farmers' earnings, thus contributing towards poverty alleviation.

The commodity strategy of the ICO during the period of the project (1998-2002) - contained in ICO document EB-3531/95 Rev. 2 – International Development Strategy for Coffee (Approved by the International Coffee Council, 19 May 1995) - identifies six main strategic areas for immediate action: market improvement, information, analysis, environmental aspects of coffee production, encouragement of consumption, and emergency assistance.

Under the goal of encouragement of consumption emphasis is placed on quality, requiring *inter alia* actions in areas such as integrated pest management.

It should be noted that the current ICO (2009) strategy (document EB-3768/01 Rev. 3) prioritises the development of a sustainable world coffee economy and seeks to promote the use of environmentally friendly technologies through the production and processing chain, including **Integrated Pest Management (IPM) as control strategy** and improved technology for the washing process.

It goes on to specify the importance of protection against pests and diseases stating that action against pests and diseases is important not only to protect the economies of producing countries and the livelihood of farming populations but also to protect the quality of the product. Care is needed when developing protection programmes to ensure that these are as environmentally friendly as possible.

The project is thus clearly consistent with overall ICO strategy.

4.3 Suitability of the means to address the problems

We have reviewed the project components and activities as summarised in section 3.2 above and consider that they are well thought out and apposite to the objectives of the project.

The four project components that emerged from the general objectives of the project comprised four main objectives with a total of 18 activities, which were not all successful, as will be discussed in Section 5.5.

From a technical viewpoint the choice of activities for Component 1 – the improvement of economic mass rearing of the parasitoids was correct.

Once these improvements are established, it seems logical to transfer these technologies to the participating countries, as was done (Component 2).

The combination of the chosen technologies into a coherent IPM package is a more difficult task, which was to be effected by using Farmers' Participatory Methods, using in-farm plots. Although this choice (Project Component 3) was in itself correct, there were in some countries problems of comprehension and misunderstandings of the concepts involved. In others these methods appear to have been very successful. In several Asian and African countries, participatory techniques have been proven to be effective as a tool to empower farmers to make their own observations and decisions (Ooi & Kenmore 2005).

In order to be able to use Farmers' Participatory Methods there needs to be appropriate Training of Trainers and suitable documentation on the technologies that will be used. Therefore the dissemination and training techniques implemented in Component 4 were appropriate.

Nevertheless we believe that on the overall level there are some omissions whose inclusion would have greatly assisted project implementation. These are as follows:

Management

The project was quite complex in terms of its range of activities, varied geographical areas, and number of participating institutions. However there seems to have been only one person (Dr Baker) assigned on a permanent basis by the PEA to project coordination and implementation. Although other colleagues assisted him at times there are signs (e.g. occasional delays, failures to complete some specified activities, failure to adjust plans in the light of project findings, etc.) that more management resources would have been desirable.

Coordination for sustainability

We believe that insufficient attention was given to establishing a structure such as a permanent working group, including representatives of all participating institutions, to facilitate coordination and to encourage sustainability after the end of the project. This would have greatly assisted in assessing the results of the various project components and activities (e.g. establishment in the field of parasitoids) as well as helping participants benefit from successes and avoid pitfalls that only became apparent after the formal termination of the project.

Cost model

Although work was done on the economics of CBB IPM (e.g. Duque & Baker 2003) it would have been useful if a simple cost model relating to the various IPM components could have been established to assist participants assess the cost-effectiveness of available IPM options.

5 ANALYSIS OF OUTPUTS AND IMPACT

The present chapter relates the findings in the project countries selected by ICO/CFC for the Impact evaluation. Examples from other participating and non-participating countries are sometimes used for comparison.

5.1 Main outputs of the project

Although many small-scale benefits emerged from the project's activities, only the principal ones are mentioned here.

For Project components 1&2: *The improvement and testing of mass-rearing and delivery systems for natural enemies (pathogens and parasitoids) of the CBB and their delivery to participating countries,* the most important outputs were:

a. Improvements in rearing systems have been developed and there is now a mass rearing system sufficiently advanced to have been transferred to participating countries.

b. Scientists from participating countries were trained in laboratory and field techniques during workshops, bench training and field plot exercises. When participating countries received the available natural enemy species for IPM development, researchers were able to establish viable laboratory cultures for release and establishment of wasps in the field.

For Project Component 3: *Integration of biological control technologies and other methods of cultural and chemical control to develop an IPM system*, the most important outputs were:

a. IPM components that were tested both for technical merit and farmer acceptability in all participating countries and used for IPM validation, model validation and as a training facility for farmers.

b. Availability of cost-effective IPM components that were increasingly adopted, together with an increase in the understanding of IPM by farmers.

c. The available project audits of national IPM activities and information obtained during the current field mission showed however, that the cultural control methods of removing berries from the trees after harvest and from the soil were the most adopted and important components (Duque 2002, LMC 2001, Campbell & McCook personal communication, Saldias & Echeverri personal communication), especially for small farmers.

For Project Component 4: *Dissemination of the IPM technologies/information and associated training of personnel to participating countries and other countries*, the most important outputs were:

a. The establishment of a complement of research and extension staff, including trainers, in each of the participating countries, competent to mass rear natural enemies, implement CBB IPM at farm level, and train others in CBB IPM implementation. These are now united in a more or less informal CBB network.

b. A wealth of documentation and presentation material has been extended to interested researchers and extensionists in participating and non-participating countries.

c. The Reports on IPM plots culminated in the Manual on Participatory Research with Farmers. However, this manual is mainly directed at researchers and extension staff.

d. Publication of research results in scientific journals.

5.2 Factors favourable and/or detrimental to the achievement of project objectives

The project as designed was ambitious. It aimed, by encouraging IPM for control of the CBB, to develop and make available to farmers a number of techniques, some of which were substantially innovative. Moreover the project aimed to disseminate its results internationally and to ensure that farmers and technicians had the necessary expertise to implement recommended practices. When reviewing favourable and detrimental factors with respect to achieving project objectives we propose that they be divided broadly into economic and technical categories.

5.2.1 Economic factors

The magnitude of the CBB problem in terms of losses as described in Section 4.1 provides a clear economic incentive for successful implementation of the project, a situation which, as shown by the results of the ICO Survey described in the same Section, does not appear to have changed very much.

Additionally some IPM techniques have a relatively low impact on production costs and can be recommended in the context of normal coffee cultivation practices.

However the implementation of the project was undoubtedly affected by the crisis of low coffee prices, which began about half way through the project period (March 1998 – April 2002). More specifically in March 1998 the monthly average of the ICO Indicator Prices for Colombian and Other Milds were 166.07 and 157.65 US cents per lb. respectively. By the end of the project period in April 2002 these prices had fallen to 69.63 and 65.29 respectively, a drop of almost 60 per cent. Looking at farm prices the annual prices to growers obtained from the annual averages for 1995 to 1997, when the project was devised and approved were 108.01 US cents per lb. for Colombia and 92.51 for Guatemala. During the years 2001 to 2002, when efforts to implement project findings and to plan for the future were under way, these prices had fallen respectively to 55.20 and 47.48 representing decreases of nearly 50 per cent. Price movements for Colombia, Guatemala and Jamaica during the period 1995-2002 are illustrated by the graphs on pp. 28 and 29. A further graph charts world coffee prices as represented by the ICO composite indicator price from 1995 to 2009.

It should be noted that Jamaica is a special case with respect to prices. Thus, largely because of the success of Blue Mountain coffee as a super-premium brand, the farm price of Jamaican coffee had fallen to 237.62 cents per lb. in 2002, a drop of only 20 per cent against the

1995-1997 average of 298.41 cents (see graph). It follows - especially in view of the quality imperative – that a strong economic incentive for CBB control persists in this country.

Looking directly at production costs the situation varies noticeably between countries such as Jamaica and Colombia where quality is rewarded by significant price premiums and those where this is not the case. An important study published by Duque & Baker 2003 noted that a coherent system of price penalties applied in Colombia. For instance coffee with 25 per cent defects would earn 23 per cent less than the benchmark price. This enables growers to assess the economics of IPM control by identifying defects levels where control becomes economically worthwhile. According to a CENICAFE model levels which are significantly higher for traditional growers (over 12 per cent CBB defects for cultural control only, compared with over 5 per cent for modernised farms), with actual costs of US$91 per ha, rising to US$140 if biological and chemical control are added. These figures remain somewhat theoretical, with a study of 46 farms giving mean production costs at US$200 per ha (Baker 1999). However such calculations are not necessarily obvious to farmers, although the Mission to Colombia was given an estimate for CBB management of 6 per cent of total production costs, which is not excessive. Nevertheless during the crisis period continuing to 2004 in Colombia as elsewhere the costs (fixed and variable) of CBB Control could not be covered by revenues. In spite of this control measures, particularly cultural, were undertaken, with positive results (see section 5.6 below).

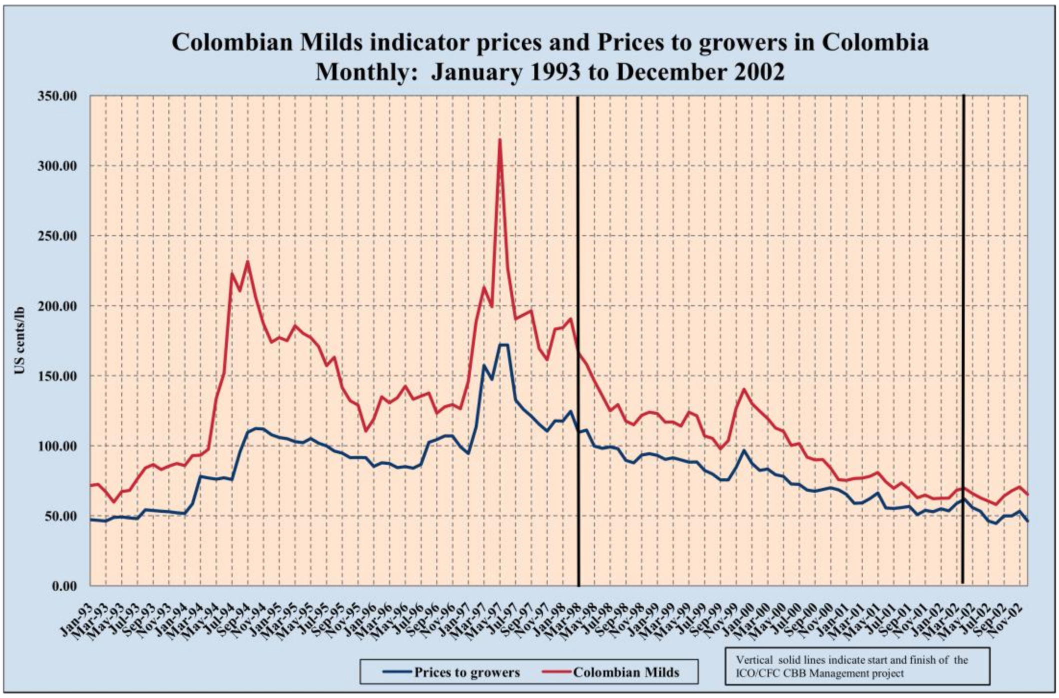
It is important to emphasise that in many countries such as Guatemala price premiums for high quality are very low[4], which provides a disincentive to invest in CBB control, particularly in periods of low prices such as obtained in the last two years of the project, when in many countries income from coffee was insufficient to cover production costs. It is significant that in CABI's Project Completion Report (Baker et al. 2002) the authors state that without transparent quality schemes with monitoring of private buyers "we feel any campaign against CBB is doomed to failure under present price strictures".

