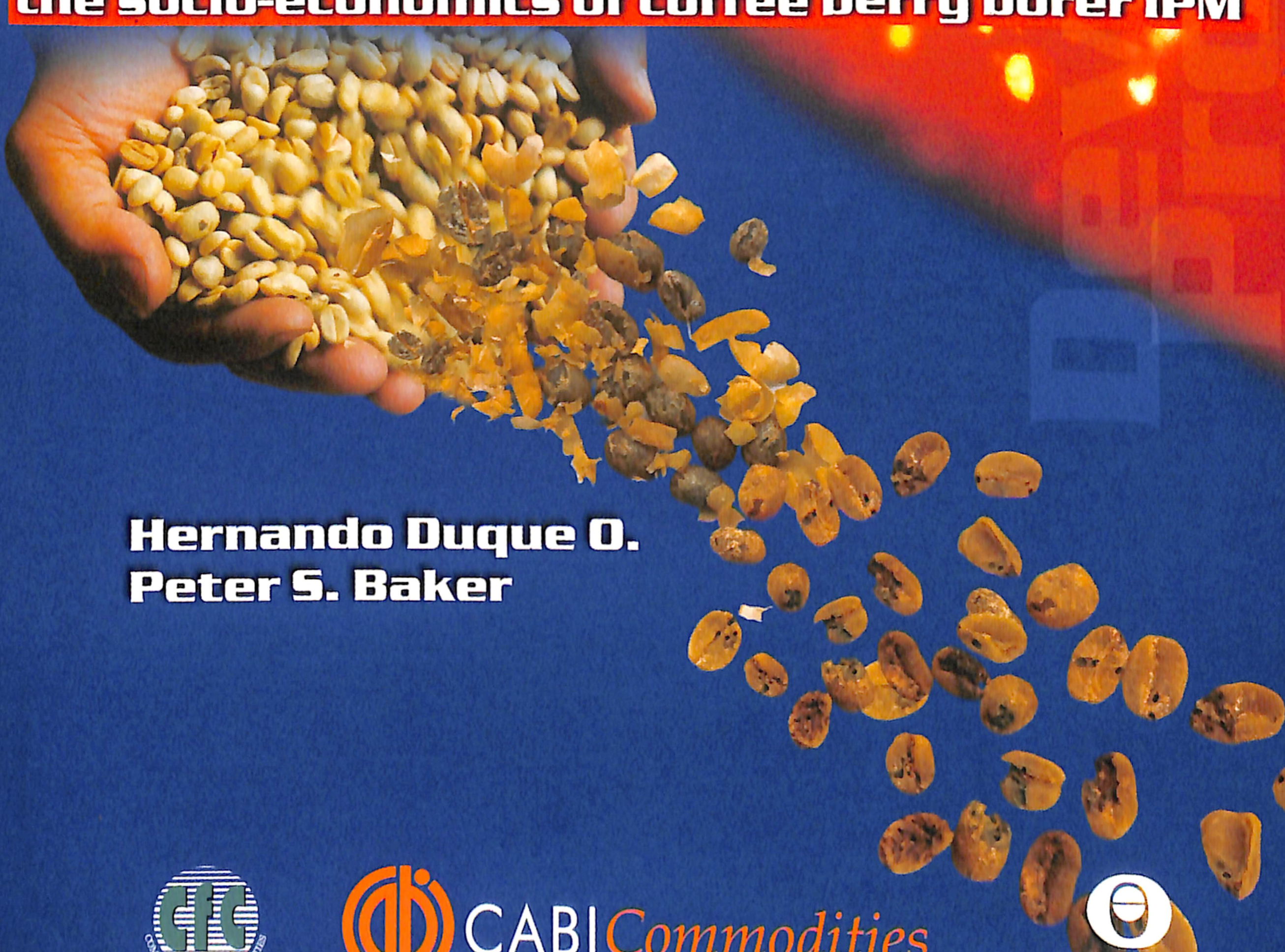
Devouring Profit

the socio-economics of coffee berry borer IPM



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CFC Common Fund for Commodities

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International Coffee Organization

Devouring Profit

the socio-economics of coffee berry borer IPM[1]

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[1] IPM: Integrated Pest Management

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Markets can be efficient, but nobody ever said they are fair.
The question is: what do we owe the future?

[Robert Stavins]

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Contents

Glossary

ANACAFÉ, Asociación Nacional del Café, the Guatemalan Coffee Institute.

ANECAFÉ, Asociación Nacional de Exportadores de Café, the Coffee Exporters Association of Ecuador.

Arroba, a weight unit, used in Colombia, equal to 12.5 kg.

Biological Control, using nature to control pests. All organisms have predators, but some manage to escape them by migrating. The coffee berry borer is one of them, its co-evolved natural enemies stayed in Africa. Projects such as the one from which this work sprang, aim to reunite them.

CABI, CAB International is a not-for-profit treaty level intergovernmental organisation with 41 member countries including several major coffee-producing countries. It consists of two divisions - CABI *Bioscience* and CABI *Publishing*. Its main goals are generation and brokering of scientific knowledge for developing countries. CABI *Commodities* is an initiative of CABI *Bioscience*.

CBB, coffee berry borer (*Hypothenemus hampei* (Ferrari 1867)) a 2 mm long black scolytid beetle (related to wood-boring beetles) that is the most significant pest of the world's most important tropical agricultural commodity.

CENICAFÉ, Centro Nacional de Investigaciones del Café, the Colombian coffee research institute, a division of the Federation of Colombian Coffee Growers.

CFC, Common Fund for Commodities is an intergovernmental financial institution, funding commodity development projects globally. The Agreement establishing the Common Fund for Commodities was negotiated in the United Nations Conference on Trade and Development (UNCTAD) in the 1970s, concluded in 1980 and came into force in 1989. Currently the Common Fund has 104 Member Countries plus the European Community, the Organisation of African Unity/African Economic Community (OAU/AEC) and the Common Market for Eastern and Southern Africa (COMESA).

Cherry, a term for the ripe intact coffee fruit with (from outside in) skin, pulp, mucilage, parchment and bean.

Cultural control, a broad term, in this book it involves the manual removal of berries from tree and/or ground.

Green coffee, the dried bean with the outer parchment removed by milling. In this form coffee is exported, ready to roast.

ECOSUR, El Colegio de la Frontera Sur, Chiapas, Mexico

■ **Gleaning,** the term for cultural control used in India, chiefly for cleaning up all berries after the main harvest.

■ **Graniteo,** frequent collection of coffee berries from the trees, a form of cultural control (q.v.).

■ **ICO,** The International Coffee Organization (ICO) is an intergovernmental body whose Members are coffee exporting and importing countries. Established in 1963 it administers the International Coffee Agreement from its headquarters in London, and is committed to improving conditions in the world coffee economy through international co-operation, helping price equilibrium by developing demand for coffee in emerging markets and through projects to reduce damage from pests and improve marketing and quality, enhancing coffee growers' long-term competitiveness and contributing to the fight against poverty.

■ **IHCAFÉ,** Instituto Hondureño del Café, the Honduran coffee institution.

■ **IPM,** Integrated Pest Management, a knowledge-intensive strategy for controlling pests where the farmer estimates current and future damage to his crop and picks from a range of techniques to optimise profit. The basic principle is that control measures should cost less than the losses incurred by inaction. It requires knowledge of pest biology, continual monitoring of the crop, an appreciation of the worth of control methods, simple maths and an understanding of commodity price dynamics.

■ **Parasitoid,** a specialised predator that lays its eggs on or (as in the case of *Phymastichus coffea*,) in the insect. The egg hatches out and kills its host by consuming it. Parasitoids differ from parasites in that the former always kill their host to complete their life-cycle.

■ **Ochratoxin,** a toxin produced by (amongst others) the fungus *Aspergillus ochraceus* which forms on poorly dried coffee.

■ **Parchment coffee,** the coffee bean with a hard outer covering (the endocarp) dried to about 12% relative humidity.

■ **Pepena,** a form of CBB cultural control used in Central America, involving the collection of the coffee berries remaining on the ground, after the harvesting period.

■ **Promecafé,** Programa Cooperativo Regional para el desarrollo tecnológico y Modernización de la caficultura - a Central America coffee technology network formed under the auspices of IICA.

■ **Repela,** a form of CBB cultural control used in Central America, involving the collection of the coffee berries remaining on coffee trees, after the harvesting period.

■ **Quintal (qq),** a weight unit, equal to 46 kg.

■ **RRA,** Rapid Rural Appraisal, a participatory method for gathering data, opinions etc. from farmers on a wide range of issues.

■ **USDA,** United States Department of Agriculture, specifically the Biological Control & Mass Rearing Research Unit at Starkville Miss.

Executive summary

The coffee berry borer (CBB) is the most important pest of coffee due to its global spread and negative effects on coffee quality and yield. Coffee is the most valuable export crop of tropical countries and it has a social importance as a stable cash earner for millions of the rural poor.

In 1998 a project started on integrated pest management (IPM) of the CBB, financed by the Common Fund for Commodities (CFC). The project, (involving Colombia, Ecuador, Guatemala, Honduras, India, Jamaica, Mexico, USDA, ICO and CABI *Commodities*) included a socio-economic component in order to understand the relationships between CBB and coffee farmers in terms of wage costs, production costs, productivity and coffee prices. The present book summarises this work and attempts to draw some conclusions on ways to overcome this enduring problem in a sustainable fashion.

We visited six countries to gather data from farmers, extensionists and decision-makers on CBB management and programmes, the idea being to gain first-hand data where possible of field realities from a 'bottom-up' standpoint. Through interviews, research and case histories, we pieced together the various ways that CBB causes economic damage, the costs of controlling it and the ways it is tackled in different countries.

From this approach we conclude that CBB is part of the current coffee quality problem. It should be viewed as a quality issue that especially affects smallholders because they lack access to buyers who are willing to pay them a sufficiently high price to warrant controlling it.

Current efforts at promoting higher quality coffee have concentrated on removal of the poorest or 'triage' coffee after it has been milled. We suggest in this book that an appreciable part of the triage problem is that farmers are not sufficiently rewarded for producing high quality coffee that is free of CBB and other defects.

This is because of poorly developed nation-wide standards and premiums as well as local market structure. We further suggest that adoption of IPM is hampered because of the same problem; it can be costly and farmers do not see sufficient reason to take it up.

We also conclude that the spread of CBB and the nature of the damage it causes, highlights shortcomings in the commodity chain that require comprehensive action from a range of stakeholders. In the context of the current coffee crisis, the CBB problem accentuates the difficulties that producer country institutions have encountered in responding adequately to new problems that threaten livelihoods of resource-poor coffee farmers. Baker *et al.* (2002) explore this subject further.