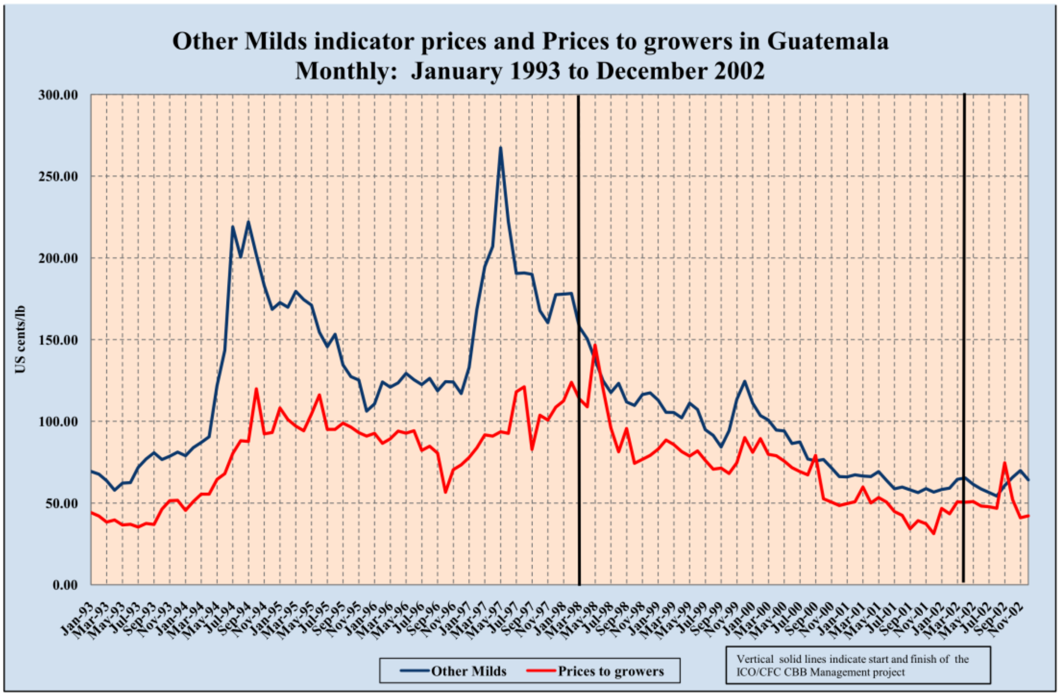
A further economic problem arises from the weakness of coffee research and extension institutes caused both by revenue shortfalls resulting from the price crisis and the weakening of institutions which had previously had a role in marketing, a function largely eliminated in favour of the private sector in the global drive towards economic liberalisation. This impacted not just on the capacity to disseminate IPM technology to farmers but on the ability to pursue biological control initiatives such as the mass rearing and establishment of parasitoids in the field, which was beyond the capacity of farmers, excepting perhaps the larger estates.

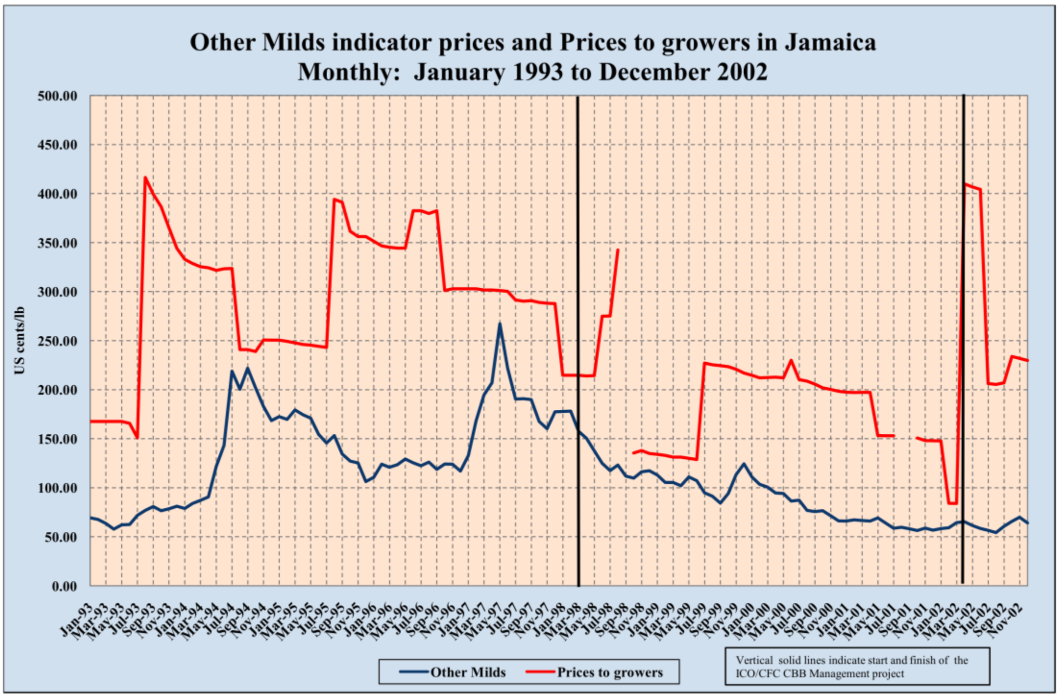
Promecafe (2007) indicated that in Central America normal CBB control measures were applied by farmers until just before the 2001/2002 crop, which suffered the consequences of the global crash in coffee prices. The effect of this was that farmers lessened

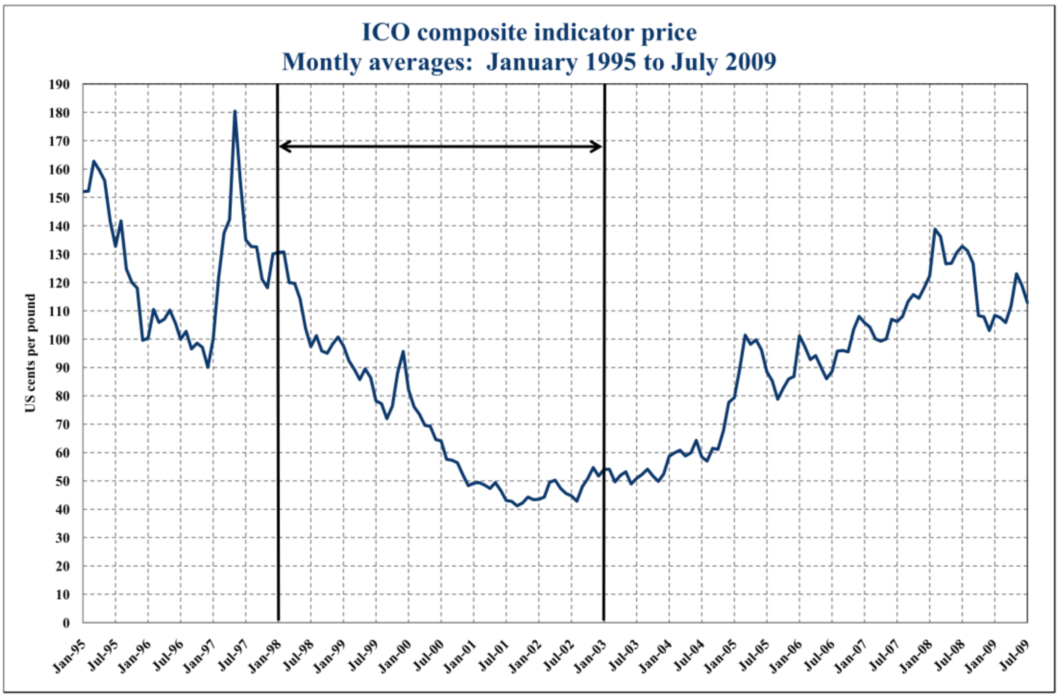
[4] *Although some estates may have established direct links with specialist buyers prepared to pay higher prices for quality.*

Graphs: Coffee Indicator Prices and Prices to Growers in Colombia, Guatemala and Jamaica; ICO composite Index Price.






Other Milds indicator prices and Prices to growers in Jamaica
Monthly: January 1993 to December 2002
US cents/lb
Other Milds
Prices to growers
Vertical solid lines indicate start and finish of the ICO/CFC CBB Management project


ICO composite indicator price
Montly averages: January 1995 to July 2009
US cents per pound

or discontinued pest management practices including even the simplest ones such as the removal of infested cherries from trees. Cases of complete abandonment of farms also aided the spread of the pest. This document also confirms that there was, for the same reasons, a drastic reduction in technical services to coffee farmers provided by coffee institutions in the region.

5.2.2 Technical factors

The techniques of cultural control of CBB were well known and had been used extensively, both in some of the project countries and elsewhere. This was an advantage that allowed for fast implementation during and after the introduction of Farmers' Participatory Methods. Clearly the technique came at the right time and developmental stage to be used and accepted by the farmers. Yet economic difficulties due to low coffee prices have also hampered the use of this technique.

On the other hand the aftermath of the project has proven that the biological control methods proposed were at too early a stage of development/research to be taken up by the farmers, in spite of the long history of the use of parasitoid wasps against CBB. Perhaps this is less true for *Cephalonomia* than for the other two species. This species, especially in Colombia and Guatemala, had already been in culture for research and practice, which may be the reason why it was accepted and is fairly widely used in Guatemala by more than 50 larger farmers, who are able to make it work economically.

For *Beauveria* it is a slightly different story. It had already been researched, but practical application in many countries was still lacking. During the project and afterwards, difficulties in its cultivation and application were overcome, and at the present day it is much more commonly used against CBB than before.

5.3 Responsiveness of the Coffee Industry to innovative outputs of the project and main reasons for this attitude

When farmers, extensionists and researchers were first exposed to the details of the project, they were very enthusiastic about the possibilities of controlling CBB, although not all were completely aware of the need for such control. When this became clear to them, the methods proposed to manage this pest were soon accepted. However, there were often barriers to implementation or continued implementation of the control techniques.

Among other things, the technical capacity of small farmers to use parasitoid wasps was too much of a problem in most, if not all countries. This is not only a technical problem, but also a socio-economic one. The management of small farmers' financial resources is very difficult for them, given the circumstances, especially so during the time of the project, when coffee prices were very low. Added to this comes the fact that in many countries quality is inadequately rewarded and there are many intermediaries. Due to these negative factors smallholder farmers in particular have become discouraged and show little initiative.

The use of improved cultural practices such as "re-re" is much easier and appears to have been accepted more widely.

With respect to traders the attitude seems to be neutral, probably because the issue is seen as a problem for farmers. It may be noted that on the whole industry in importing countries has traditionally not become involved in matters relating to control of pests and diseases in countries of origin, but this could change if and when MRLs are being demanded by importing countries.

5.4 Operational management of the project

The project involved a wide-ranging programme of activities in seven countries in two continents, together with a regional organization – PROMECAFE – responsible for project execution in four of its Member countries. From a managerial standpoint, a geographical spread of this extent must present a major difficulty for any project. The Project Executing Agency, CABI Bioscience (originally the International Institute for Biological Control [IIBC]) was responsible for overall implementation and management, including annual programming and budgeting and the maintenance of project accounts. Dr Peter Baker of the IIBC was appointed Project Coordinator. Although Dr Baker had impressive expertise in the areas covered we believe that further full-time managerial support would have been desirable.

The involvement of PROMECAFE as an extra tier of management undoubtedly had a delaying effect on the project. Although the project was launched in March 1998, the September 1998 Progress Report indicated that funding had still not been made available for activities in PROMECAFE countries and the June 2000 report continued to mention administrative problems in the PROMECAFE area.

The progress reports reveal some inconsistencies or inadequacies in adjusting activities to results and also give rise to further uncertainties. For instance the May 1999 Progress Report indicates that, in the light of research carried out in Colombia, mass rearing of *Cephalonomia* should be abandoned in favour of concentration on *Phymastichus*. Clearly this recommendation was not implemented consistently, since the April 2001 report states that Jamaica has made “excellent progress in culturing and releasing Cephalonomia”. To complicate matters (Campos 2005) asserts that surveys in Guatemala had confirmed the effectiveness of *Cephalonomia* in reducing CBB infestation.

Although meetings of participating institutions and bilateral contacts took place we consider that the lack of a permanent working group of representatives of institutions involved to disseminate information, monitor results and coordinate cooperation after the project’s term had ended has impeded the sustainable development of CBB IPM. In effect too much reliance was placed on the role of the PEA, whose involvement largely came to an end in May 2002. A working group would have been of particular value in the development of cost-effective biological control agents, since a lot of data, for example evidence of the establishment in the field of sustainable parasitoid populations, could only have emerged after the formal conclusion of the project.

5.5 Objectives against results and targets

Activities under Project Component 1 Act. 1-3b (Improved rearing of CBB and parasitoids) have been carried out to a certain point. This has been limited by the fact that the artificial diet developed for the CBB, including the necessary equipment, was uneconomic and further work was cancelled. Work on mass rearing of CBB was taken up by USDA on alternative funding. This successful research was only finalized after completion of the present CBB project (Portilla & Streett 2005, Leach 2001). Therefore in Colombia and other participating countries the use of cherries and parchment coffee, with their limitations, was continued. Rearing of the parasitoids was fine-tuned to a level where the Colombian facility was regularly producing nearly 3 million wasps per month (mostly *Cephalonomia* and *Prorops*). These were released in the field and distributed to participating countries (Activity 2). *Phymastichus* had been reared from a later date and in smaller numbers. More attention was to be given to *Phymastichus* after the first efforts, because it is the only one of the three parasitoids that directly attacks the CBB females when they are in the process of entering the coffee berry.

The reason why the use of *Cephalonomia* was not an economic success, as indicated in the results table of the Project Completion Report, is not clear. Perhaps the coffee price at the time made the use of *Cephalonomia* uneconomical, but certainly the economic situation has changed during the last few years (2006-8). In effect it seems that due to funding or technical problems, the rearing and release of parasitoids gradually diminished after completion of the project. Here a well-structured and funded technical cooperation framework between participating countries could have helped to overcome these problems and enabled the work on natural enemies to continue.

Research and development work on *Beauveria bassiana*, a fungal pathogen of CBB (Project Component 1, Act. 4), was halted because of “farmers’ rejection”(Baker et al. 2002). This was possibly due to the fact that the available technology was not yet ready for use by farmers. Although the project management stopped this activity, different national authorities continued - in particular CENICAFE - with very high standard research projects. Field testing, and successful commercial use of *Beauveria* against CBB is current in four of the six countries visited during the mission (Brazil, Colombia, Guatemala, Indonesia).

Training courses for technical staff from all participating countries on participatory research and mass rearing of CBB and parasitic wasps (Project Component 1, Act. 5) were successfully conducted. The target numbers in the Project Appraisal Document were not reached (Baker pers. comm.) perhaps because they were too ambitious, but on the other hand there may not have been enough suitable candidates in each country or the funds might not have been sufficient to cater for a larger number.

Component 2 of the project comprised the shipment/distribution of parasitoid wasps to the participating countries. This was duly performed and cultures were established, with subsequent releases in the field during the project period. After the project terminated this was not vigorously continued in most project countries, although Jamaica and Colombia are continuing to rear parasitoids for research. During the field mission we observed that the only country where *C. stephanoderis* is continually mass-reared was Guatemala, where over 50 larger farmers are financing and using Rural Rearing Facilities (RRFs). They have been releasing *C. stephanoderis* for over 12 years now, which is proving effective as a CBB control

method, especially in combination with cultural control. This was already established before the present project (Campos 2005).
The Integration of biological control technologies and other methods for cultural and chemical control to develop IPM systems (Project Component 3) was investigated through Farmers' Participatory Research with varying degrees of success in the different project countries. There was initial incomprehension and/or change of plans in India and Ecuador, where farmers' participation initially was limited to an "extension" exercise. Where possible and/or necessary this was corrected after the misunderstanding was cleared up.

In any case tight integration of IPM techniques does not seem to have been possible in most project countries. Main emphasis remained on cultural control methods (See e.g. Duque & Baker et al. 2002).

Special beneficial impact on farmers' practices can be mentioned in the cases of Ecuador and India, although these countries were not visited during the Impact Assessment mission (Baker 2002).

Predictive modelling as outlined textually in Component 3, was not further substantiated in the activities of the project. Both economic analysis and predictive modelling would have been negatively influenced by the very low world coffee market prices by the end of the project. The economic analysis of coffee growing and CBB control that was performed (Duque and Baker 2001, 2002 etc) showed that in most countries farmers could only hope to recuperate variable costs during this price crisis. Re-re was economically the most feasible, especially if coffee prices would rise, and appears to be behind the substantial gains achieved in Colombia (see 5.6 below).

The Audits performed in the project countries (Duque / LMC 2001, 2002), furthermore did not refer to the use of parasitic wasps or *Beauveria*. Only in the Guatemala report were they mentioned. That work however, had already been started in previous projects. Should we conclude from this that the project's work on biological control was unsuccessful? Or only developed up to a point where it was not yet ready to be handed over to farmers? It is worth noting that in a few small locations the technique appears to have achieved good results.

Component 4: Dissemination of IPM technology/information and associated training to participating and other countries was very modestly accounted for in the Project Completion Report. Although 6 activities were listed initially, the results of these do not become clear from the results table. This may be partly because they (such as training activities) have already been mentioned in previous/other results sections. On the other hand, there is only very little mention of project publications and scientific articles. This might have been due to the fact that, at the time of composition of the Project Completion Report, these publications had not yet been completed. However, there has been a large number of officially published documents produced by the project that are useful for other countries wishing to use the techniques and methods developed during the project.

5.6 Overall economic and social impact

The coffee sector is important in many producing countries because of the number of farmers involved, its position as a key generator of cash income in rural areas, and its contribution in terms of export earnings at the national level.

Colombia's coffee sector involves some 500,000 farmers and others representing over a quarter of the rural population. The coffee industry has been the principal motor of Colombian economic and social development. Given its role as a major source of employment in the rural sector, coffee continues to be indispensable, and has been a major influence in regional development. It has assisted in the creation of an economic infrastructure and a social safety net. For many years coffee was the principal contributor to export earnings and, though its share in total exports revenue has declined, it contributed some US$ 900 million in 2003, about 7 % of commodity exports. With the improvement in prices export earnings rose to US $ 2,112 million in 2008, or around 5.7 % of commodity exports.

In Guatemala there are some 43,000 farmers and perhaps some 400,000 people overall involved in coffee. Export earnings from coffee rose from US $ 247 million in 2003 to US $ 649 million in 2008, representing 11.3 % and 12.0 % of total commodity earnings respectively.

Jamaica has around 8,000 coffee farmers. Export earnings from coffee were US $ 29 million in 2003 and US $ 27 million in 2008, representing 2.5 % and 1.0 % of total commodity earnings respectively.

Production of coffee thus continues to hold great social and economic (less so in Jamaica) importance in project countries, which is particularly the case in the main coffee areas. It follows that any reduction in losses caused by the CBB will have a positive socio-economic impact, other things being equal.

In the case of **Colombia** the Mission was informed that annual losses from CBB had dropped from US$269.7 million before the start of the project in April 1998 to US$53 million by May 2002 and US$28 million as of May 2009. This represents a gain of US $216.7 million a year in the last over the first year of the project, which could be attributed to or would certainly derive substantially from the project[5]. Such a gain represents nearly 45 times the total value of the project. With respect to quality, problems caused by CBB affected 1.2 million 125 kg bags (parchment) a year as at April 1998, dropping to 460,000 in May 2002 and 90,000 in May 2009.

Unfortunately quantified estimates of changes in bean loss or quality due to CBB could not be obtained from Guatemala or Jamaica. Nevertheless in the case of **Guatemala** it was indicated that IPM measures introduced by the project were resumed after the recovery in coffee prices in 2004/05 with a consequent reduction in losses, which had totalled nearly US$76 million in the period 2000/2001 to 2002/2003.

[5] *However improvements may also derive from other factors such as work undertaken prior to the project and occurrence of climate conditions less suitable for the CBB. For instance 1997/98 is given as a bad year, thus giving a high initial reference point for infestation.*

The problems caused by CBB infestation also decreased in **Jamaica** between 1998 and 2009. The project itself was considered moderately successful by the authorities concerned, citing the introduction of IPM albeit with a prime focus on the more effective use of pesticides.

Finally it should be noted that the successful introduction of the farmers' participatory method (FPM) for extension has had an important social impact where introduced successfully in getting coffee farmers to work together, not just on CBB. As stated in the Final Report (Baker et al. 2002) on the project in India, over 120 FPM groups involving 2,579 farmers were formed: "…the FPM programme launched as a part of the CBB management activity under this Project resulted in extension activities being made more visible, in motivating growers to actively participate in such activities and it inspired extensionists to adopt new extension tools made available to them."

5.7 Impact of the project by sector

In view of the time (7 years) since the completion of the project, the large number of relevant factors and unavailability of data in many areas it proved quite difficult to determine the performance of the project in a quantitative and/or qualitative way. Nevertheless enough material was obtained to allow a reasonable vision of the project's impact in the three countries studied. Apart from the economic and social impact reviewed in section 5.6 above, the project's impact is analysed below on a sectoral basis.

5.7.1 Impact on farmers

In **Colombia** farmers in the period 1998 to 2002 received an average of around 75.8 per cent of the ICO indicator price for Colombian Milds. On the basis of the figures given in 5.6 above farmers may have benefited by up to US$163 million from the project by the time it terminated with subsequent continued gains from reduced incidence of CBB. Farmers in the most important coffee areas also benefited from a good degree of take up of IPM, facilitated by the Farmers' Participatory Methods, but this remains mainly limited to "Re-re" because with the current rearing methods the biocontrol options for IPM remain too expensive for most.

The impact of the project in **Guatemala** is clearly illustrated in a 2004 study by Campos showing the impact of IPM on specified farms. In the case of Finca Los Encantos the percentage of CBB infestation in 1998 and 1999 (1.37 and 1.29 per cent respectively, was reduced by over half to 0.59 and 0.52 per cent in 2000 and 2001 through the use of cultural control measures. In the Chocolá area the average CBB infestation on small-scale farmers' plots using IPM was 2.44 per cent compared with 8.07 per cent on plots without IPM. Although IPM applications were widely abandoned by farmers during the price crisis they were continued on experimental farms and some larger estates. Some but not all of these practices were resumed more widely when prices recovered. The project therefore can be said to have had a positive albeit interrupted impact. Biological control using *Cephalonomia* is now also used in combination with cultural practices on some 50 larger farms and these farmers massively apply trapping/ monitoring using "alcohol traps" as well. In addition, even smaller farmers tried the biological control options for IPM, but these were abandoned due to financial difficulties and have not been resumed after coffee prices increased.

The main impact of the project on farms in **Jamaica** appears to be the development of awareness of IPM options although chemical pesticides (mainly endosulfan) still predominate, with sometimes 3-4 sprays/season. However as stated elsewhere in the present report, due to a further choice limitation of available pesticides, demand for non-chemical options is likely to grow in the future, so the increased awareness is important.

5.7.2 Impact on extension services

In the three project countries visited by the Mission, the Extension agents were well versed in IPM techniques and commonly transferred these to farmers. However, the top-down approach for extension was still prevalent, which is less effective in empowering the farmers compared with the participative model. Extensionists in all countries are doing a good job with various types of farmer training, but due to the characteristics of the current extension model, massive adoption and acceleration towards farmer empowerment is unlikely to take place.

5.7.3 Impact on research institutions

In **Colombia**, in research the most advanced of the three project countries visited by the Mission, there is no doubt that the project has contributed significantly to the efforts of CENICAFE in combating the CBB. After the project ended, research has continued full steam, although the emphasis may now be more on understanding the theoretical aspects of CBB management. By understanding better how and why the techniques are effective or not, one could thus propose improvements towards their effectiveness. This is taking place for CBB behaviour, and trapping/monitoring by “alcohol traps”. The use of *Beauveria* and the intricacies of this organism with a view of making it a more potent control agent form another line of active research at present. The practical side of *Beauveria* culturing and application has now mushroomed into about ten small private firms that produce and sell the biopesticide.

The use of parasitoid wasps has not taken off and maintenance of the three wasp species cultures has been handed to private enterprise, but as mentioned above, farmers are not making use of it due to high cost (Benavides pers. comm.). For massive releases as researched and suggested by Portilla & Streett (2007) there has not been support from internal or external donors.

In **Guatemala** the project has given support to the biocontrol efforts with *Cephalonomia* already on the way and could be seen as instrumental in maintaining the momentum of this work as well as stimulating interest and work on *Beauveria,* which is presently being accelerated.