Some of the recommendations of this book are:

- Rewarding farmers for producing good quality coffee will stimulate interest in controlling CBB.
- When this happens, a range of techniques and ways of imparting knowledge need to be available to satisfy demand.
- These techniques are most likely to be developed through participatory interaction with farmers.
- The methods need to be practical, economically viable and objectively validated in the field.
- These will take time to develop and researchers and extensionists will need to be retrained to accomplish it.

For a discussion and a more expanded set of conclusions, turn to Chapter 7.

CHAPTER 1

Introduction

1.0 Setting the scene

■ **India:** *"Reduced to penury by low prices for more than two seasons, coffee growers in the southern Indian state of Karnataka have started taking their own lives. The burden of debt and continuing heavy losses in spite of recent marginal price improvements have led at least half a dozen planters to commit suicide at Chikmagalur and Kodagu. As gloom pervades the country's two most productive coffee growing centres, small planters are being chased by moneylenders for recovery of dues.* [Kunal Bose, Financial Times; Aug 15, 2002]

■ **Ecuador:** *"The campesinos of Orellana [NE Ecuador] are struggling in order to improve their production so that they won't be forced to cultivate coca, Pedro Garcia, a farmer of the province, told IPS. "We want to continue planting coffee or some other profitable crop, but for this we need credits, subsidies, roads to transport our harvest. If not, we will have to plant coca," as has happened in Colombia, Peru, and Bolivia, he insisted. Garcia explained that "strange people" have approached him offering to pay five to seven times as much for coca as he receives from coffee. "Coca is a more resistant crop, and they will give us everything we need in order to cultivate it, they pay five to seven times as much as for coffee, and they take out the crop from our farms for us. If the government doesn't help us, we are being pushed into planting coca".* [Kintto Lucas, Interpress Service News Agency, Quito, 28 Feb, 2002]

■ **Guatemala:** *"…the coffee crop's role as life support system for the region's mass of poor tenant farmers has been highlighted this year by a famine. Farmers, many of them indigenous Indians, survive poor harvests by hiring themselves out to pick coffee between November and March. But after drought withered the crops there were 300,000 fewer jobs this year. At least 125 people have died of malnutrition in Guatemala and 60,000 face starvation*". *Coffee has been the sector that has given life to Guatemala."* [Fernando Montenegro, president of Anacafé, cited by Andrew Bounds Financial Times; Jun 26, 2002]

■ **Honduras:** *"Coffee in Honduras is fundamental for the national economy, not only by being the country's principal export but also for its ability to directly redistribute wealth to more than 109,000 families. Coffee generates employment, develops internal transport to many regions, backs public finances and encourages commerce in both the industrial and rural sectors. The economic, political and social life of many towns in Honduras revolves around this bean."* [La Central, 2001]

■ **Mexico:** *"The Mexican government has started to distribute a long promised US$147 m. aid package to coffee farmers. The distribution had been delayed until the Mexican government completed a census of coffee farmers. The government is aiming to provide a subsidy of US$20 for each 46 kg bag of coffee produced by the farmer in 01/02. The census found that there were 369,000 coffee farmers in Mexico cultivating 650,000 hectares. The majority of farmers are in serious trouble with the internal price well below the cost of production, which is estimated by the Mexican Coffee Council at 53 ¢/lb."* [NKG Statistical Unit, www.nkgstat.com, September 2002]

■ **Colombia:** "*Authorities from the police and army confirmed that in the last three years, as the coffee sector crisis deepened, the Departments of Caldas, Tolima, Risaralda, Quindío and N Valle suffered a severe fracturing of public order. Robberies rose by 90% in the last 3 years, kidnappings shot up and the insecurity on the highways became generalised.*" [El Tiempo, Colombia, December 2001]

Coffee is globally significant for development. As the most valuable product of the tropics, for more than a century it has been a principal product of national economies in many developing countries. Some rough calculations estimate that about 22 million families live from coffee. Additionally, the coffee industry as a whole generates about 100 million jobs with 60% of them in the producer countries (Federación Nacional de Cafeteros, 2001).

The coffee berry borer (CBB) is the most important coffee pest because of its world-wide distribution (present now in all coffee-producing countries except Hawaii, Papua New Guinea and Panama) and its cryptic lifestyle (Le Pelley, 1968). Hidden inside the bean for most of its life, it causes direct loss of value to the product and is hard to control by pesticide applications.

A problem such as CBB throws into high relief many of the issues caused by the rapidly changing and globalising coffee industry. These include: the quest for higher quality, health and environmental concerns about pesticide abuse, the applicability of developed country concepts to solve developing country problems, the declining fortunes of research/extension services and the difficulties of providing the rural poor with new knowledge and techniques.

To understand the issues, we will first resume some relevant knowledge about CBB and how it is presently controlled. We will then examine the problem in specific countries from several sources including data collected through interaction with poor smallholder farmers. From this we develop both an economic analysis of CBB and then generate some hypotheses about the underlying forces involved. We end by making recommendations to improve CBB control in the future.

1.1 The berry borer problem

The female CBB perforates the berry and penetrates into the developing coffee bean. She then starts to feed from the bean and the reproductive cycle commences, causing very significant losses (Decazy, 1990). The degree of damage is complex to define because the pest can cause at least three types of loss: premature drop of younger berries, loss in weight and loss in quality (see Chapter 4).

CBB live almost exclusively in coffee berries. There are a few records of them attacking other seeds, but alternative hosts are insignificant. Each female (2 mm long) will lay 30 or more eggs that take four to six weeks to mature to new adults. Siblings incestuously mate inside the berry. Some females will then emerge but others will stay and start laying their own brood. Eventually the whole bean and its pair inside the berry can be eaten out. But this takes many months and the majority of berries are harvested before this happens so that most berries harvested with a CBB entry-hole have one infested and one normal bean.

It was previously thought that CBB could only fly short distances. Now we know that a kilometre or more is well within their range. This is a significant factor in times of low coffee prices when some farmers abandon their plots leaving a source of CBB to infest surrounding areas.

Only the female flies and when she finds a new berry she immediately starts boring into it. When she gets as far as the bean (endosperm), she makes a decision that depends on its consistency. If it is more than about 20% dry weight she will carry on boring and start laying eggs within two or three days. If it is less than 20%, she will stop and most often she will wait in the short tunnel until the bean has developed further. Not surprisingly, the borer has the ability to locate mature berries so that if these are present, they will be preferentially attacked. This gives rise to the following rules:

- When CBB levels are low, most of them will be found in maturing berries (>180 days after flowering).
- As CBB levels rise, available ideal berries will be occupied and they will increas ingly attack younger berries.
- Younger berries are less suitable hosts for the CBB, fecundity is lower and mortality is higher.
- Hence as populations rise there is a density dependent effect tending to reduce the rate of increase.
- This means that it may be very difficult to control CBB at low levels but easier at high levels because in the former case most of the population is deep inside the berry and consequently harder to kill.

The critical period for applying control of the CBB is before it does damage to the endosperm, i.e. before about 110 to 120 days after flowering. In some countries farmers are exhorted to record moments of major flowering and carry out spraying at about 100 days after each of these events. This can work well where there are one or two major flowerings and a few very minor ones. But in Colombia for instance, with many flowerings, well-timed sprays become more difficult.

This leads to the idea of integrating various methods and observations into a control strategy known as integrated pest management (IPM). Thus from the knowledge above, the farmer could take two sorts of measurements, pest levels (so that he monitors the population and takes action before CBB multiply) and flowerings and then, according to what he finds, make a decision to control or not. Unfortunately, smallholder farmers are not used to making measurements and recording them for future reference and action. We will return to IPM later.

1.2 Ways to control CBB

Insecticides: a number of products are employed, though endosulfan is the overwhelming favourite of farmers and regrettably this is also a highly toxic product to humans.

- Advantages of insecticides: efficient (up to 80% mortality) to kill adult females in the entry tunnel.
- Disadvantages of insecticides: health risk; environmental damage; costly to apply (up to 5 man-days/ha for a small farmer); not so effective at killing mature infestations; CBB can develop resistance to insecticides; poor image for coffee exports.

Until recently, it was common for governments, commodity boards and donors to subsidise pesticide inputs. Now subsidies are out of fashion and NGOs have done a good job of pointing out the perils of the cheap provision of poisons. The use of chemicals is becoming increasingly unacceptable in modern coffee production and in the case of CBB, the two most effective pesticides, endosulfan and chlorpyrifos, are also two of the most dangerous to apply. At the policy level, the argument for sustainable agriculture has been won, the chemical approach is no longer acceptable, as is now confirmed by the approaching EU-wide ban on many of these substances. But no one has told the farmers and simple alternatives are not easy to come by.

Biological control (parasitoid wasps): there are four principal wasps*, Cephalonomia stephanoderis, Prorops nasuta, Heterospilus coffeicola,* and *Phymastichus coffea*. The first two have been studied extensively and released in many countries; although they establish readily in most regions, the control they exert is small and even when released in large numbers their control effect has been disappointing. *H. coffeicola* has been studied in the field and seems promising, but as yet rearing it has proved too difficult to allow it to be quarantined and shipped to other countries. *P. coffea* on the other hand can now be reared successfully and preliminary experiments suggest it is more effective than the previously tried wasps.

- Advantages of wasps: environmentally clean; no health risk; easy to use.
- Disadvantages of wasps: still too expensive for commercial augmentative release, though this may change in the short to mid-term.

Biological control (pathogens): *Beauveria bassiana* (*Bb*) is the most studied and field-tested. Lifetable studies in Colombia suggest that *Bb* is the major natural biotic mortal-

Box 1. The farmer's treadmill.

Coffee production increased in many countries over the last decades of the 20th century through the use of high yielding varieties, fertilisers, high-density planting and pesticides. Indeed, because of increasing competition leading to overproduction and declining prices, farmers may feel forced to intensify production further in order to increase margins and stay in profit. A Brazilian coffee growers' leader recently stated that only Brazilian farmers who produce about 40 bags[4] per ha, more than double the Brazilian average (and several times more than many countries) will survive and prosper in the future (Knight, 2002).

Before the arrival of CBB in Latin America, farmers had few pest problems. In times of low prices, poor farmers could effectively abandon their coffee but still return to pick a crop, albeit smaller, but at a profit. Furthermore, their lack of husbandry would lead to lower yields that would help to restore prices. But now, if farmers do nothing, CBB may often render the crop worthless. So either they abandon the crop altogether, which is difficult because of few alternatives on mountain slopes, or they intensify production to pay for control costs.