The research efforts in **Jamaica** have continued after the project, albeit in a different form. Due to a number of circumstances, the Coffee Industry Board is no longer cooperating with CARDI (Caribbean Agricultural Research and Development Institute) and is now pursuing CBB research together with the University of the West Indies. This work has emphasised trapping and cultural control methods and the economics thereof, but data analysis has not yet been finalized and published. A maintenance culture of two parasitoid species is kept, but is not actively used for releases. This might be picked up again in the future.

5.7.4 Impact on coffee sector profitability

In **Colombia** the emphasis is on cultural practices easily integrated with normal coffee tree maintenance. Costs of CBB IPM are estimated at 6 per cent of total costs and considered affordable. At normal or high price levels the use of IPM undoubtedly enhances profitability significantly in view of the improvements achievable in both quantity and quality.

The situation in **Guatemala** is similar although probably not so pronounced. IPM of CBB costs based on the use of two or three components are estimated at 295 Quetzals/ha equivalent to US$35.80. With average yields[6] of around 980 kg/ha (in many cases more) of green coffee this is not high.

Costs per ha in **Jamaica** of CBB IPM are given as US$110 for chemical control, US$102 for stripping and US$89 for traps, totalling US$301 (JMD 26,500). Although high, so is the export price and yield. By facilitating a greater choice of control options the project has enhanced potential profitability although growers are at present seemingly slow to relinquish the use of endosulfan.

5.8 Impact on other areas such as environment

The fact that cultural control methods are the mainstay of CBB control in most if not all countries signifies that control of this insect is mainly based on environmentally friendly methods, which cause no harm to the environment. Given that the project aimed at introducing pest management techniques using the principles of biological control, there does not seem to be a danger to the environment.

These methods are the use of parasitic wasps and pathogenic fungi that attack the CBB. The parasitic wasps introduced are extremely selective and only attack CBB and possibly some closely related species. *Beauveria bassiana* is a fungal pathogen that attacks the CBB while it is entering the coffee berry. Neither of these two organisms have any environmental side effects, although *B. bassiana* could also affect other pest species.

One of the positive results of the CBB management project may be that it possibly induces a reduction in the use of chemical pesticides. Duque (2003) established that when Colombian farmers were educated on IPM in a participatory framework, they tended to continue to use cultural control methods (95-98 % adoption), but that their preference to use biological control methods increased from 18 % to 80 %. At the same time the percentage of farmers opting for chemical control tumbled from 80 % to 38 %, thus reducing possible effects on the environment.

The trend to certification of “specialty” and “organic” coffees also helps in this effort. In effect, due to specialty coffee requirements as well as new importing countries’ regulations, more attention may be given to pesticides’ maximum residue levels (MRLs). “Organic” coffee should, of course, be produced without any use of synthetic inputs.

Some more interesting facts were learnt during the mission about the pesticide endosulfan. In Jamaica the use of endosulfan will no longer be permitted after 2010. In addition, one of the

[6] Source: ANACAFE, cited in USDA GAIN Report, May 2008

main producers of this pesticide announced in July 2009 that it would cease production and delivery of the compound after 2010. The reason for these measures is the existence of a number of studies concluding that this chemical is environmentally very harmful. These facts, together with the advantages of biological control, may induce coffee growers, in particular those who produce specialty and organic coffees, to step up their efforts in this direction.

5.9 SWOT Analysis of CBB IPM by Country

Matrices (see below) have been completed for the following project countries: Colombia, Guatemala and Jamaica, mainly using material gleaned during the Mission. Comments follow.

Colombia

It is interesting that the positive results in reduced CBB incidence (see 5.2 above) are seen as threatening to generate overconfidence. Together with this the implied weakness of biological control should also be seen as significant. The question arises as to whether the use of parasitoids has been adequately tested in the light of the success of improved cultural methods. The effects of parasitoids in Colombia remain somewhat unclear and it would be helpful to review the effects of the concentration on *Phymastichus* and rejection of other agents in view of the apparent successful use of *Cephalonomia* in Guatemala. With regard to strengths there seems little doubt that the strong institutional support brought to the Colombian coffee sector by the Federación has played a major part in obtaining satisfactory reductions in losses generated by CBB infestation during the period of the project. Finally the opportunities identified endorse the desirability of further reviewing the area of biological control.

Guatemala

The matrix identifies a number of positive factors, which have clearly been reinforced by the project. In particular, knowledge has been developed over many years, which makes measures taken more effective. The preservation of this expertise is of great importance. The weaknesses identified are mainly related to a lack of financial resources to farmers and institutions. One of the most effective ways to address this is to work for a scenario where higher quality coffee is recognised by significant price premiums. Favourable conditions for coffee and the identification of top areas with distinctive characteristics should assist here. Nevertheless prices paid to growers (particularly smallholders) by most traders do not reflect the retail value, which can be generated by the better coffees. To change this is not easy given the prevalent market structure, but in the long term dealing directly with specialist importers, the use of auctions for certain categories of coffee, and strengthening cooperatives could all be considered.

Jamaica

In view of the high prices commanded by Jamaican coffee the cost of IPM should not be a major problem. Moreover all forms of IPM seem to be available with the possible exception of *Phymastichus* for biological control. Nevertheless there still seems to be excessive reliance on chemicals. It may therefore be desirable to stress the potential damage to a premium coffee such as produced in Jamaica by chemical insecticides and to revisit IPM options including the use of *Phymastichus*.

SWOT ANALYSIS: CBB IN COLOMBIA

Strengths Positive factors relating to CBB management.	**Weaknesses** Negative factors relating to CBB management.
• Continuous training for small growers. • Good research and extension services. • Strong commercial structure. • Quality management.	• Pressure for the use of agrochemicals. • Expanding biological control to become more effective.
Opportunities Factors or situations with the potential for improving CBB IPM.	**Threats** External factors which could have a limiting effect on the capacity to control CBB
• Use of IPM as an exemplary technology. • Environmental benefits of IPM. • The need to continue improving quality.	• Overconfidence from good results so far. • Possibility of future pesticide resistance.

SWOT ANALYSIS: CBB IN GUATEMALA

Strengths Positive factors relating to CBB management.	**Weaknesses** Negative factors relating to CBB management.
• Good institutional structure (ANACAFE) dealing with coffee research and extension. • Good level of knowledge of the pest and its control developed over many years. • Knowledge has been transferred to extension workers and farmers in a continuing process. • This has resulted in the availability of a package of IPM tools, with considerable reduction in the use of chemical pesticides.	• Lack of financial resources on the part of small coffee producers which do not allow adequate implementation of control measures even when they are familiar with IPM. • The coffee price crisis weakened national technical teams with reductions or disappearance of qualified staff. • Limited resources available to widen geographical coverage of IPM implementation.
Opportunities Factors or situations with the potential for improving CBB IPM.	**Threats** External factors which could have a limiting effect on the capacity to control CBB
• Promecafe, as a regional body facilitating the integration of experience accumulated at the national level, can promote technical cooperation between Member countries and other countries in the area. • Farmers are receptive with respect to evaluating and adopting new technologies relating to IPM. • There is a close relationship between IPM and coffee quality criteria, including sanitary considerations such as pesticide residues.	• As a result of constraints resulting from low coffee prices control measures were reduced, with concomitant high levels of infestation. • As well as a wider horizontal spread of the pest there is evidence of infestation at higher altitudes, where there is a greater proportion of smallholders. • Limited control through IPM could lead to a return to chemical control, with its well-known risks and consequences. • The interaction of climate change with changes in the biology of the CBB has led to adaptation to changing conditions by the pest with greater incidence arising from shorter reproductive cycles.

SWOT ANALYSIS: CBB IN JAMAICA

Strengths Positive factors relating to CBB management.	**Weaknesses** Negative factors relating to CBB management.
• Industry aware of problem. • Industry aware of IPM techniques. • Availability of trained extension workers. • Pest control affordable.	• Lack of commitment and support from traders. • Unwillingness of some farmers to take action.
Opportunities Factors or situations with the potential for improving CBB IPM.	**Threats** External factors which could limit the capacity to control CBB
• Chance to improve income through CBB management. • Availability of all forms of IPM strategies. • Potential to use IPM to enhance quality image.	• Reliance on thiodan (endosulfan), which will soon be taken off the market, for CBB control. • Desire for short-term results through chemical control. • Risk to image through use of toxic chemicals.

5.10 Sustainability and replicability of results

The control of CBB by using different components of an IPM system has proved very feasible and can be applied in different regions, countries and even continents, given a good match between crops, edaphic conditions and climate zones. This is mostly the case for coffee cultivation, which is why the use of natural enemies from one continent has been successful to a significant degree in others. Thus it is perfectly possible to use natural predators or pathogens of CBB from one region in a matching zone elsewhere.

However, the experience with currently-known agents have not been as successful as so-called “classical biological control”, in which the agent is released in a new area, then establishes itself and takes care of controlling the pest without further human intervention or input. The biocontrol methods involving parasitoids introduced or augmented during the project have all shown that establishment and reproduction in the field is possible, but at the same time it became clear that without further intervention the level of control was not sufficient to control CBB. Therefore at the present time only augmentative biological control[7] is doable, which needs continuous effort and financial input. This is particularly the case where there are clear periods between harvests when the number of cherries available to the CBB is greatly reduced. Even though this method can be effective, as demonstrated in Guatemala (Campos 2005) it will only be economical and hence sustainable if the price of coffee remains at sufficiently remunerative levels to ensure a positive return on the IPM techniques used.

With respect to the use of the fungus *Beauveria bassiana* results have been variable but its relative ease of use, with application methods similar to those for chemical insecticides, and the development of methods to produce this fungus on farms[8], encourage further research into conditions under which this agent can be used successfully.

On the other hand improved cultural practices such as careful attention to hygiene in coffee plantations can be integrated into sustainable mainstream cultivation and are easily replicable with appropriate small adjustments to local conditions. In India these operations have been assisted by the use of picking mats to reduce the quantity of fallen fruits to be retrieved. The main constraints are the availability and cost of the additional labour required. The necessary inputs will usually be more easily found on family farms and in countries where labour costs are low.

We conclude that there are significant variations in the level of sustainability of the various IPM components identified, with positive replicability linked, as could be expected, to prevalent ecological and socio-economic conditions in new target areas. We would also like to reiterate that the lack of a permanent working group of representatives of institutions involved in the project (see 5.4 above) has almost certainly made achieving sustainability more difficult.

[7] *This refers to the process of augmenting existing populations by releasing large additional quantities of mass-reared natural predators of the pest.*

[8] *Email of 31 August 2009 from the Chairman of the Indian Coffee Board to the Consultants.*

6 LESSONS LEARNED

The study of project reports and other relevant literature, together with observations during the field mission (see Annex I for full details of the methodology followed) have led to the following conclusions:

6.1 Project Design

The design of the project was complex, in terms of the range of activities, the number of countries and spread over several continents, which probably made project management more difficult.

The economic malaise in coffee from 2000 to 2004 greatly reduced the interest of coffee farmers in investing in their farming systems, which had a significant impact on the project.

6.2 Implementation/Operational Aspects

Although central project management was good, more human resources in management would have been helpful in view of the project's complexity in terms of its range of activities and number of countries involved.

Farmers' awareness and knowledge in some countries can be quite high but future demands in a very difficult market situation may mean that both public and private sectors should be encouraged to help improve such knowledge, including IPM strategies. While farmers developed a stronger understanding of the IPM concept during the project, it could be useful to separate out the individual contribution of each component to the reduction of pest populations. In a scenario of low coffee prices coffee farmers could then choose the component(s) with the most impact if economic resources become scarce.

The development of a basic easy-to-apply economic model to help farmers choose the optimal IPM component mix would be very useful.

IPM strategies as implemented in this project should help to develop organic coffee production in these countries.

Small farmers accepted the situation before and during the project too passively. Often they expected government bailouts. This situation can at least in part be attributed to a lack of education in the smallholder sector, which is a major obstacle to improving production, coffee quality and CBB management. Consequently work with farmers should be focused on small coffee producers because they are facing more difficulties with CBB management. In the future much effort needs to be made towards community strengthening, learning and empowerment so that farmers can cope better by themselves, with emphasis on participatory methods such as Farmers’ Field Schools.

High input costs are severe problems, while low world prices, low productivity and low quality can be offset in the short term by abundant cheap labour although there are signs that labour may become scarcer.