Another problem is that CBB control tends to become more difficult as production intensifies and trees are planted close together, making them harder to spray effectively without increasing self-contamination of the spray operative. Thus farmers risk the health of family members or hired hands, and lay themselves open to opposition and action from NGOs, unions, environmentalists and consumers. If they use full protective gear against poisoning, costs spiral because operatives are slower, uncomfortable and require frequent rest. In practice very few take more than the most rudimentary precautions; one Colombian farmer explained to us that although it was his son that now ran the farm, he still carried out the spraying to protect his son and any future grandchildren from harm.

ity factor affecting the CBB in Colombia. Its effect is especially heavy when CBB are attacking young berries and in this case, and under rainy conditions, mortalities of > 80% have been recorded.

Considerable data is now available from small scale spraying trials (Baker, 1999). Mortalities of 80% of adults in entry tunnels have been achieved, i.e. equivalent to the most efficient insecticides, but at doses far above the commercial rate. Furthermore, full mortality takes about a month to become apparent so even if sprayed, the female lives long enough to enter the berry and damage it.

4 One bag = 60 kg green coffee

- Advantages of *Bb*: environmentally safe; little health risk.

- Disadvantages: slow acting; kills CBB in the entry tunnel but at a commercial dose only at about a half of the rate of insecticides; difficult to apply (up to 5 man days/ha for a small farmer), quality control problems of commercially produced *Bb*; needs to be stored cool; has a shorter shelf-life than chemicals.

Cultural control: the simplest method, consists of hand removal of infested berries, most usually by paying extra labour to pick off all berries (clean and infested) after harvest or by picking more regularly. It sometimes includes picking berries off the ground where, if conditions are not too wet, CBB can build up to very high numbers (in some cases more than 100 CBB per berry).

- Advantages of cultural control: environmentally clean; no health risk; easy to understand; no equipment required; it is very effective if done rigorously, can sometimes generate an extra income to the farmers.

- Disadvantages of cultural control: costly and tedious; difficult to do on old trees; very dependent on quality of labour; coffee collected by this method may be of low quality but could still be sold.

Overview: there exists no simple way of controlling this pest, that is clean, efficient, easy to understand and carry out and moderately priced. One response made by farmers is to intensify production so that the extra income can pay for the control (Box 1). Another is to do little, which causes loss of income and leads to increase in infestation of neighbours' plots as CBB migrate in.

1.3 Integrated Pest Management (IPM)

Due to the potential damage caused by CBB, many countries have adopted control policies to reduce economic losses without deleterious environment effects. These have focused on the integrated pest management strategy (IPM) of which there are several definitions. One of them states that: "IPM is an ecological and multidisciplinary strategy that uses several control and compatible tactics in one co-ordinated system in pest management" (Prudot, 1986). Definitions tend to emphasise that IPM gives the best combination of methods for pest control in order to maximise the harvest value, minimise the human health risks and avoid environmental damage. Some definitions give more or less emphasis to the environmental or economic component and most stress the need to determine pest damage before control is taken, weighing up the cost of the intervention against the likely benefit.

Thus with IPM of CBB, the farmer chooses from a range of options that may include cultural control (manual methods, trapping, *etc*.), biological control (parasitoids and microbials) and, if necessary, the occasional use of safer pesticides. In theory, the farmer should be sufficiently knowledgeable about CBB to estimate its economic potential to eat into his profit and employ the right control method at the right time to optimise his income by rationalising costs incurred.

This is a tall order. The farmer is expected to make quite detailed field-measurements, take notes, calculate damage and employ a "just-in-time" approach to control. The reality is that the farmer's understanding and resources severely limit his ability to accomplish this. He therefore frequently adopts a "just-in-case" approach where he sprays insecticide, perhaps several times a year, to suppress the problem. This may cost him more money, damage the environment, his health and the image of coffee to the consumer.

IPM was not developed in the tropics for smallholder farmers but in northern countries. According to Morse and Buhler (1997) the broad approach of IPM as we understand it today had its origins in North America and as such it can be seen as a technological innovation born out of the industrialisation of capital-intensive agriculture where the expansion of production based on price supports generated an appreciable surplus for the U.S. government in the 50's. This expansion of agriculture developed a particular dependence upon chemical pest control that inevitably led to environmental problems. Under these circumstances IPM emerged as a new alternative to deal with pest problems as an environmentally friendly strategy with the aim of reducing the worrying dependence of farmers on pesticides.

Morse and Buhler observe that since IPM stems from capital-intensive agriculture: "*it can not be easily transferred into the social context of resource-poor farmers doing agricultural work in developing countries*". As we will see, the adoption of IPM components in the case of CBB illustrates this important insight.

A further problem with IPM is that everyone, from organic farmers to agrochemical companies, claim to adopt its principles. As such it has lost a certain amount of force due to the broadness of its constituency.

CHAPTER 2
Talking to the farmers

I believe that a man who has spent a considerable part of his life growing coffee, and on extension work in coffee country, has a right to air opinions and advance ideas that may prove of value.

[AE Haarer, 1956]

Although the project (CFC/ICO 02) was focused on only one of the most important problems in coffee production, it was considered important to have an overall view of coffee farmers' concerns to gain perspective and help guide future research and extension efforts. The following analysis involves the information gathered in rural meetings, using methodologies such as Rapid Rural Appraisal (RRA). More background data on farmers can be found in Appendix A.

The advantage of this participatory approach is that much of the data collected is up to date and gathered directly from the mouths of stakeholders. In consequence however, it has the disadvantage of being less rigorous than a long-term in-depth study. Nevertheless, we believe the results obtained are a reliable estimate of the true socio-economic state of small coffee farmers in all these countries.

As development scientists we have to make a pragmatic balance between scientific method and practicability, to give an analytical but useful contribution to the economic implications of the problems caused by CBB and how they are affecting coffee growers lives. We hope that the information here can serve as the basis for future research and extension activities. More general information on coffee in each country can be found in Appendix B.

The coffee producers in all the countries in this case study were mainly smallholders. They are a heterogeneous group but many displayed some or most of the following characteristics:

- Widespread lack of the legal property rights to land, which implies lack of collateral.
- A low education level, many with less than full primary education.
- The majority of them above 50 years old, with sons and daughters apparently unwilling to take over from fathers.
- Aversion to risk.
- Low income, and diversification of income such as employment off-farm; thereby increasing the opportunity cost of labour on the farm and thus reducing the likelihood of adopting new and labour-intensive activities.
- Lack of entrepreneurial capability.
- Resignation to the status quo and/or passively expecting government assistance.
- Small farms (less that 3 ha in coffee).

2.1 India

In India two main regions were analysed. At Chettalli Coffee Research Sub Station, a meeting was carried out with coffee growers from the region. Firstly an RRA on the main coffee production problems was done and then a survey related to CBB management was also carried out. The main problems in coffee production identified and ranked by the farmers appear in Table 1.

■ **Table 1.** Problems in coffee production, Kogadu region.

Problem	Importance
Price fluctuations & commercialisation problems	1
Lack of infrastructure (irrigation facilities as key point)	2
Input costs	3
Rainfall pattern	4
CBB & other pests & diseases	5
Lack of credit	6
Lack of skilled labour	7
Size of holdings	8

Thus the main problems are to do with how the coffee is sold, lack of infrastructure where irrigation facilities are seen as very important in coffee production and in third place the cost of inputs needed in coffee production such as fertilisers, herbicides, etc. CBB is in the fifth place though a lot of concern about this problem was expressed. Additionally, this group of farmers saw the following strategies as potential solutions to the price fluctuations and market problems (Table 2).

■ **Table 2.** Kogadu farmers' potential solutions to price and marketing problems.

Solution	Responsible
Better marketing strategies at national level	Government
Promotion of internal consumption	Government
Improvement of coffee quality	Farmers
Adoption of low cost technology	Farmers
To increase coffee productivity at farm level	Farmers

Apart from government responsibilities, farmers' opinions are oriented towards improving economic conditions of their business but as active participants, which means taking action by themselves in order to overcome difficulties that they see as their responsibility.

The results of the survey carried out on perceptions of CBB are as follows: all of the farmers thought that CBB is a very important problem; 57% of them have suffered economic damage from the pest; the average level of infestation for the 2000-2001 coffee harvest was 3.6%. 83% of them have the opinion that phytosanitary control measures are the most important against CBB, whilst just 17% thought that chemical control was the most important. 71% of the growers find control measures easy to adopt. Finally, 85% consider they have enough resources to deal with the pest while the other 15% lacked financial assistance to manage it.

On the other hand, in a meeting held in Kalpetta (Wayanad district), farmers listed the following problems (Table 3).

■ **Table 3.** Problems in coffee production, Kalpetta.

Problem	Importance
Low coffee prices & general market situation	1
High wage costs & low labour efficiency	2
Lack of technical knowledge on spraying	3
Rainfall pattern	4
Assessment of CBB losses	5

In this case the main problems are similar to those of Kogadu farmers with low prices and the poor market situation identified as the most serious problems. However farmers here rated labour problems higher, believing workers to be costly and inefficient. Another key point is that they were worried about lack of knowledge on spraying insecticides and the difficulty of assessing CBB losses.

As potential solutions to their problems, coffee planters suggested diversification of agricultural production in order to spread their income sources, to reduce production costs, to have government support and to promote coffee consumption.

In this meeting a survey was also held on CBB with the following results: 57% of the farmers indicated that CBB is a very important problem, 29% classified it as “important” whilst 14% felt that CBB is less important. 42% of them have suffered economic damage due to CBB attacks whilst the other 58% have not experienced significant damage caused by this insect. The average level of infestation was about 7.8%, i.e. about twice as high as the other group and this has clearly influenced their prioritisation of problems. Over which is the most important control measure, opinions were divided: 42% believed that chemical control is best, another 42% indicated that cultural control is sufficient while 16% thought that alcohol traps were more useful. When asked about whether they have enough resources to carry out CBB control, 71% told us that they have no problems, whilst 29% of the farmers indicated that they do not have enough money to do these activities.

2.2 Ecuador

An RRA was carried out in Las Flores (Manabi). The goal was to understand farmers' opinions about the main problems in coffee production. They listed the problems and ranked them (Table 4).

Table 4. Main problems in coffee production, Las Flores.

Problem	Score
Lack of community organisation	5
Low productivity	3
Commercialisation problems	3
Coffee berry borer	2
Pelicularia koleroga – a coffee disease	2
Coffee rust disease – *H. vastatrix*	0

Thus when farmers were asked in an informal but systematic manner about the gravity of the problems facing coffee production, 'lack of community organisation' was thought to be the main problem followed by low productivity and problems in the commercialisation process. Despite all the farmers being aware of the CBB problem this is not their main worry. For instance a group of farmers from Piñas, mentioned that they had had this pest for more than 8 years and during this period its advance was slow without serious attacks. Having categorised the problems listed above, we focused on low productivity as a topic and invited farmers to suggest possible solutions. Table 5 describes the potential solutions for these problems.