CBB management for small coffee producers based on cultural control has been reasonably effective, but the low price climate during the project was inimical to labour-intensive methods in view of high wage costs. Hence as a long-term strategy it is insufficient, and if coffee is to prosper, either labour-saving technologies or high quality premiums will be required.

Quality is not clearly rewarded by the market structure in many countries. This can discourage farmers from improving CBB management even if they are aware of the implications of the pest attack in terms of coffee weight and defects. Therefore it is important to work more on the conversion rate between cherry coffee and dried coffee under different CBB population levels and to make the possible effects on their gross income better understood by farmers.

The evaluation concluded that considerable advances had been made in the biological control methods proposed. However, these were at too early a stage of development to be taken up by farmers during the project. This is particularly the case with parasitoid wasps, although some positive results have been achieved with *Cephalonomia stephanoderis* in Guatemala. The Rural Rearing Facilities (RRF) for parasitoids, as applied there, can be an effective way of transferring technology. RRFs also serve to decentralize production of parasitoids.

It should be noted that technologies for cost-effective automated mass-rearing of parasitoids only became available at the end of the project and require substantial investment, which was not forthcoming at the time of the coffee crisis. If countries within a region would be able to muster sufficient financial and technical resources, using parasitoids for control of CBB might become more successful and economically viable.

For the application of parasitoids the three years of the project were insufficient and therefore future biological control projects should be approved for five (5) years instead of three (3).

During the project, when rearing and use of parasitoids was being developed, other research developments that appeared easier to apply were making their appearance. A particular case was the "alcohol trap", which in some countries diverted attention from parasitoids.

For the fungus *Beauveria bassiana,* some of the difficulties in its cultivation and application were overcome during and after the project, and at the present day it is much more commonly used than before and at the end of the project.

6.3 Sustainability

Cultural control is a sustainable, effective and environmentally sound method, but the cost of labour (and its availability) make its use difficult to maintain under adverse market conditions where labour costs are high and coffee market prices are low.

Poor money management skills of farmers and lack of access to financial services have had a negative impact on the use of necessary management practices for coffee farms.

The existence of an inter-country structural working party on CBB IPM that could have continued after the project had ended would have significantly enhanced the project's sustainability.

7 CBB IN NON-PROJECT COUNTRIES

7.1 Use of project results and independent action

The overall aim of the project was the integration in practice of different compatible control methods into a cost-effective CBB management system.

In addition to the three project countries to be assessed, the terms of reference called for an evaluation of CBB in three additional countries where new or different strategies to those of the project were implemented. The countries indicated were Brazil, Ethiopia and Indonesia.

Indeed the project has shown that the techniques suggested at the beginning, especially cultural control methods, were of use in practice and were able to achieve good levels of control of CBB. But none of the techniques by itself provides sufficient control of CBB in the field. The use of biological control against this pest is not new either, and during the course of the project it was not successful enough to have a major impact. Perhaps the use of *Cephalonomia* in Guatemala represents the most successful experience here.

The mass-rearing techniques for CBB, which were developed (Portilla & Streett 2005), are an essential pre-requisite for an eventual economically viable mass-rearing of parasitoids (Leach 2001). While these techniques became available just after termination of the CFC/ICO project, they are now feasible, but would require a fairly large investment in machinery.

The project was unique in that it was the largest concerted effort to control CBB in a region or country. The experience with Farmers' Participatory Methods (FPM) in Central / South America and above all in India (reviewed from reports only) was very impressive. It was proven in other crops and continents (Ooi & Kenmore 2005) that FPM gets more farmers interested and motivated to improve the quality of their coffee, of which CBB management is an essential part. It follows that FPM merits much more emphasis in future projects.

7.2 Case study 1 – Brazil

In consultation with EMBRAPA, the Brazilian Agricultural Research Organization, it was decided to visit the State of Rondônia, where EMBRAPA has a research station, where research on control of CBB is conducted, and which lies in a relatively new Robusta coffee growing area in the Amazon region.

In many of the coffee growing states such as Minas Gerais and Espirito Santo, CBB is currently less severe than before; but in Rondônia it has become a serious problem. Both at the research station and coffee farms high levels of infestation were found. Control is mainly by cultural methods, which can include green harvesting to avoid CBB infestation. Whereas CBB control in many states is based on chemical pesticides, this is not the case in Rondônia. The technology to improve coffee production is available but mostly not applied and consequently the productive area in Rondônia has of late fallen by 25%.

Given that the use of endosulfan to control CBB will have to be gradually phased out in the years to come due its effect on the environment, Brazilian authorities are now in the process of registering an organophosphorous insecticide chlorpyrifos, which is also effective on CBB, so that endosulfan can be phased out.

The research conducted by EMBRAPA now and planned for the future focuses on biological control, including the use of parasitoids, but emphasising *Beauveria* with the aim of its practical application. A similar research project on testing different strains to find highly virulent strains of *Beauveria* and different formulations is being conducted at the College of Agriculture, University of São Paulo (USP).

At the USP other interesting studies on behaviour of CBB may lead to the discovery of new attractants for this insect, which could be used in monitoring or enhanced control methods.

7.3 Case study 2 – Indonesia

Indonesian authorities (Ministry of Agriculture and Min. of Trade) as well as the organization of coffee exporters (AEKI) planned the mission's visit to Northern Sumatra – Aceh, Lampung, East Java and Bali.

During the field mission we observed in all provinces visited that CBB can cause serious damage, both in arabica and robusta coffee. Indonesian researchers have found that CBB since the last few decades is occurring at higher altitudes than before, probably due to climatic change. In Aceh province CBB was found at elevations up to 1400 masl. In Lampung where the main harvest had already taken place the remaining berries were ripening and were very heavily infested with CBB. Cultural control could normally take care of this infestation, but was not applied. A few Broca traps of the commercial variety had been installed; farmers found these very expensive. In East Java (which is the region where the Indonesian Coffee and Cocoa Research Institute is established) farmers were more disciplined in using cultural control methods and infestation levels were lower than in the other provinces. CBB infestations in Bali were at levels that were just about acceptable with little economic damage. Coffee farmers in many districts have been participating in Farmers' Field Schools (FFS) and did manage CBB by means of cultural methods. They learned good practices of coffee cultivation in the FFS, which, together with the management of CBB, resulted in a yield increase of 10-20% and better quality than possible previously. The farmers' groups that were thus formed continued after the initial FFS and have regular meetings, field and social activities.

Control of CBB in Indonesia is mainly by cultural methods; insecticides are rarely used (Soekadar pers. comm.). Of the common biological control methods *Cephalonomia* is still in the research phase, whereas some advanced farmers are now using *Beauveria* and traps are being promoted for monitoring and trapping. Estate Crops officers have laid out experiments with the pathogen in farmers' fields, but it was observed that several of these were initiated at a time when the CBB females had already entered the fruit, causing the failure of the experiments, which could become a discouragement to farmers to use *Beauveria*.

Research on management of CBB is severely restricted due to a lack of funds. *Beauveria* and *Cephalonomia* and the use of traps are the main topics to be dealt with when funds permit.

7.4 Case study 3 – Ethiopia: A natural balance?

The region that covers South West Ethiopia, North West Kenya and South Sudan has long been considered the origin of the CBB. As such, a great complement of natural enemies can be expected and the insect may not or only occasionally reach pest status. Similar situations are prevalent in other African countries, where the coffee berry borer and some of its main parasitoids, *C. stephanoderis* and *P. coffeae* live in relative balance, keeping damage low (Wegbe et al. 2003).

Until recently CBB was considered a minor pest in Ethiopia, causing relatively little damage on left over berries (Million 1987) and therefore received little attention. Some research into this insect's occurrence and behavior was conducted when survey work during the past decade revealed that it is widespread throughout the country, and especially worrying in lower altitude areas with large-scale coffee plantations, such as Tepi at 1200 masl (Esayas et al., 2003). Global warming may be another cause for a further increase in severity and spread of this insect within Ethiopia (Jaramillo et al. 2009). It is therefore important that CBB be monitored regularly. It would also be beneficial to further study this insect and its ecology to explore systematically conditions where a natural balance between the pest and its enemies may occur.

8 RECOMMENDATIONS FOR FUTURE PROJECT DESIGN AND OTHER ACTION

8.1 SWOT Analysis of the Coffee Sector by Country

Matrices (see below) have been completed for the following project countries: Colombia, Guatemala and Jamaica, mainly using material gleaned during the Mission. Comments follow.

Colombia

Colombia remains exceptionally well equipped to adopt relevant new technology throughout the sector. It needs to remain so in view of the challenges posed by high production costs and the potential threats from climate change. Important work is currently under way to replace aging trees and this provides an opportunity to reassess IPM methods, which currently emphasise cultural practices ("re-re"). One of Colombia's strong points is its positive image for quality. Since this is safeguarded by biological control it seems desirable to look again at this area without downplaying the great success of "re-re". Local sentiment is that IPM is affordable at current (mid-2009) prices.

Guatemala

Guatemala has a strong institutional structure and a range of excellent high-altitude coffees. Unfortunately the marketing system does not in general reward quality, which discourages farmers from taking a number of quality-related measures including IPM, in spite of several successful technical initiatives, which appear to be affecting only very limited geographical areas. The weaknesses identified are mainly related to a lack of financial resources to farmers and institutions, which include the difficulties of obtaining credit for plant renewal. Both government and private institutions need to consider encouraging alternative marketing mechanisms to realise the potential value of the product. The effects of climate change on coffee need to be monitored.

Jamaica

Jamaican coffee benefits from a highly beneficial premium status. Care must be taken that considerations of short-term gain should not jeopardise its favourable market position. Monitoring and appropriate action for pest management and to deal with climate change are affordable and the industry should ensure it keeps up with all recent relevant technical and research developments.

SWOT ANALYSIS: COFFEE IN COLOMBIA

Strengths Positive factors relating to the outlook for coffee.	**Weaknesses** Negative factors relating to the outlook for coffee.
• Social and economic importance of coffee. • Strong institutional structures (Federación) to support the sector in all aspects. • Powers of the Federación to market coffee allows reasonable price differentials to reward quality. • Quality high and consistent, with image spread internationally through large-scale promotion campaigns.	• Weather and climate change problems. • Relatively high production costs.
Opportunities Factors or situations with the potential for improving coffee farming.	**Threats** External factors, which could have a limiting, effect on the outlook for coffee.
• To benefit from the development of the “gourmet” market. • Initiate projects to renew old plantations. • Recognition of the provision of environmental services relating to coffee.	• New pests and diseases. • Increase in the incidence of pests and diseases related to climate change. • Danger of switching to alternative crops.

SWOT ANALYSIS: COFFEE IN GUATEMALA

<table>
<tr><th>Strengths
Positive factors relating to the outlook for coffee.</th><th>Weaknesses
Negative factors relating to the outlook for coffee.</th></tr>
<tr><td>• Good institutional structure (ANACAFE) dealing with coffee research and extension, promotion on the international market, and export quality control.
• Most (some 80 per cent) coffee growing occurs at altitudes in excess of 1,200 metres, which results in a substantial supply of high quality coffee.
• Considerable diversity in microclimates also gives a wide range of quality coffees leading to the definition of named production zones, which has resulted in improved recognition and value accorded to Guatemalan coffee on the international market.</td><td>• Aging coffee trees, with little renewal of plantations.
• Low average yields (bags/ha.).
• A financial system that does not grant credit to farmers for renewal of plantations.
• As with many producers worldwide, there is still a heavy dependency on the international coffee price.</td></tr>
<tr><th>Opportunities
Factors or situations with the potential for improving coffee farming.</th><th>Threats
External factors which could have a limiting effect on the outlook for coffee.</th></tr>
<tr><td>• To increase direct negotiations between producers and small and medium importers.
• Greater recognition of Guatemala as a quality origin, resulting in higher prices.
• Recognition of the provision of environmental services relating to coffee.</td><td>• Decreasing national production and exports.
• Partial abandonment of some coffee zones, or change in land use, arising from the low profitability of coffee growing.
• Increase in the incidence of pests and diseases related to climate change.
• Pronounced fluctuations in the international coffee price.</td></tr>
</table>

SWOT ANALYSIS: COFFEE IN JAMAICA

Strengths Positive factors relating to the outlook for coffee.	**Weaknesses** Negative factors relating to the outlook for coffee.
• Produces premium price coffee led by Blue Mountain • Good technical support structures. • Trained extension workers available. • Successful international marketing structure.	• Excessive reliance on chemicals for pest control. • Divisions between traders and farmers.
Opportunities Factors or situations with the potential for improving coffee farming.	**Threats** External factors which could have a limiting effect on the outlook for coffee.
• Reinforce quality image through use of IPM. .	. • Increase in the incidence of pests and diseases related to climate change. • Threats to quality arising from climate change. • Constant vigilance needed to maintain quality.

8.2 Follow-up of the project

The SWOT analyses (5.8 and 8.1 above) clearly point to the desirability of continuing to develop biological control initiatives and to reinforce the process of abandoning the use of chemical insecticides. New initiatives need to take into account the possible effects of climate change and to integrate IPM into the context of enhancing quality and marketing. Within this overall framework and taking into account the results as described in Chapter 5 we wish to make the following recommendations to be considered when considering new initiatives:

a) Farmers' participatory methods should be central to any further projects to be conducted.

The traditional method of extension includes the so-called "Training and Visit" system, a "Top down" system, which is not working well. As a consequence the "Farmers Field School" was developed (Ooi & Kenmore 2005) which has as its purpose the empowerment of farmers. It aims to bring farmers together whereby through carrying out carefully guided collective field activities the farmers can use the 'discovery experiential learning process', solving their own problems and at the same time developing a sense of community. In the present project this approach was successfully applied, especially in India (CABI, Commodities Press 2002).

b) Continued but carefully focused testing of biological control agents in the field should be encouraged.

Considerable advances had been made in the biological control methods proposed by the project. However, these were at too early a stage of development to be taken up by farmers. This is particularly the case with parasitoid wasps, although some positive results have been achieved with *Cephalonomia stephanoderis* in Guatemala. It should be noted that technologies for cost-effective automated mass-rearing of parasitoids only became available at the end of the project and require substantial investment. Regarding the fungus *Beauveria bassiana*, some of the difficulties in its cultivation and application were overcome during and after the project, and at the present day it is much more commonly used than before.

c) Priority should be given, within an IPM framework, to abandoning the use of chemicals for CBB control.

The development of "Organic" and "Specialty" coffees with higher farm gate prices, as well as the requirement of Maximum Residue Levels (MRL) by importing countries should be an incentive to reduce or eliminate the use of synthetic pesticides to control CBB.

d) CBB Monitoring systems can be established by using locally produced "alcohol" traps.

Based on work that became available from other sources (e.g. CIRAD, Dufour 2009) during the time of the project, it is now possible to produce locally these traps for control trapping and for monitoring to establish "treatment" levels. Promising work is being conducted in project countries and elsewhere and follow-up projects should incorporate this.

e) Small farmers in Central American countries that have not participated in the original project could benefit from its results and the advances that have been made since.

The original project did not cover all member states of PROMECAFE. Due to the unfavourable economic conditions many coffee farmers in the participating countries were not able to take full benefit of the project either. These groups should be given the opportunity to participate in a possible follow-up.

f) Farmers in certain parts of Indonesia need to be organized in farmers' groups and be empowered to understand and apply sound IPM techniques against CBB.

Some remote regions of Northern Sumatra in Aceh and N. Sumatra provinces are relatively new coffee (Arabica) growing areas. The farmers there (and perhaps in other provinces) have not yet been exposed to participatory methods of managing CBB and other aspects of coffee cultivation. A project with emphasis on Farmers' Field Schools would enhance and accelerate the work being carried out by the provincial authorities.

g) Greater price incentives to farmers for quality need to be adopted.

In many project countries, as well as in other coffee producing countries, the price of coffee at the farm gate does not take quality of the product into account to a significant extent; hence there is not much incentive for farmers to control CBB, since they believe it does not benefit them economically. However most farmers are not aware that the conversion factor from berries to parchment coffee is also greatly affected by CBB. Since their losses are increased by weight losses as well as defects CBB control would benefit them doubly, provided that coffee prices reflect the quality of the product.

h) Impact of climate change should be considered

Future initiatives, such as new projects, should assess the possible impact of climate change in areas where such initiatives are proposed.

i) Formation of an international consultative group

The Formation of an international consultative group or working party on CBB research should be encouraged. A number of priority research topics are identified (See Section 8.3).

8.3 Future CBB research and development

The field mission and other sources (e.g. literature) have shown that many avenues of research remain open with good chances of improving the effectiveness of Integrated Management of CBB in the future. Some of these are mentioned below.

Detailed investigation on the chemical compounds produced by coffee (berries and/or bush) and of the pheromones or kairomones that attract *H. hampei* could lead to the development of a species-specific trap, using these substances. Some work along these lines is being conducted at the University of São Paolo in Brazil (Bento pers. comm.). A possible drawback of using such traps is that natural enemies might also be attracted and killed, since it has been shown with insects of the family Scolytidae that the same substances frequently attract the pest and its natural enemies.

Research into the application of saprophytic or pathogenic microorganisms, such as bacteria, fungi and nematodes, to degrade coffee berries on the ground, which harbour *H. hampei* during the inter-harvest period.

Although the use of pesticides should be discouraged in the light of organic coffees and MRLs imposed by importing countries, there are a number of producing countries that still heavily depend on insecticide sprays. In those cases treatment of CBB "hotspots" should be considered to replace "blanket spraying" and alternative "softer" compounds should be developed where possible to replace the environmentally dangerous ones currently being phased out by chemical companies.

A clear analysis of environmental, economic and management factors that influence infestation levels of *H. hampei* in different parts of the world could shed light on the status of the pest in different coffee growing areas. In Colombia the level of CBB infestation seems to be linked with the so-called "El Niño" phenomenon (Benavides pers. comm.). Such useful aspects could be built into decision-making tools for integrated pest management strategies geared to regional conditions.

In general, with parasitoids, not enough attention has been paid to climate matching between the source and destination area of the natural enemy; failures of biological control have been documented in which climate and ecological matching were not carried out conclusively. For instance, Klein-Koch (1989) in Colombia, cited by Vega (1999) mentioned a strain of *P. nasuta* from Togo that was more efficient than insects of the same species collected from Kenya.

Biodiversity studies of the coffee pest complex, in particular CBB and its natural enemies, in regions such as south east Ethiopia, and northern Kenya and Uganda, may yield further unknown natural enemies, as shown by Jaramillo et al. (2009), and provide further scope for biological control.

Several authors (e.g. Damon 2000) have highlighted the lack of coordination in coffee berry borer research between interested parties in coffee-producing areas, and the lack of a global strategy which would include improved quarantine procedures, a widening of research activities to include one or more of the novel aspects mentioned and adequate technology transfer. Some efforts in this direction have recently been made (Jaramillo pers. comm.), but the formation as suggested elsewhere in this Report of an international consultative group or working party on the CBB could be very helpful. Assuming an existing coffee research institution could host such a group it should be able to function cost-effectively with a relatively modest level of support from participants.

9. ANNEXES

Annex I - Methodology

This was based essentially on the Terms of Reference for the Study, included below in this Annex. More specifically the sequence and actions undertaken were as follows:

a) Review of project literature
b) Consultation with PEA (CABI) and SB (ICO)
c) Development of Guideline Questionnaire for use on field missions (attached below to this Annex)
d) Field mission for interviews with participating institutions, farmers, project staff, government officials and private sector association representatives (list of contacts Annex 3)
e) Establishment of report structure
f) Analysis of data and development of country reports for situation before implementation and on conclusion of project, and that at the present day to assess:
   1. Management of the project
   2 Project target fulfilment
   3 Analysis of results in technical and economic terms
   4 Review of lessons learned
   5 Review of current situation
   6 Identification of opportunities and threats using SWOT analysis
   7 Final report to include recommendations
g) Analysis of CBB situation in non-project countries including 3 case studies (incorporated into the final report).

TERMS OF REFERENCE

Impact Evaluation of Project "Integrated Management of the Coffee Berry Borer" CFC/ICO/02 Terms of Reference

Background

The capacity to plan, manage, implement, and account for results of policies and programs, is critical for the achievement of development objectives. Diagnostic reviews of experiences and lessons drawn from project results, monitoring and evaluation of projects and programs are an effective means of ensuring that the system in operation and the procedures and policies for managing development resources are effective, accountable and transparent. Managing resources and improving decision-making for results implies implementing projects and programs with a focus on desired results and use of information to improve decision-making. These are the overarching objectives of the evaluation.

The Five Year Action Plan (FYAP) 2003 to 2005 recognizes that "…ex-post evaluation of completed projects is essential in order to assess the impact, cost effectiveness, sustainability and replicability of Common Fund financed projects and to draw lessons from past experience."

Specific Objectives of the evaluation

The purpose of the evaluation is to assess the development impact of the above project and the extent to which the projects' objectives and targets have been achieved. It is also to examine the elements of success and failure in the project design and implementation, with a view to drawing lessons from the experiences. In this regard, the evaluation is expected to assess the impact of the projects on the development of the sector concerned using selected indicators. Specific indicators should be used to measure progress towards goals and specify the output measured in order to determine the performance of the projects, in a quantitative and/or qualitative way. Such indicators should measure, *inter alia,* the impacts of proposed technology, know-how through replication and dissemination to intended beneficiaries.

An important aspect of the evaluation is also the extent to which the projects were relevant to the development strategy and priorities and their ownership by the beneficiary countries. The evaluation should, therefore, assess:

- whether the design of the project was suitable to achieve the stated objectives;
- relevance of the methods of the project for achievement of the objectives;
- the extent to which the project objectives have been met;
- the extent to which new technologies and techniques developed by the project have been adopted by farmers and disseminated to other beneficiaries and in case this has not been the case identify the main problems encountered;
- the lessons that can be drawn from the projects and their implementation to serve as guide for future projects financed by the Common Fund.

Proposed time frame for the mission

The impact evaluation is to be undertaken by the consultant from April 09 to June 09 and include selected visits to three countries where the project was implemented and another three where new/different strategies may have been implemented. The detailed itinerary will be prepared in due course, based on confirmed availability of the counterparts in the countries selected. The consultant(s) will make travel arrangements accordingly and inform the parties in the countries in time about arrival and departure details. The consultant should feel free to contact the country contacts in advance to elaborate specific program/meetings as deemed appropriate. Final program arrangements will be made by the consultant with the contact persons when in the country. The Fund will support in these arrangements and expect to be informed of final arrangements.

Expected Output

The consultant is expected to prepare an impact evaluation report detailing the factual findings and their analysis in the areas of the terms of reference.

The impact evaluation report shall be produced together with a clear summary of the situation prior to the CFC/ICO/02 project, which could include *amongst others* infestation levels, losses, financial inputs aimed at the insect, and its comparison with the present situation.

This should be complemented with empirical determinations on what recommendations from the project were accepted and implemented by growers, which were effective and whether any of them are still in place.

A comprehensive summary of the present situation with detailed benefits of the project, if any, should also be prepared.

In the event that the findings confirm that the situation has not improved with the project, then the evaluation should determine whether there was any failure with the project design and in which conditions there is room for new projects on this particular area.

Conversely, if the findings confirm that the situation has improved with the project, there should be clear elucidation as to how these improvements are a result of the project, as the project finished in May 2002.

The evaluation should be able to find locations where strategies related to the project were implemented and produced measurable outputs.

Sources of data and other information shall be given. Where assumptions have been applied, these must be made explicit. In an annex to the report a complete list shall be given of all documents consulted, all meetings held and contacts made by the consultant indicating dates, venues, persons involved and subjects discussed.

Payment

The consultant will be paid a lump sum including consultancy fees, daily subsistence allowance and travel cost. 50% of this sum will be paid up-front and 50% upon satisfactory submission of the evaluation report. The consultant will first submit a draft version of the evaluation report and obtain the comments of the CFC Secretariat to finalize the report.

The Impact Evaluation Report

The evaluation report should be prepared in English and be submitted in draft form to the Common Fund for Commodities by 31st July 2009. After adjustments are made, as necessary, taking into account the comments received, the final Report should be submitted to the Common Fund for Commodities in hard and electronic copies, at the latest, by 31st August 2009.