Table 5. Potential solutions for coffee productivity.

Problem	Score
Fertilisation	4
Prune coffee trees	2
Improve harvest efficiency [5]	2
New coffee varieties	1
Change shade trees	1

It seems clear that fertilisation is seen as the first step to improve coffee productivity, but credit access difficulties were raised as a difficult hurdle to overcome. Nevertheless, the key point here is the generalised perception of low coffee productivity by most coffee farmers and that it was considered more important than CBB. Productivity is a relevant variable to take into account when dealing with CBB since experiences in other countries facing this pest have shown that coffee productivity and CBB are two sides of the same coin. Thus low productivity will not provide sufficient economic conditions to stimulate CBB control among the coffee growers. From this we conclude that if coffee production in Ecuador remains generally unintensive, high IPM adoption levels for this pest will always be difficult. We suggest that actions aimed at improving coffee profitability are vital in order to help change the coffee farmers' attitudes towards IPM.

[5] This means to collect more selectively red berries

Commercialisation problems: this is one of the most serious problems of coffee production in Ecuador, because the present set up is squeezing farmers' income. A large part of the profit seems to remain in the hands of the intermediaries, which generates dissatisfaction among the coffee farmers. This sentiment could be observed during all our rural meetings.

In fact between the coffee farmer and the coffee exporter there are a number of intermediaries, which in the best of cases we encountered was two, and in the worst, four. The coffee farmers sell their product in different forms: 61% sell as berries, 4% as partly dried parchment, 14% as dry parchment, 19% as dry berries and 2% as green beans. However in each case the intermediary assigns a price in an apparently arbitrary way. E.g., during the previous harvest (May to July 1999), for the same week and in the same municipality the price was about US$16/qq cherries for some farmers but for others it was about US$12/qq without any apparent reason to justify this differential. Moreover, this internal market structure does not pressure farmers to improve the quality of Ecuadorian coffee and the general rule when buying coffee is to take into account only its weight and no other characteristics. Thus these coffee intermediaries generally do not check coffee quality for both damage caused by CBB and other defects. This situation militates against production of good quality coffee because the market does not pay for it. Indeed it was mentioned that an additional factor seriously affecting quality is that these same intermediaries provide inadequate care of the coffee during the time they hold it, so that delays in the subsequent processing jeopardises its quality.

The cost of the commercialisation chain: an example given by the farmers. A typical situation encountered in the coffee chain is explained below. The case is for arabica coffee, which is assumed to have an international price US 103 cents of dollar per pound on the New York exchange (price at the time of the survey in early 2000). Taking this price as a baseline, we can see how the price erodes until it arrives at farm level (Table 6).

In real terms, price has decreased by about 53%, a serious reduction of the farmer's potential income. A similar situation happens in the case of robusta coffee but in this

■ **Table 6.** Price fixing analysis in February, 2000.

Commercialisation Stages	US$ cents/green pound
1. International price–arabica washed	103
(minus) quality penalty	16
2. Sub-total	87
(minus) exporter's fixed costs	12
3. Sub-total	75
(minus) exporter's profit	3
4. Sub-total	72
(minus) first intermediary	8
(minus) second intermediary	8
(minus) third intermediary	8
5. Coffee farmers' price	48

case reduction for quality is smaller than arabica (US$0.08/pound). Hence another preliminary conclusion is that prices depend far too much on the various interests of the many intermediaries involved in this process. In broad terms, ultimately Ecuadorian farmers are risk takers because there are no measures in place to protect their income.

2.3 Honduras

Two meetings were carried out and each of them detected different problems, which are analysed independently.

■ Agua de Piedra farmers

This group was from the small town of San Luis. They were asked about their main problems as coffee producers. Table 7 shows their choices.

■ **Table 7.** Main problems in coffee production, Agua de Piedra region.

Problems	Score
Intermediaries	5
Low Coffee Prices	4
Lack of Credit	3
Lack of Labour	2
Inputs' Costs	1
Coffee Quality	0

The main two difficulties were commercialisation and low coffee prices, which confirmed what local extensionists had told us. Again CBB is not regarded as a main problem in coffee production. But it was evident that farmers think that poor commercialisation and low prices are negatively affecting crop management. Hence from this lack of management we expect increased CBB attacks in the future and in this way increased losses and poorer quality.

■ El Tigre coffee farmers

This group of farmers is near to Lake Yojoa, an important coffee zone. Table 8 summarises the perspectives of this group on coffee production.

■ **Table 8.** Main problems in coffee production, El Tigre region.

Problems	Score
Low coffee prices	4
Lack of credit	4
Input costs	3
New pests	2
Intermediaries (local traders)	2
Bad post-harvest management	0

For farmers in this area, low coffee prices and lack of credit are the main problems, followed by the cost of the inputs needed to produce coffee. New pests, such as CBB and the role of intermediaries are also important. They gave higher importance to pest problems, especially CBB; perhaps climatic conditions in this region are more favourable to pests because of the more humid climate. Intermediaries there can demand an interest rate of about 40% per year from farmers, which is significantly higher than the interest rate offered by the local banks.

Commercialisation problems: an imperfect market, which is the case of the Honduran internal coffee market, can lead to seasonal and normally low coffee prices because of the harvesting peaks. The result is a highly vulnerable production system because of fluctuating availability of labour and assets. For instance, labour costs tend to be higher during the harvest period because it is scarce and in many cases farmers have to bus workers to and from distant villages. Another important factor is that the internal market buys coffee by weight and discounts the price reduction according to level of CBB damage. There is no national standard for these penalties, for instance one trader reduces the price by 1% for each 3% of perforated dry cherry coffee from a 500g sample, which should correspond to 1.5% in parchment coffee. At the Coex Company, coffee exporters take a sample of 100 g of cherry coffee. If CBB damage is over 2%, the company will refuse the coffee, which seems a very severe penalty.

2.4 Guatemala

The case of the Chocola community: Chocola is a peasant coffee community, with an area of about 2,450 ha. This enterprise was founded by the Guatemalan government in 1972, giving the land to 772 farmers as a result of a programme of land reform. Although Chocola has its own post-harvest infrastructure, this has been rented to Coex, a coffee trading firm. For this reason most of the coffee producers sell their coffee to this firm which buys the coffee by weight, ignoring any potential differentiation by quality. So farmers here are not encouraged to achieve better coffee quality because the market does not reward it. We had a meeting with 12 coffee growers from Chocola who we involved in a RRA; Table 9 shows the results.

From this analysis, it seems that lack of commitment to maintain a sound coffee crop is the main problem. Farmers were almost unanimous that people from their commu-

■ **Table 9.** Main coffee production problems in Chocola.

Problem	Score
Lack of community interest	5
Lack ofcommunity organisation	4
Low coffee prices	3
Lack of money	2
Coffee berry borer	1
Coffee leaf rust	0

nity are not paying enough attention to their coffee crops. They felt that the state of the coffee business is so difficult that they are discouraged to invest time or money to improve productivity. They also cited the lack of organisation at the community level as a principal reason for lack of enterprise. However all of them were concerned about CBB; they considered that this pest is able to substantially reduce the out-turn (conversion rate) of coffee cherries to parchment coffee. Asked about the possible solution to the lack of interest, these farmers analysed all the factors they could think of and Table 10 summarises their deliberations.

Thus from the farmers viewpoint, education is seen as the main path to self-motivation. Despite these difficulties, farmers were asked about CBB management before

■ **Table 10.** Potential solutions to Chocola farmers' lack of interest.

Potential solutions	Score
More education	3
To increase motivation	2
To become conscious of the situation	1
More money	0

and after the project started. They admitted that before the project began CBB management was non-existent. After the activities carried out by the project the situation had improved, at least for the farmers interviewed, because they were trying to adopt some of the proposed practices.

Selling the coffee: there is frequently a long commodity chain for smallholder farmers in Guatemala. The first actor in the chain is the coffee producer who sells his coffee to an intermediary. There can be two or three intermediaries that buy coffee in different ways such as ripe cherries, parchment coffee or even green coffee. The longer the chain, the lower the price paid to the farmers. These intermediaries sell the coffee to the exporters who apply discounts according to quality.

In the case of Chocola, the farmers could sell their coffee to the community organisation that was paying 58 Quetzals[6]/qq of cherries, but they preferred to sell to the intermediary who pays 60 Quetzals /qq, though some farmers had doubts about the reliability of the weighing machines used. Intermediaries also act as an informal bank because farmers borrow money from them. The amount they lend varies between 3,000 and 8,000 Quetzals per farmer; sometimes as much as 15,000 Quetzals. The interest rate is very high, about 5% a month. But this credit facility leads many smallholders to sell their coffee to the intermediaries most of the time. Larger farms trade their coffee themselves, many of them are also exporters so this most likely makes them more aware of losses due to CBB. The quality problem is worth highlighting: the middlemen simply weigh the coffee and pay for it, ignoring the real quality. Hence there is no encouragement to improve quality of the coffee. This must negatively affect the efforts to encourage active CBB management.

6 US$1 = 7.7 Quetzales (2000)

2.5 Mexico

■ **Ejido Mixcun:**

Is composed of about 76 members who have been facing CBB problems since 1978. In this place a meeting was carried out with 7 coffee farmers. The main problems they mentioned appear in Table 11.

In these farmers' opinion, lack of credit is the main problem. Surprisingly there was no mention about coffee productivity despite all the coffee plots being very old and with very poorly bearing trees. The coffee farmers said that before the CFC project was

■ **Table 11.** Main problems in coffee production, Ejido Mixcun.

Problem	Ranking
Lack of rural credit	4
Weather problems (droughts & excess of rains)	3
Coffee leaf rust	2
Coffee berry borer	1

started there, CBB management was focused on spraying endosulfan and other products with copper as the active ingredient. There was practically no true management and the coffee farmers just harvested the ripe beans but without doing any sanitary cleaning afterwards. They sold the coffee to intermediaries who did not care about the amount of CBB in the coffee bought.

Currently some coffee farmers have started to implement an IPM strategy for CBB management. They do this through their own interest and they realise that IPM works well. Moreover some neighbours (not part of the project) have seen the benefits of IPM and a few of them have followed the same strategy. One reason they stated was that now the Union of Ejidos buys coffee according to quality, though sometimes there is a price reduction so in this case they prefer to sell to the intermediaries (they call them "*coyotes*", a derogatory term) because they do not analyse the coffee quality.

■ **Ejido Santa Rosalia:**

During this visit we met 7 smallholders involved in the project. The first topic analysed concerned coffee production problems. Although on this occasion we did not score these problems, they are listed in Table 12. They said that one of their main problems is that they do not really consider themselves as true coffee producers because they lack community organisation. Because of this, they felt that some potential earnings go instead into intermediaries' hands.