The report of the consultant will be the final outcome of the independent impact evaluation of the project concerned.

The evaluation should be able to find locations where strategies related to the project were implemented and produced measurable outputs.

The three suggested countries to be assessed - from the seven that participated in the original CBB project (Colombia, Ecuador, Guatemala, Honduras, India, Jamaica and Mexico) are:

- Colombia, Jamaica, and Guatemala.

Colombia has a very strong scientific coffee berry borer programs and is where strong implementation and follow-up on any project recommendation related to the insect would be expected. **Guatemala** is expected to be a good contrast to Colombia, and **Jamaica** of course is an island, thus representing a different setting which would be interesting to learn more about.

Three additional countries, different from those directly involved in the project, should also be assessed in order to also evaluate locations where new/different strategies to the project have been implemented so that present situation responds not solely to the project.

For this, the evaluation team will have to keep in mind how to separate aspects of strategies from subsequent strategies unrelated to the project. These three suggested countries are as follows: in Africa, although Kenya was previously mentioned, **Ethiopia** may be more suitable. Ethiopian coffee receives enormous attention and learning more about thecoffee berry borer situation there would be quite important, as it might also suggest newresearch avenues related to the genetic diversity present in the country. The other twocountries should be **Brazil** and **Indonesia**.

The impact evaluation report shall have the following structure:

I. Executive Summary

- Main findings;
- Lessons learnt; and
- Major recommendations.

II. Introduction

- Period and place(s) of evaluation
- Composition of the evaluation team

III. Description of the Main Elements of the Projects

- Problems addressed by the project
- The means applied to solve the problems
- Stated beneficiaries
- Results achieved
- The main players involved

IV. Project Objectives

- Importance of the problems addressed for the commodity and the beneficiaries
- Relevance to poverty alleviation and to the ICB strategy(s) of coffee development
- Suitability of the means to address the problems

V. Analysis of Outputs and Impact:

- What were the main outputs of the projects
- Factors favourable and/or detrimental to the achievement of project objectives
- Appropriateness of the measures chosen to address the project's problematique
- The responsiveness of the coffee industry to the innovative outputs of the projects and what were the main reasons for this attitude

VI. Lessons Learned

VII. Consultants other findings and Recommendations for future project design

VIII. Annexes

1. Methods applied for the evaluation
2. Work schedule
3. Places visited and persons contacted
4. Other sources of information

GUIDELINE QUESTIONNAIRE (English – Spanish and Portuguese versions also used)

CBB Project impact evaluation
GUIDELINE QUESTIONNAIRE FOR INTERVIEWS

The questionnaire is for use by the consultants to provide a framework for interviews to obtain the information sought for the evaluation. It would be appreciated if information would be prepared before arrival of the consultant but the form is not meant to be completed by other parties.

1. Does your country have a monitoring system for determining the incidence of CBB on the quantity and value of coffee produced?
   What phrase best describes your situation:

a) System exists ____
b) Possibility of developing a new system ___________________
c) Possibility of spot surveys ______________________________
d) Other ways (including informal) of measuring CBB effects

Comments: ____

____

2. If data available we seek data on incidence of lost beans caused by the CBB in terms of production quantity:

	Prod1
a) April 1998	_____
b) May 2002	_____
c) May 2009	_____

[Prod1 = annual production loss from CBB, in bags] NB. For value loss this should be multiplied by average farm gate price for farmers' losses and by market price or export unit value (available from the ICO) for losses to the country.

3. If data available we seek incidence of CBB on quality, showing price losses for affected crop.

	Prod2	Pr1	Pr2	Pr3	Pr4
a) April 1998	_____	___	___	___	___
b) May 2002	_____	___	___	___	___
c) May 2009	_____	___	___	___	___

[Prod2 = annual quantity of CBB-affected beans. Pr1 and Pr2 = average coffee market price or export unit value and average farm gate price. Pr3 and Pr4 = market price or export UV and farm gate price for CBB-affected beans]

4. Are there significant regional variations in CBB incidence?

Comments: ____

5. Has CBB become more or less of a problem:

a) between 1998 and 2002 **MORE/LESS**
b) between 2002 and 2009 **MORE/LESS**
c) between 1998 and 2009 **MORE/LESS**

Comments on reasons for changes: ______________________________

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6. Can you recognize any particular years of "**Heavy CBB** infestations" where a distinct drop in coffee quality was observed? **YES / NO**

CBB years with distinct drop in quality:

a) 19 _____ b) 19 _____ c) 200_____ d)200_____ e) 200_____

7. What are the current CBB management options recommended to farmers?

a) Sanitation, e.g. cleaning ground after picking: __________________
b) Established parasitic wasps: _________________________________
c) Use of *Beauveria*: ____
d) Use of chemical pesticides: indicate name of chemical ____________
e) Other, please provide details _________________________________

8. Have biological control agents been introduced and established in the country? **YES / NO**

If yes, state name(s): ____

9. Has the development / establishment of the introduced biological control agents been monitored? **YES / NO**

If yes, please indicate:

___continuous monitoring ___temporary monitoring ___irreg. monitoring

10. Have farmers been informed about/participated in the biological control program against CBB? **YES / NO**

If yes, which method was used?

____Participatory method ____Farmers IPM plots ____Information/documents
____Other; describe_______________

11. Attitude to current CBB management options of:

a) Farmers **Positive/Negative/Neutral**

b) Extension Workers **Positive/Negative/Neutral**
c) Traders **Positive/Negative/Neutral**
d) Government **Positive/Negative/Neutral**

Comments as appropriate: ________________________________

____

12. Situation of CBB management in your country in terms of the following:

a) Strengths: ____
b) Weaknesses: ____
c) Opportunities: ____
d) Threats: ____

13. Assessment of the outlook for coffee in your country in terms of the following:

a) Strengths: ____
b) Weaknesses: ____
c) Opportunities: ____
d) Threats: ____

14. Cost of CBB management by farmers– expenditure (cost per hectare)

Comments ____

15. How much is the country spending specifically on CBB research/extension per year?
research ______________________$/year
extension ______________________$/year

16. Are you familiar with the ICO/CFC/CABI Integrated Pest Management Project for control of the Coffee Berry Borer carried out from 1998 to 2002? **YES/NO**

17. Was this project:

a) Very successful
b) Moderately successful
c) Unsuccessful

Comments as appropriate________________________________

____

ANNEX 2 *Work Plan*

ANNEX 3 *Persons Met/Interviewed*

Name	***Function / Organisation***	***Subject***	***Dates (2009)***
SEUDIEU Denis	Chief Economist ICO	Initial briefing on CBB Project	20-22 May
DENGU Caleb	First Project Officer CFC	Initial briefing on CBB Project	4 May
VOLCAN Lilian	Project Officer / Economist ICO	Initial briefing on CBB Project	20-22 May
SETTE José Dauster	Head of Operations ICO	Initial briefing on CBB Project	20-22 May
BAKER Peter	CBB Project leader CABI Bioscience, UK	Meeting on CBB project	22 May
GENTLES Chris	Director General Coffee Industry Board, Jamaica	Discussions and meeting on CBB Project	10-13 June
CAMPBELL Louis	Manager Field Services, Coffee Industry Board, Jamaica	Meeting on CBB project/Field visit	11 June
MCCOOK Gusland	Regional Advisory Officer, Coffee Industry Board, Jamaica	Meeting on CBB project/Field visit	11-12 June
Farmer	Field manager Lyntona Farm, Mount James, Blue mountains	Field trip and discussion on CBB	11 June
WATSON Gary	Regional Advisory Officer, Coffee Industry Board, Jamaica	Meeting on CBB project	11 June
RICHARDS Noel	Regional Advisory Officer, Coffee Industry Board, Jamaica	Meeting on CBB project	11 June
WEATHERBURN Damian	Regional Advisory Officer, Coffee Industry Board, Jamaica	Meeting on CBB project	11 June
BENNETT Stacy Ann	Legal Officer, Coffee Industry Board, Jamaica	Meeting on CBB project	11 June
ROBINSON Dwight	Entomologist, University of the West Indies, Kingston	Meeting on CBB project	11 June
SHARP Jason	Coffee Trader/ Farm Manager/owner, Clydesdale Coffee	Discussion on CBB project	11 June
SHARP Richard	Farm Manager/owner /Coffee Trader, Clifton Mount Estate	Discussion on CBB project	11 June
KRANT Robert	Coffee Trader, Hawaii Roasters, Hawaii, USA	Discussion on CBB project	11 June
REID Douet	Estate Manager, SJP Coffee Estate, Baron Hall, Jamaica	Field visit and discussion on CBB	12 June
GRIFFITH Glen Roy	Regional Advisory Officer, Coffee Industry Board, Jamaica	Field visit and discussion on CBB	12 June
HAYDEN Robert	Small holder coffee farmer, Baron Hall	Field visit and discussion on CBB	12 June
ARCILA Jaime	Director , CENICAFE, Chinchiná, Colombia	Discussion on CBB Project	16 June
BENAVIDES Pablo	Entomologist, CENICAFE, Chinchiná, Colombia	Discussion and presentations on CBB Project	16 June
MEJIA Carlos Gonzalo	Extensionist, CENICAFE, Chinchiná, Colombia	Discussion and presentations on CBB Project	16 June
GONGORA Carmenza	Entomologist/geneticist, CENICAFE, Chinchiná, Colombia	Discussion and presentations on CBB Project	16 June
MONCADA Maria del Pilar	Entomologist/geneticist, CENICAFE, Chinchiná, Colombia	Discussion and presentations on CBB Project	16 June

Name	***Function / Organisation***	***Subject***	***Dates (2009)***
MONTOYA R. Esther Cecilia	Biometrician, CENICAFE, Chinchiná, Colombia	Discussion and presentations on CBB Project	16 June
DUQUE Hernando	National Coffee Growers Federation of Colombia	Discussion and presentations on CBB Project	17 June
CUESTA Giovanni	Assistant Manager Naranjal Experiment Station	Field visit	17 June
SALAZAR Mauricio	Researcher/Extensionist National Coffee Growers Federation of Colombia, Manizales	Discussion and presentations on CBB Project/Field visits	17 June
ARISTIZABAL Carolina	Project manager, National Coffee Growers Federation of Colombia, Manizales	Discussion and presentations on CBB Project	17 June
MEJIA Roberto	Extensionist, National Coffee Growers Federation of Colombia, Chinchiná	Field trip and discussion on CBB	17 June
MONSALVE Carlos	Coffee grower, Finca San José, Chinchiná	Field visit and discussion on CBB	17 June
GONZALES Andrez	Coffee grower, Finca La Francia, Chinchiná	Field visit and discussion on CBB	17 June
LONDOÑA Eduardo	Coffee grower, Finca La Samaria I, Lisboa, Manizales	Field visit and discussion on CBB	18 June
LONDOÑA Linda	Coffee grower, Finca La Samaria II, Lisboa, Manizales	Field visit and discussion on CBB	18 June
Extensionist	National Coffee Growers Federation of Colombia, Lisboa, Manizales	Field visit and discussion on CBB	18 June
ELIEZER Don	Coffee grower, Finca La Castellana, Palestina	Field visit and discussion on CBB	18 June
PAES Jorge Umberto	Extensionist, National Coffee Growers Federation of Colombia, Palestina	Field visit and discussion on CBB	19 June
SALDIAZ, Carlos	Extension Leader National Coffee Growers Federation of Colombia, Bogotá	Discussion on CBB Project	19 June
AREVALO Hector	Plant Protection Consultant, National Coffee Growers Federation of Colombia, Bogotá	Discussion on CBB Project	19 June
ECHEVERRI GOMEZ Edgar	Technical Manager, National Coffee Growers Federation of Colombia, Bogotá	Discussion on CBB Project	19 June
ROJAS Leonardo	Extensionist, National Coffee Growers Federation of Colombia, Condinamara, La Vega	Field visit and discussion on CBB	20 June
ROCHA Wilson	Extensionist, National Coffee Growers Federation of Colombia, Condinamara, La Vega	Field visit and discussion on CBB	20 June
AGUDELO Juan	Coffee grower (manager), Finca San Ignacio, Gualiua	Field visit and discussion on CBB	20 June
PARRA Jaime	Coffee grower (manager), Finca La Palma, Sasaima	Field visit and discussion on CBB	20 June
FAJARDO Don Iwan	Coffee grower (owner), Finca La Palma, Sasaima	Discussion on CBB Project	20 June

Name	***Function / Organisation***	***Subject***	***Dates (2009)***
TEIXEIRA César	Entomologist/Research leader EMBRAPA, Porto Velho, Rondônia, Brazil	Discussion and presentations on CBB Project/Field visits	22-25 June
COSTA José Medeiros NILTON	Entomologist EMBRAPA, Porto Velho	Discussion and presentations on CBB Project/Field visits	22-25 June
ALVEZ da.C. Antonio	Farmer, Finca San Francisco, Uniao Bondeirante, Rondônia, Brazil	Field visit	24 June
DE MORAES Gilberto	Professor of Entomology, University of São Paulo, Brazil	Discussion on CBB Project	26 June
SIMÕES BENTO José Maurício	Professor of Entomology, University of São Paulo, Brazil	Discussion on CBB “behaviour” Research Projects	26 June
DELALIBERA Italo	Professor of Entomology, University of São Paulo, Brazil	Discussion on CBB “*Beauveria*” Research Projects	26 June
MOURA Gabriel	Student Entomology Dept., University of São Paulo, Brazil	Discussion and presentations on CBB Project	26 June
GONZALEZ Rodolfo	General Manager National Coffee Association (ANACAFE), of Guatemala	Discussion and presentations on CBB Project	29 June
ANZUETO Francisco	Research Leader, ANACAFE, Guatemala	Discussion and presentations on CBB Project	29 June- 2 July
CANET Guillermo	Executive Secretary PROMECAFE, Guatemala	Discussion and presentations on CBB Project	29 June
GARCIA Armando	Technical Specialist, PROMECAFE, Guatemala	Discussion and presentations on CBB Project	29 June
CAMPOS Oscar	Entomologist, ANACAFE, Guatemala	Discussion and presentations on CBB Project/Field visits	29 June- 1 July
PENATE MUNGUIA Luis Moises	Agronomist, ANACAFE, Guatemala	Discussion and presentations on CBB Project/Field visits	29 June- 2 July
LACAN Fredy	Finca Los Encantos, Samayec, Suchitepequez, Guatemala	Discussion on CBB Project/Field visit	30 June
Don BARTOLO	Finca Santa Isabel, near Chocolá, Suchitepequez, Guatemala	Discussion on CBB Project/Field visit	30 June
MULUGETA Assefa	MinAgri, Extension Service Addis Ababa, Ethiopia	Discussion on CBB Project/Field visit	13, 14 July
GEZAHEGH Birhanu	MinAgri, Marketing Director Addis Ababa, Ethiopia	Discussion on CBB Project/Field visit	13, 14 July
HASSAN Ali	Deputy FAO representative, Addis Ababa, Ethiopia	Coffee Research Programme	14 July
KOTECHA Surendra	Coffee specialist/Consultant	Discussion on CBB Project	14 July
WONDYIFRAW Tefere	Centre Manager, Jimma Agricultural Research Centre (JARC), EIAR, Ethiopia	Discussion on CBB Project, Introduction to Research Centre & Coffee Research Program	15 July

Name	***Function / Organisation***	***Subject***	***Dates (2009)***
ABEBE, Million	Previous Centre Manager, Jimma Agricultural Research Centre (JARC), EIAR, Ethiopia	Telephone Discussion on CBB Project	16 July
TEDESSE Eshetu	Crop Protection Staff JARC, EIAR, Jimma	Discussion on CBB /Field visit	16,17 July
ADUGNA Girma	Crop Protection Staff JARC, EIAR, Jimma	Discussion on CBB /Field visit	16,17 July
BEKELE Getu	Crop Breeding Staff JARC, EIAR, Jimma	Discussion on CBB /Field visit	16,17 July
Mr DJAFER	AEKI Representative, Aceh, Sumatra, Indonesia	Discussion, Field visits and meeting on CBB Project	26-31 July
SULAIMAN Makmun	AEKI Representative, N. Sumatra, Sumatra, Indonesia	Discussion, Field visits and meeting on CBB Project	26-31 July
HUSIN Rizwan	Director Cooperative BQ Baburrayan, Sumatra, Indonesia	Discussion on CBB /Field visit	27 July
KONYEL Jamur	Extensionist State Dept of Agriculture, Aceh Tengga	Discussion on CBB /Field visit	27 July
ISA Em	Extensionist State Dept of Agriculture, Aceh Tengga	Discussion on CBB /Field visit	27, 28 July
KAULAN	Farmer, District Bintang, Aceh Tengga, Sumatra, Indonesia	Discussion on CBB /Field visit	27 July
MUK A.	Farmer, District Bintang, Aceh Tengga, Sumatra, Indonesia	Discussion on CBB /Field visit	27 July
AL MAHDI Mahdi	Farmer, District Bintang, Aceh Tengga, Sumatra, Indonesia	Discussion on CBB /Field visit	27 July
HAMA Euna	Farmer, District Bintang, Aceh Tengga, Sumatra, Indonesia	Discussion on CBB /Field visit	27 July
SUMARDI	Farmer, District Timan Gaya, Aceh Tengga, Sumatra	Discussion on CBB /Field visit	28 July
AJI AKBAR	Farmer, District Timan Gaya, Aceh Tengga, Sumatra	Discussion on CBB /Field visit	28 July
ALI Mustafa	Leader Coffee Forum Aceh, Sumatra, Indonesia	Discussion CBB Project	29 July
NASARUDDIN A.	Regent of ACEH Tengah district, Sumatra, Indonesia	Discussion CBB Project	29 July
ALAM Saidul	AEKI Representative, Medan, Sumatra, Indonesia	Discussions and meeting on CBB Project	26-31 July
DAUD Masyitah	AEKI Representative, Medan, Sumatra, Indonesia	Meeting on CBB Project	30 July
BAHAGIA Ismail	AIKI member, Medan, Sumatra, Indonesia	Meeting on CBB Project	30 July
Various exporters & growers	AIKI members and growers, Medan, Sumatra (about 10). List repeatedly requested, but not received	Meeting on CBB Project	30 July
SUMITA Sopian	Head of Marketing Compartment, AEKI, Lampung, Sumatra	Discussion, Field visits and meetings on CBB Project	31/7-3/8
YAMANAH, AC	Director Export for Agriculture and Forestry, Ministry of Trade, Jakarta	Meeting on CBB Project	31 July
WADJAJANTI, Tri	Deputy Director International Market Development, Ministry of Agriculture, Jakarta	Meeting on CBB Project	31 July
HERDRADJAT, N	Director Crop Protection, Estate Crops Division, Ministry of Agriculture, Jakarta	Meeting on CBB Project	31 July

Name	***Function / Organisation***	***Subject***	***Dates (2009)***
SIMARMATI Sahat	Crop Protection specialist, Estate Crops Division, Ministry of Agriculture, Jakarta	Meeting on CBB Project, Field trip Lampung	31/7, 1/8
SUNDAM A	Ministry of Trade, Jakarta	Meeting on CBB Project	31 July
KARTANIDJAJA Hamala	Ministry of Trade, Jakarta	Meeting on CBB Project	31 July
HADI	Ministry of Trade, Jakarta	Meeting on CBB Project	31 July
SISWO Radix	Ministry of Trade, Jakarta	Meeting on CBB Project	31 July
NIKEN	Ministry of Trade, Jakarta	Meeting on CBB Project	31 July
INA L.	Ministry of Trade, Jakarta	Meeting on CBB Project	31 July
KUSMIYARSI Ida	Ministry of Trade, Jakarta	Meeting on CBB Project	31 July
WARA	Ministry of Trade, Jakarta	Meeting on CBB Project	31 July
ZAMZANAH Siti	Ministry of Trade, Jakarta	Meeting on CBB Project	31 July
SUPIANTO	Ministry of Trade, Jakarta	Meeting on CBB Project	31 July
HALIYANTI Sri	Ministry of Trade, Jakarta	Meeting on CBB Project	31 July
Mr DANURI	Head Farmer, Air Naningan, Lampung, Sumatra	Discussion on CBB /Field visit Air Naningan	1 August
TAHIR Desmond	AEKI, Lampung, Sumatra, Indonesia	Discussion on CBB /Field visit Air Naningan	1 August
LUTHFIE Muchtar	AEKI, Lampung, Sumatra, Indonesia	Discussion on CBB /Field visit Air Naningan	1 August
SUMADI Bambang	Provincial Office, Estate Crops Dept. Lampung, Sumatra	Discussion on CBB /Field visit Air Naningan	1 August
Mr TAMRIN	Provincial Biocontrol Lab, Agric. Dept. Lampung, Sumatra	Discussion on CBB /Field visit	1 August
Mr SUWARNO	Head Farmer, Desa Sidomulya, Silo District, East Java	Discussion on CBB /Field visit	2 August
Mr ICHWAN	AEKI, East Java, Surabaya	Discussion on CBB /Field visit	2 August
KARTA Adi	Extensionist Estate Crops Dept. East Java	Discussion on CBB /Field visit	2 August
ZARKASSI Haji	Farmer, Desa Sidomulya, Silo District, East Java	Discussion on CBB /Field visit	2 August
MAWARDI Surip	Coffee Breeder, ICCRI, Jember, East Java, Indonesia	Discussion, Field visits and meeting on CBB Project	29/7, 3/8
SOEKADER Wiryadiputra	Entomologist, ICCRI, Jember, East Java, Indonesia	Discussion, Field visits and meeting on CBB Project	3-8 August
SOETANTO Abdoellah	Head Research Division, ICCRI, Jember, East Java,	Meeting on CBB Project	3 August
SULISTYOWATI Endang	Entomologist, ICCRI, Jember, East Java, Indonesia	Meeting on CBB Project	3 August
WIJAYANTO	Ministry of Trade, Jakarta	Meeting on CBB Project	31/7, 3/8
FLORA Susan	Ministry of Trade, Jakarta	Meeting on CBB Project	31/7, 3/8
POLII Dudiek	AEKI, East Java	Meeting on CBB Project	3 August

Name	***Function / Organisation***	***Subject***	***Dates (2009)***
MELINA Susi	Estate Crops Division, Ministry of Agriculture, Surabaya	Meeting on CBB Project	3 August
PRESETIONO Hari	Estate Crops Division, Ministry of Agriculture, Surabaya	Meeting on CBB Project	3 August
SUBEKTI Iwan Setiawan	Plantation Manager “Kali Bendo”, Banyuwangi, East Java	Discussion and Field visits on CBB Project	4 August
MINARSA P. Made	AEKI Representative Bali, Indonesia	Discussion and Field visits on CBB Project	5, 6 August
HEDIARSA Wayan	Head Farmer, Desa Pajahan, Pupuan District, Bali	Discussion and Field visits on CBB Project	5 August
ABIAN Subak	Farmer, Desa Pajahan, Pupuan District, Bali	Discussion and Field visits on CBB Project	5 August
KARYA Amerta	Farmer, Desa Pajahan, Pupuan District, Bali	Discussion and Field visits on CBB Project	5 August
DANA Yoman	District Officer, Estate Crops Dept. Pupuan District, Bali	Discussion and Field visits on CBB Project	5 August
PRYIONA Aanang	Plant Protection Officer, Provincial Estate Crops Dept., Bali	Discussion and Field visits on CBB Project	5, 6 August
ARSADJAH Nyoman	Farmer, Desa Banfiran, Pupuan District, Bali	Discussion and Field visits on CBB Project	5 August
ALISANTIKA Dewi	Official Prov. Estate Crops Dept., Kintamani District, Bali	Discussion and Field visits on CBB Project	6 August
BALTHI Wayan	Farmer, Desa Belanthe, Kintamani District, Bali	Discussion and Field visits on CBB Project	6 August
SOMA Ketut	Researcher Biocontrol Lab. , Prov. Estate Crops Dept., Bali	Discussion and Field visits on CBB Project	7 August

Annex 4 *References*

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