Apart from this they stated that low coffee productivity was another factor regarded as a key problem in coffee production because the level of technology used is very low. Villafuerte (1993) observed that most of the coffee producers in this area devote almost the whole area of their farm to coffee, creating a high dependency on this

■ **Table 12.** Main problems in coffee production, Ejido Sta. Rosalia.

Problems (not ranked)
Lack of economic resources
High transportation costs, due to distance between farm & selling point
Low coffee prices
Lack of government support
Coffee pests & diseases (CBB & *Mycena citricolor*)

crop. A key point is that average productivity is only about 10.5 qq of parchment coffee per hectare, similar to the national average. The density of trees per hectare suggests the coffee production in this locality is intermediate (between traditional,-1500 to 2000 trees/ha, and intensive,- at least 4000 trees/ha). Each year they renew an average of 370 coffee trees per hectare (range 200 to 500), which demonstrates interest in having new trees even though crop management is not intensive. Regarding coffee varieties, they prefer the traditional Borbon and Typica, observing that a coffee tree is considered old when it is more than 50 years old. In the case of Caturra or Catimor varieties on the other hand, trees over 12 years are considered as old and unproductive. We developed a work calendar with the farmers, from which we estimated total labour needs at about 200 working days/ha distributed throughout the year, presenting a peak in November due to the coffee harvest. Labour requirements are significantly less than would be the case with intensive production.

They commented that the "*coyotes*" (private buyers) check the coffee and mark down the price for poor quality. If the coffee farmer does not control CBB, price reductions can be about 8 to 10%; moreover it can be further affected by a weight reduction of around 2 kg in a 60 kg sack. In both cases this is a significant amount of money for them to lose.

The role of the intermediary: Belisario Dominguez is the name of a village where most local coffee farmers sell their coffee to intermediaries. In this place Mr. Juventino Velásquez, a local coffee trader, was interviewed. He has been buying coffee for more than 15 years; sometimes he also lends money to farmers. Normally he works with a capital of $100,000 Mexican pesos, which can be distributed among 20 farmers, i.e. an average of $5,000 per person (about US$500). The interest rate he charges is about 5% per month, which was six times the national Mexican inflation rate. At the beginning of harvest, farmers often lack funds so they are more or less forced to approach the intermediaries. But he is worried because since 1998-99 the people to whom he sells on the coffee have been sampling the quality and make deductions for poor quality.

The cost calculation he does is very simple: if the coffee price is about US$62.5/qq in Huixtla[7], the baseline price in Belisario would be around US$59 to 60. Intermediaries

7 Huixtla is in this case the nearest most important coffee market where all the intermediaries of this locality sell coffee.

get the daily coffee price from nearest main towns: Huixtla & Motozintla. With a price of US$60.0/qq, to be paid to the farmers, if in a handful of parchment coffee there are 4 fermented or defective beans, the purchase price will be reduced to US$55 to 56/qq. If there are 6 beans broken or damaged by CBB, the price will be US$56 to 57/qq.

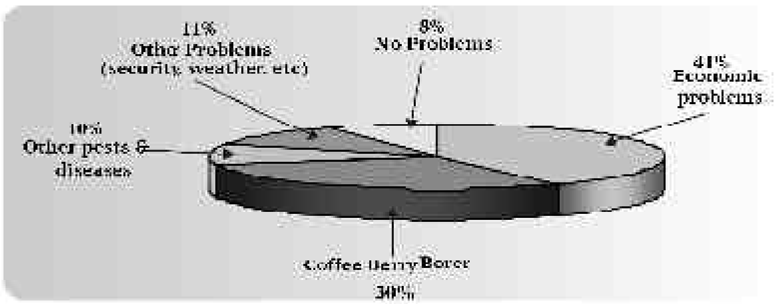
Farmers claimed that some traders bias the scales in order to pay less money for the same amount of coffee. It is believed that the intermediary can gain 2 or maybe 2.5 kg per sack of 60 kg.

2.6 Colombia

Colombian coffee growers are facing many problems. As in other countries, the most important is the low coffee price, which has been ruling the coffee market over recent years, leading in 2002 to the lowest real price ever. Social conditions have also changed because of the economic crisis leading to increased violence and insecurity. Despite these circumstances the internal coffee market continues to operate well. Colombian coffee farmers are in a fortunate minority of those who receive immediate payment for their coffee at a transparent rate closely related to the international coffee price. They achieve this because of the well established co-operative system and a sound coffee institutional structure. However at the beginning of the project ICO/02 a survey was carried out in order to determine the main problems faced by the Colombian coffee producers. Figure 1 describes these problems.

Hence low coffee prices and CBB were the main problems and comprised 71% of the total. Of the countries visited for this study, only in Colombia did CBB figure as a principal problem. In the other countries it appeared more to be a symptom of other structural problems which were weighing heavily on farmers.

In the Colombian case we can conclude that CBB was one of the most important problems because the internal coffee market punishes the price if the level of damage exceeds certain limit. The main consequence was a severe price reduction.



■ **Figure 1.** Main problems affecting IPM participatory research project farmers

CHAPTER 3

How the coffee berry borer is controlled: evidence from six countries

"Agricultural production has evolved into a complex business. It requires the accumulation and integration of knowledge and information from many diverse sources including marketing, horticulture, pest management, accounting and tax laws. Emerging sustainable practices require even more information (to substitute for purchased inputs such as pesticides) for implementation. Growers seldom have at their disposal all information available in a usable form when major management decisions must be made. Increasingly, modern growers must become experts in the acquisition of information for decision making in order to remain competitive.

Unfortunately assistance from specialists is becoming relatively scarce as the complexity of agriculture is increasing. As growers struggle with the new "rules" of agricultural production, they are faced with a still greater problem. The public wants reduced pesticide residues, but high quality fruit. The rapid change in pest control is further complicated by new labour, marketing and social concerns that threaten to exceed the capacity of what growers can manage."

[Travis & Edwin, 1995]

3.1 CBB control strategies

Before we get to the main economic analysis of CBB IPM, in this chapter we present a synopsis of our field survey data showing what is actually happening on farms. The purpose is collect first-hand information to inform our analysis and help generate new ideas. The methods used for collecting data were through direct interviews and rural meetings. The former was used mainly at the decision-maker level and the latter at the level of technicians, agronomists and farmers. All countries have officially adopted a broad IPM approach to CBB control, though a clear statement about what IPM means and how to transfer it to farmers we found to be mostly lacking. There were differences in approaches between countries, but the main elements were shared in common. Although it was impossible to get a comprehensive picture of countrywide IPM we are confident that the following account is reasonably accurate.

Researchers have a good grasp of IPM principles, though the regimes they have suggested tend to be overly complex and seemingly not designed for resource-poor farmers, indeed we found that many scientists had an imperfect appreciation of rural socio-economic realities. For example, when suggesting a new activity, coffee institute experts may be unaware of the labour needs of other crops grown by the farmer. For the best of motives, biological control is recommended, though the economic utility of so doing has still not been established clearly in most cases. Cultural control (manual collection of berries) is the main recommendation and the dangers of chemical control are duly stressed.

In no country has every candidate element of IPM had a full cost-benefit assessment and then been integrated into an optimal IPM regime. Instead researchers have had to make more *ad hoc* recommendations to respond to urgent demands from farmers. Generally they have made sensible suggestions but long-term research to approach an optimal system, adaptable to farmers of differing means, has not been set up. With the current scarcity of funds it seems unlikely that this will be carried out in the foreseeable future. Prior to the project from which this book stemmed, research was not participatory, i.e. farmers were not formally contracted as partners in the research process to develop practical ways of building an IPM strategy. To an extent then, we feel that IPM theory has dominated the research process, rather than the more modern approach of research as an inclusive and pragmatic process-driven exercise.

3.2 CBB IPM in six countries

3.2.1 IPM in India

In order to cope with the CBB problem the Coffee Board of India has structured an IPM strategy based on the following components:

- Picking of the infested berries and treating them with hot water, then burying in the soil.
- Timely and thorough harvest.
- Proper gleanings using harvesting picking mats to collect the falling berries.
- Drying coffee to the standard test weight.
- Early disposal of the crop.
- Spraying insecticides in hot spots (in extreme cases only).

The Indian Coffee Board has proposed a standard method for CBB sampling at plot level as a component of the IPM strategy. Farmers are instructed to take 10 plants per acre at random and then to select 5 branches per coffee tree (50 branches/acre in total). They establish the infestation level by counting both attacked and non-attacked berries. This process should be carried out once a month and the decision level for control is when CBB attacks exceed 5% infestation.

Awareness of the pest a report of the extension campaign on CBB awareness held in Kogadu district (Coffee Board, 2001), covering 130 holdings, reported the following findings:

- All coffee growers were aware of CBB. Personnel from the coffee board had trained 52% of them, 44% got information through mass media and 4% knew about the pest from neighbouring farmers.
- Knowledge of the pest: 97% of the coffee planters were able to identify the CBB attack symptoms.
- Chemical control: about 11% were acquainted with chemical control measures, doses, time of spraying, etc. Many of them did not use this measure because of the low infestation level.
- Phytosanitary measures: 65% of coffee growers showed good knowledge of this control measure.
- Biological control: in the survey just one grower was using it. Farmers were quite sceptical about the utility of bio-pesticides.
- Post harvest measures: only 24% were aware of possible control measures during post harvest processing.

Technology adoption: A socio-economic study carried out by Coffee Board and recently analysed by Duque (2002), showed that the adoption of the components proposed for CBB management was variable. For instance, components such as gleaning collections and the use of picking mats were the most adopted. However the fungus *B. bassiana* was poorly adopted by the farmers as was the use of sticky traps. Table 13 summarizes the adoption of all the components of the IPM strategy for controlling CBB in India.

■ **Table 13.** Adoption of components in Indian IPM.

Component	Adoption (%)
Beauveria bassiana	5
Spot sprayings	35
Blanket sprayings	41
Hot water treatment	20
Sticky traps	3
Picking mats	74
Gleaning collections	95

CBB – calendar of operations: despite some differences in CBB management between arabica and robusta the following calendar of operations represents the most important practices in CBB management in robusta coffee. Table 14 describes these monthly operations.

■ **Table 14.** Calendar of operations in Indian CBB management – robusta coffee[8] .

Month	Main CBB Operations
January	Start harvest from infested blocks / leave few plants unharvested / dry the coffee to the standard weight.
February	Complete crop harvest / treat the floats in boiling water / dry the coffee as indicated.
March	Similar operations as February / harvest remaining crop near the drying yard /collect gleanings and leftover berries and subject these to boiling water before drying.
April	Continue collection of leftover fruits and gleanings, boil and bury them.
May	Monitor the pest / spray insecticide if needed / remove all-of the off season fruits or monsoon coffee / give them the boiling water treatment.
June	Monitor the pest closely / remove off season coffee / spray insecticide if needed.
July to August	Monitor the pest closely / spray insecticide only if absolutely needed.
September	Programme insecticide spraying depending on the level of infestation.
October	Monitor the pest closely as also the development of the berries / spray insecticide if required and not done before.
November	Monitor the pest closely, identifying hot spots in the estate / deploy biological control if needed.
December	Monitor the pest closely identifying hot spots in the estate / deploy biological control if needed.

As may be concluded from Table 14, there are some key months for CBB management, such as those around the beginning of the year and also those from August to December.

Inter-crops are also important income generators. Approximate estimates that we made with the farmers suggest that inter-crops represent from 20 to 30% of total income, which confirms their importance in the coffee production systems in India. Table 15

[8] Coffee Board – India, 2000

■ **Table 15.** Harvesting periods of some inter-crops in India.

Regions	Crops	Harvesting months
Kogadu	Orange	September / October
	Pepper	December / January / February
Wayanad	Pepper	December / January / February
	Ginger[9]	September / October
Pulneys	Pepper	December / January / February

shows the harvesting periods for the inter-crops in three coffee zones of India. It is clear that all of them have non-coffee labour needs that compete with those operations required for coffee. Despite cheap labour in India, if coffee prices continue low, some critical decisions for optimal deployment of labour may be necessary. For instance if certain CBB operations need to be carried out at the same time that orange or pepper have to be collected, a problem of labour allocation could arise. This is a good example of the importance of a comprehensive analysis of the whole farm budget to assess the likely impact of new control recommendations.

3.2.2 IPM in Ecuador

The Consejo Cafetalero Nacional, Cofenac[10] (1999) has made recommendations to reduce the infestation levels of CBB. These recommendations include:

- Pick up and burn the berries attacked by CBB, especially from minor flowerings.
- Carry out shade regulation in order to increase illumination, which is less favourable to the pest.
- Prune the coffee trees to promote healthy and vigorous plantations.
- Carry out sufficient weeding to avoid competition for sunlight, water and nutrients.
- Apply fertiliser to ensure good crop productivity.

Anecafé (1999), an exporter organisation working in CBB control, principally promotes the use of cultural control. This control measure is based on coffee harvesting of all ripe beans, collection of the fallen berries and pruning the coffee tree. The use of organic insecticides and biological control is also increasingly promoted.

Thus the main IPM message given to farmers concerns the employment of cultural control. We believe this to be the correct approach but since farmers are not paid more for CBB-free coffee, the usefulness of carrying out this measure depends en-

9 Used just during establishment, 2-3 years
10 National Coffee Council of Ecuador

tirely on convincing farmers that the extra weight they save by selling CBB-free berries is worth more than the extra labour cost. This may well be true, but there is no experimental evidence to back it up. Hence the need for farmer participatory studies to quantify these fundamental IPM parameters in a form that can be readily assimilated.

3.2.3 IPM in Honduras

Since in Honduras coffee trees flower in January and February, problems caused by CBB start to be seen in the developing berries by May, June and July. In this country the IPM strategy is based on five components: use of parasitoids, cultural control (the two main activities are '*pepena*' and '*repela*'), chemical control, sampling of the pest populations and general crop management practices. The extension service of IHCAFÉ has been involved in transferring all these components to the coffee farmers.

During a meeting in Santa Barbara with a group of extensionists, an RRA was carried out on the various components of this IPM strategy. They were asked about several features of each IPM component: effectiveness, easiness, cost, environmental effects and effects on human health. Table 16 shows the score given to each component on a set of characteristics.

Table 16. Components of IPM strategy and their characteristics (higher score indicates more of the attribute).

Component	Effectiveness	Easiness to carry out	Costly	Environment friendly	Healthy
Parasitoids	17	8	14	24	24
Pepena /Repela	24	24	15	24	24
Chemical Control	24	8	9	8	8
Sampling	22	9	16	20	23
Crop management[11]	14	21	10	18	16

According to Table 16, the most effective components are both manual CBB removal and chemical controls, where "effective" means that they are good at reducing pest populations. The lowest effectiveness is seen with crop management, which is logical because these activities are addressed to general activities and are not related directly to CBB population control. Regarding "easiness to carry out", which should play an important role in the readiness to adopt the component, *pepena/repela* and cultural practices are seen as the best. In reality this means they are not difficult to understand and require no special equipment or skills and that they have been accustomed to carrying out these activities over a long period.

Related to the cost of each element, the use of parasitoids, *pepena/repela* and sampling are considered as most costly, followed by cultural practices and chemical control

[11] For example, pruning and weeding.

which is in fact the cheapest component of all. This is not a desirable combination; if chemical control is regarded as both effective and cheap, it may well encourage farmers to choose this component over others. Nevertheless, chemical control is considered the most dangerous for both the environment and human health.

In the meeting we convened in Agua de Piedra, coffee farmers were asked how they ranked in importance the different IPM components, results appear in Table 17.

■ **Table 17.** Ranking of importance of CBB practices. Agua de Piedra farmers.

Practice	Score
Collection of damaged berries	4
Pepena & repela	3
Weed control (cultural practice)	2
Pruning of trees (cultural practice)	1
Shade regulation	0

As can be deduced from Table 17, the collection of coffee berries is the most important activity carried out in CBB management by these coffee farmers. This is an encouraging result because they do not consider the use of insecticides before trying cultural control. However, we cannot ignore that these very resource-poor farmers mostly lack spray equipment.

3.2.4 IPM in Guatemala

The recommended CBB management strategy is based on several components (Campos *et al.*, 1998). Sampling methods should be used to support control decision-making. CBB sampling should start 90 days after the most important flowering in order to know both the infestation level and to identify infestation “hot spots” in the coffee plots. Manual control is the second component. This is based on the collections of remaining berries after harvesting on both coffee tree and ground. Also, new perforated fruits from the new harvest should be removed from the plot. Biological control is implemented by using the parasitoid *Cephalonomia stephanoderis*. This natural enemy of CBB should be released from the finishing of the harvest up to the beginning of the new one (January to September), but so far this recommendation is made only for large plantations.

Accurate information about IPM uptake at a national level was hard to accurately assess. We suspect that most large estates still use significant amounts of chemical insecticides under an IPM framework whereas smallholders use much less. The CFC project concentrated on one community of smallholders and, although this may not be representative of Guatemalan smallholders in general, an account of CBB management there now follows.

CBB Management in the Chocola Community: a survey was carried out here in 1998, when coffee farmers were asked about CBB management. The findings were remarkable, 81% of them said that they did not manage CBB as such. The main reasons were lack of advice and economic problems. However all of them carried out at least one activity against this pest. Cultural control was done by 38% of farmers but more than 30% were ignorant of the benefit/cost aspect of this activity. Chemical control was carried out by 22% of them, by spraying with endosulfan; those that did not spray cited lack of money as the main reason. However when spraying they do it over the entire plot, and not in hot-spots as recommended under IPM criteria. Moreover, of those that use insecticides almost 60% spray twice despite the recommendation of once a year. Regarding biological control, none of them were carrying out this measure; just 19% had received information about this but 81% of them indicated that they would be interested to test this control measure.

97% of the farmers did not sample. The cause seems to be lack of knowledge and information. Only one farmer reported using flowering as a reference to calculate spraying time. None of the other farmers who sprayed assessed pest levels in their plots and perhaps the low education level is one of the barriers to adoption of this component of the IPM strategy. Remarkably, despite CBB having arrived in Guatemala in 1971, farmers stated that they do not have enough information about sampling CBB. This is a similar result to the other countries we visited, where most farmers do not sample, one of the main reasons being the lack of mathematical ability to carry out the calculations. But despite this problem, most coffee farmers have developed at least a subjective method to assess pest levels in their farms but we do not have enough knowledge of it to recommend its use and implementations. Clearly this would be a suitable area for a participatory approach, but Anacafé staff has not taken this up. If they truly want to introduce IPM they need to intensify their efforts in this area because estimation of pest numbers is a fundamental component of IPM.

3.2.5 IPM in Mexico

In the case of Mexico, it was clear that the almost total absence of a solid and functional extension service has left the coffee farmers in a unenviable state to face CBB.

Farmers' basic IPM strategy concerns the use of cultural control, which has two key components: *graniteo* and *pepena*. This strategy is very similar to that observed in Honduras and Guatemala. The approach is understandable since farmers are poorly paid for their coffee whether CBB-free or not, and they do not have enough money to obtain external inputs. However we could see that many small farmers carry out some control measures such as cultural control (though not intensively), but lack concepts or expected results. In the case of the larger producers it was clear that insecticides were the most used tool against CBB.

3.2.6 IPM in Colombia

Colombia has prominently promoted an IPM strategy for dealing with CBB. This strategy consists of a combination of cultural and biological control; the most important benefit seen as a consequence of the adoption of this system is the maintenance of the ecological balance in the coffee area and hence sustainability of the coffee regions in Colombia (Cadena, 1991). Cenicafé has designed a group of technological components for the management of this pest, which have been transferred to the coffee growers through the extension service of the National Federation of Coffee Growers over the last decade. This has been carried out using an educational campaign, which has as a main goal the continued production of good quality exportable parchment coffee despite the presence of CBB (Saldías, 1996).

The strategy stresses cultural control, which consists of maintaining the coffee plots free of ripe, over ripe and dry coffee beans through frequent collections (Federación Nacional de Cafeteros de Colombia, 1994, 1995). This activity ("*Re-re*") reduces the CBB populations and avoids the build up of fallen berries, which are an important source of new infestations.

Another component is field sampling of CBB to establish the infestation level of CBB and should be, as explained previously, the baseline to take actions related to pest control. Sampling allows farmers also to know the "hot spots" in the coffee plots (foci of infestation where for some reason CBB is more concentrated) and, if dissections are made, to become aware of the state of progress of the CBB's penetration to the endosperm. To record flowerings is also important in order to know the critical periods of CBB attacks. There have also been several advances in CBB management during the post harvesting process (Bustillo *et al.*, 1998).

Technology adoption: since the introduction of the IPM strategy, Cenicafé has stressed that the various components are divisible, and that IPM is not a 'package' of control measures that need to be adopted concurrently. Some components, such as evaluation, are effectively pre-requisites to the effective use of others, such as chemical control. Few farmers though have adopted sampling. Cenicafé recommends that growers decide on which control components to deploy according to the level of infestation and the resources available.

Cenicafé assessed the adoption of the various IPM components by growers. The results suggested that cultural control (Re-re) is by far the most common control method. Table 18 describes the adoption of IPM components in Colombia (Duque *et al.*, 2000).

■ **Table 18.** Indices of adoption of IPM components in 2000.

Component	Index
Cultural control	0.89
Post-harvest control	0.40
Chemical control	0.32
Evaluation of infestation level	0.24
Recording of flowerings	0.25
Biological control (*B. bassiana*)	0.19

Notes: Where 0 = non adoption and 1 = maximum level of adoption

Despite the individual adoption index for each component, a weighted adoption index was calculated according to the estimated individual contribution of each method to overall control. The weighted index was 0.64, which is a good level, considering that IPM is more a concept than a technology. The adoption of the cultural component was higher than in the other countries involved in the project.

In 1998 Cenicafé commenced an IPM participatory research project with 115 small coffee growers affected by CBB in the central coffee zone (Baker *et al.* 2002). Of the total, 68% were intensive growers (5000 or more trees/ha) and 9% were traditional growers, with the remainder placed in the intermediate category. The objectives of the project were to:

- Increase adoption of components of the IPM strategy.
- Develop a process to facilitate understanding of IPM by coffee growers.

As part of the project, the change in the adoption rate of the IPM components between 1998 and 2001 was measured. Cultural control (Re-re) remained a predominant form of control, whilst the use of chemical control was significantly reduced between 1998 and 2001; significant increases occurred in the use of other components, such as biological and post-harvest control (Table 19).

Table 19. Adoption of IPM components by IPM participatory research project growers 1998 and 2001.

Component	Adoption % 1998	Adoption % 2001
Cultural control	95	98
Post-harvest control	5	80
Chemical control	80	38
Evaluation of infestation level	12	80
Biological control (*B. bassiana*)	18	80

Source: Cenicafé

2.7 Synopsis

What were farmers who we met trying to tell us? Looking at the problems of the non-Colombian countries together, there is little doubt that most farmers find commercial problems in their broadest sense, centring around credit and marketing, as their principal difficulties. They tend to focus blame for their problems on intermediaries and government; they never mentioned the wider world and the globalisation debate.

Because of the lack of premiums for quality, too many farmers simply do not see their coffee as a high value product that will repay careful tending. Probably the single most important step towards controlling CBB would be the introduction of a country-wide quality scheme such as in Colombia.

But we have to consider also that the use and implementation of the IPM strategy has not been easy for the coffee farmers. IPM is a knowledge-intensive strategy which is difficult to adopt due to the many measurements, calculations and estimations required to arrive at an optimally cost-effective control regime.

CHAPTER 4

The economic losses caused by CBB

As one reviews IPM research programmes for small farmers in the Third World what is most striking is how frequently these programmes avoid the economic bottom line: is IPM worth the farmers' effort?

[Goodell, 1984]

CBB is a complex pest because it can cause different types of loss. Normally coffee farmers are aware of one or maybe two, but in reality it can cause up to three types of loss. Duque (2000) made an assessment of the economic importance of this pest.

4.1 Categories of losses caused by CBB

Drop of immature berries: CBB may cause considerable shedding of young berries. In Colombia it has been observed that berries less that 90 days old can drop easily if they are attacked by CBB. Unfortunately we do not currently have measurements for this damage though a project by Cenicafé is under way to quantify this effect.

Loss in weight: because of pest damage, the quantity of ripe cherries required to obtain a certain amount of parchment coffee can vary. For instance a normal proportion is 5:1, e.g. 5 kilograms of ripe picked cherries to make 1 kilogram of a tradable standard of parchment coffee, e.g. the *Tipo Federación* standard in Colombia. Farmers' comments informed that with high CBB attacks this proportion can rise from 5:1 to 6, 7 or even 8:1, which translated in economic terms, means heavy losses. Saldarriaga (1994) observed that at high infestation levels, large amounts of ripe cherries were needed to get 1 kilogram of parchment coffee, e.g. for a coffee plot with no control carried out, she found for the period June to August 1992, that the relationship reached 17:1. Likewise when visiting the project in Mexico, we interviewed a farmer (Mr. Estanislao) about coffee and CBB management. He told us that under normal conditions 2 baskets of ripe coffee should yield 1 kg of parchment coffee but with CBB he now needed up to 3 coffee baskets to obtain 1 kg of parchment coffee. So the farmer had reasoned out that this loss was due to CBB attacks.

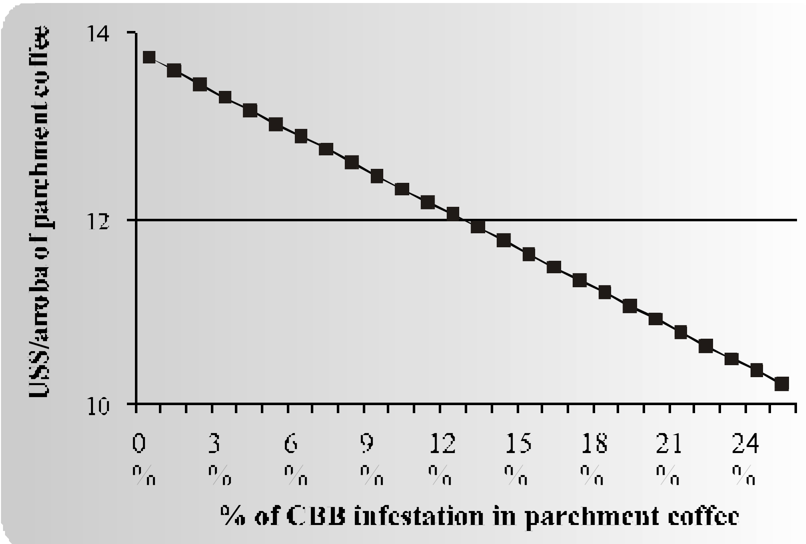
In the above cases, the farmer understands the weight loss effect because he processes his coffee to the parchment stage (dried to 12% humidity) where he can confirm the quality of his coffee and probable causes of defects by simple visual inspection. The problem arises when farmers sell coffee cherries, where the true damage level may be much harder to determine. In this case the buyer, who often buys by volume, not weight, would most likely adopt a 'worst case scenario' and pay the farmer a low price that would include a tacit discount for the likely quality of the resulting parchment coffee.

Loss in quality: in Colombia, the National Federation of Coffee Growers has defined standard rules to buy coffee from farmers. These rules aim to ensure that Colombian coffee meets a certain quality in order to attract a favourable international price. Coffee that meets the established norms gets the full official price (*Tipo Federación*).

A bean that has been the host of a developing brood of CBB is clearly defective and if present in roasted coffee will cause a decline in organoleptic (taste and aroma) quality. The authors do not know the threshold for detection although Montoya (1999), studying different types of damage in coffee, found that if the percentage of beans with even the minimum CBB damage (known in Colombia as the Broca's kiss - e*l beso de la broca*) rises above 3%, the aroma begins to be altered. Puerta (2000) mentions that if a sample of beans has 25% perforations, and these perforated beans have lost up to 30% of their total weight, this will produce a marked deterioration in the taste of the coffee. However this figure should be taken as an upper limit over which the quality can be regarded as unacceptable.

In Colombia, at the point of sale, buyers sample quality in order to define the final price. From the sample taken, the coffee beans are split in two parts: normal beans and defective beans. The defective beans are then separated into two sub-groups. In one sub-group go traditional defects such as beans with abnormal colours, over fermented, vinegar beans, etc. Beans with CBB damage are placed in the second subgroup. Both fractions are weighed in order to estimate the percentage of each defect. According to the weight of each group, the price is defined.

In the Colombian case, the buyers exact quite severe penalties for bad coffee quality. In Figure 2 we can see a simulation of price reduction per unit weight as CBB levels rise. For this simulation it was assumed that the traditional defects remained constant and below the penalty limit, with a national purchase price of US$13.3/arroba[12]. When CBB levels are zero, the price in the graph is higher because of an extra price premium for this case. As CBB levels increase, the price falls steeply. This situation can eventually lead to considerable economic losses per hectare, which for many farmers now on very small or negative margins, could mean unsustainable losses.



■ **Figure 2.** Parchment coffee price penalties in Colombia due to CBB incidence, a simulation.

12 Assuming a exchange rate of $ 2,255/1US$D; 1 arroba = 12.5 kg

4.2 Estimation of a loss function for CBB in India

According to Zadoks (1987) any reduction in quantity and/or quality of yield is called "damage" which is equivalent to "crop loss", expressed as reduction in revenue or income per unit of yield (kg, pound, etc.). As population densities of harmful organisms can be determined directly by counting (e.g. insects) or indirectly by injury assessment (e.g. foliar pathogens), the loss function aims to equate losses to damage or incidence measurements:

$$L = f(D\ or\ I)$$

Where:
L= Loss
D= Damage
I= Incidence

In a study carried out in India, Prakasan (Central Coffee Research Station, 2001), made an estimation of crop loss due to CBB. Crop loss was estimated at different levels of infestation from 0% up to 100%. The study included loss in weight only, because the internal coffee market in India does not have a clear standard of rules to penalize or reward coffee depending on low or high quality. However the study is important from the point of view of CBB-induced yield loss and the findings should be used to teach the Indian coffee growers about the potential damage caused by CBB. Loss data from this study is listed in Table 20.

■ **Table 20.** Loss due to CBB according to rising levels of infestation[13].

% infestation	Loss in Forlits per 1000[14] kg of green coffee	Loss in Percentage of green coffee
0	0	0
10	2.8	2.7
30	5.2	5.1
50	12.8	12.6
70	23.8	23.4
90	31.6	31.3
100	37.9	37.2

From this information a loss function was estimated (Duque, 2002), using as independent variable the percentage of infestation caused by CBB and as dependent variable the loss in percentage of green coffee. A quadratic loss model was obtained ($P < 0.0001$; $R^2 = 0.992$). The main features of the model appear in Table 21.

13 Study conducted by C.R. Prakasan. Central Coffee Research Institute, India 2001.
14 A forlit = 40 litres

■ **Table 21.** Characteristics of the loss function model derived from Indian data.

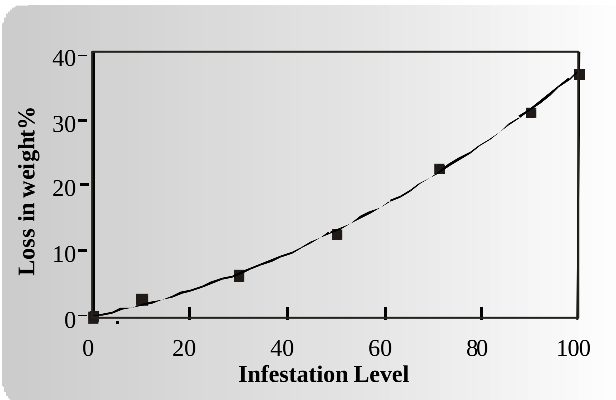
Variable	Parameter	P value
Intercept	0.075	0.95
Infestation	0.149	0.05
Infestation²	0.003	0.01

Hence the model is expressed as:

$$Y = 0.075 + 0.149\,INF + 0.003\,INF^2$$

Where:
Y = Loss in percentage of green coffee
INF = Percentage of infestation

Figure 3 depicts the model. The nature of the function, from the farmers' point of view is especially worrying because losses increase more than proportional to the level of pest attack. Why the curve should be this shape is not entirely clear but it is possible that higher infestations are the result of more mature attacks where CBB have had longer to develop, so that their progeny have had more time to proliferate. Thus the damage curve could be a reflection of population dynamics of CBB inside the berry.



■ **Figure 3.** Loss function due to CBB attacks in India.

Using the model, a simulation of economic loss can be carried out assuming an average yield of green coffee/acre and a coffee price in Rs[15] /kg of green coffee. Apart from the crop loss analysis made by Prakasan above, other estimates were carried out in a similar fashion, Sreedharan (1995) indicates that in India severe infestations of CBB can cause up to 80% crop loss, while Bheemaiah *et al.* (1996) observe that preliminary trials in India have revealed that at 100% infestation, a crop loss of about 66% can be expected.

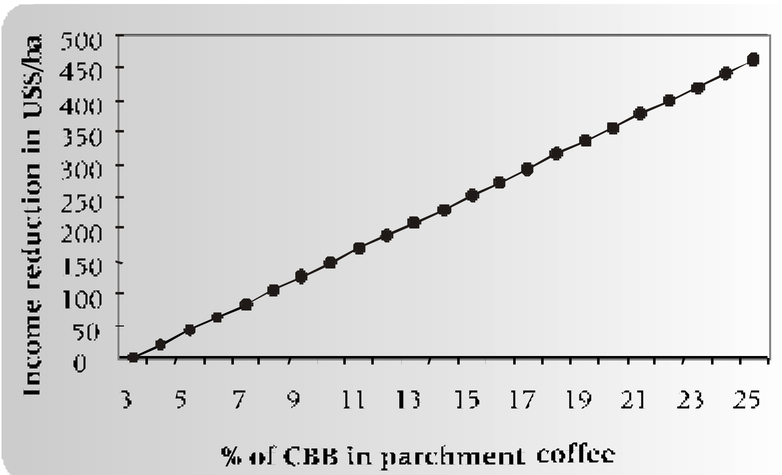
[15] Rs = Rupees

During the field visits many farmers told us about potential losses due to CBB. E.g. Mr. Vijayakumar pointed out that with poor control of CBB, 30% of the yield could be lost. Mr. Manojkumar explained that when attacks were high, the expected yield would be reduced by 20%.

4.3 Farmers' income reduction due to CBB

Through loss of quality: according to research conducted by Cenicafé, one of the most important losses caused by CBB is deteriorating coffee quality. This is due to the consumption of the bean by the CBB as well as secondary fungal or bacterial infections. This is manifested in the level of defects found in the routine sample taken at the buying point, which determines the price received by the grower. Under the Federation's current buying rules, when the level of defects exceeds 5.5% of the sample due to CBB damage, a 1% price reduction is applied for each 1% increase in defects over 3.5%. On the other hand, a premium is applied at the same rate when the level of defects (traditional defects – "*pasilla*", as well as those caused by CBB damage) is below 3.5%.

Figure 4 shows the income reduction in US dollars per hectare, according to different levels of attack of CBB in the parchment coffee in Colombia. In this simulation we take a coffee purchase price of US$13.30/arroba and an average yield of 150 arrobas/ha/year for intensively farmed coffee (1,875 kg parchment coffee/ha).



■ **Figure 4.** Simulation of income reduction through loss of quality due to CBB attacks.

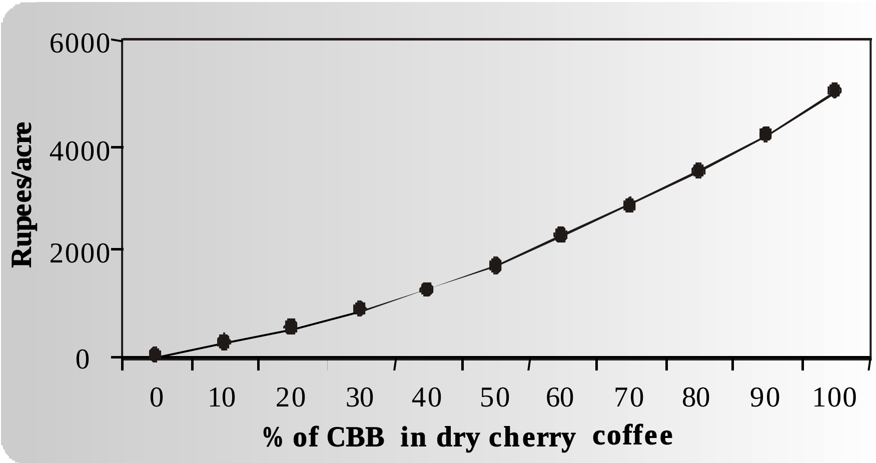
These expected losses can be very severe; under present low price conditions this could represent more than the potential income per hectare. Hence the pest by itself can threaten the economic viability of the business when the farmer faces severe attacks.

Through weight loss: in this case we can use the loss function as estimated from the Indian data as described above. Assuming an average yield of 468 kg of green coffee/acre with a price of Rs 28.5/kg of green coffee, the percentage loss can be calculated as in Table 22.

■ **Table 22.** Simulation of crop losses.

Infestation Level	% of Loss	Yield lost (kg/acre)
0	0.0	0.4
10	1.8	8.4
20	4.0	18.5
30	6.6	30.7
40	9.6	45.1
50	13.1	61.9
60	17.1	80.0
70	21.5	100.7
80	26.4	123.4
90	31.7	148.2
100	37.4	175.2

The potential losses relating to different infestation levels, expressed in Rupees/acre are shown in Figure 5, and can be severe.



■ **Figure 5.** Simulation of crop loss due to CBB infestation levels, Rupees/acre.

4.4 Cost structure for CBB management

In case studies carried out in Colombia (Duque *et al.*, 2002), the cost of CBB management varied between 5.5% and 11.0% of the total production cost. Here it is important to clarify that a higher or lower percentage is related not only to the intensity of the pest management but also with the proportion of coffee in production or under new plantings. When there are extensive areas with young trees, CBB control costs less. On the other hand if coffee is not being renovated (the case with most smallholders), the effect of CBB and its costs of control become greater. A theoretical model of CBB cost management developed in Cenicafé (Duque, 2001), shows clearly that when the coffee plots are younger the management cost is lower than for older plots. In these latter plots the average cost was about 8.7% whilst the estimated national average is about 7%. 8.7% is an appreciable extra cost burden and shows why CBB management has become a key component of coffee production in Colombia. Of this CBB management cost, labour costs comprise 89% because of the high dependence on laborious cultural control.

This high dependence on labour is a severe problem and has many ramifications:

- It has long been recognised that smallholders can produce better quality coffee than large farmers because they know their plots well, carry out timely controls and can pick the berries at the optimum moment to achieve peak quality.

- It is customarily believed that smallholder farmers have abundant family labour to accomplish these tasks.But results from this (Appendix A) and a previous study (Baker, 1999) suggest that this is not necessarily so; families are now not always so large and in some places farmers see more future for their family in keeping their children in school.

- Smallholder farmers may work on neighbouring large farms because of their need for ready cash.

- Larger farmers may tend to reduce labour costs by resorting to insecticides, sprayed by these same smallholders.

- Smallholders may therefore neglect their own farm, leading to higher pest levels and lower quality. In this case, migration of CBB from their untended plots spreads the problem.

CHAPTER 5

Case studies in CBB economics

Economics is the science which studies human behaviour as a relationship between ends and scarce means which have alternative uses.

[LC Robbins]

The previous chapter dealt with the losses due to CBB damage. We now draw on studies to look further at the implications of the pest in different countries. Data on coffee farmers in each country can be found in Appendix A; data on coffee in these countries in Appendix B.

5.1 Economics of CBB in India

5.1.1 Losses due to CBB

Figure 6 simulates income reduction in Rupees per hectare due to different levels of CBB damage. As can be seen, reductions will depend on the expected yield. E.g. for a yield of 1,200 kg of green coffee/ha losses will be approximately Rs 7,000 for 20% damage, equivalent to US$155, which is a serious loss.

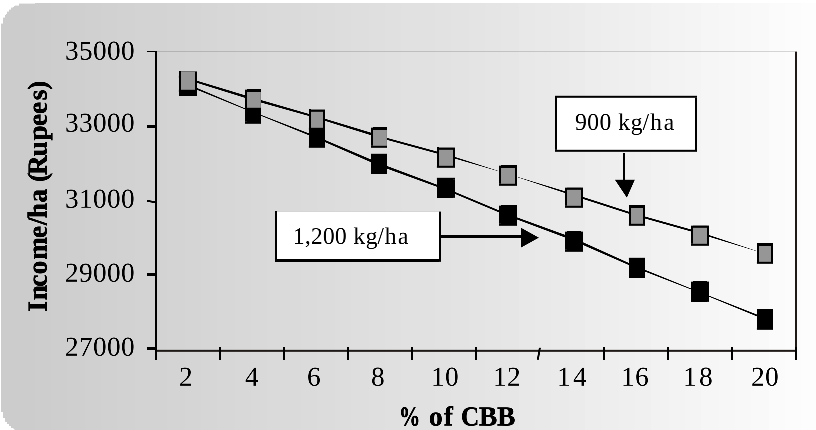
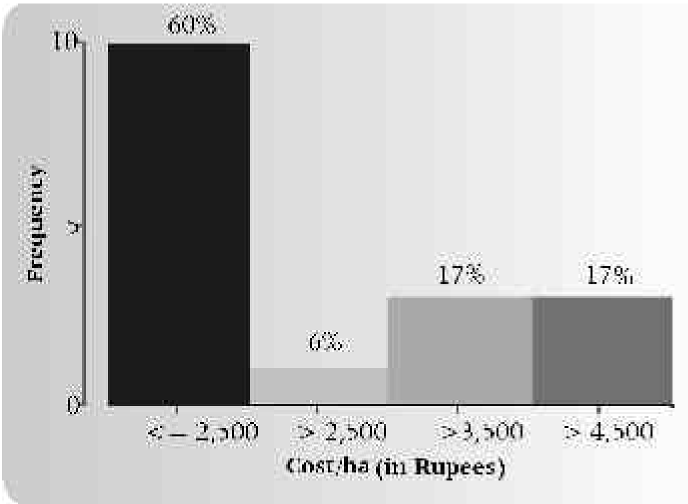


Figure 6. Income reduction per hectare due to CBB damage rates.

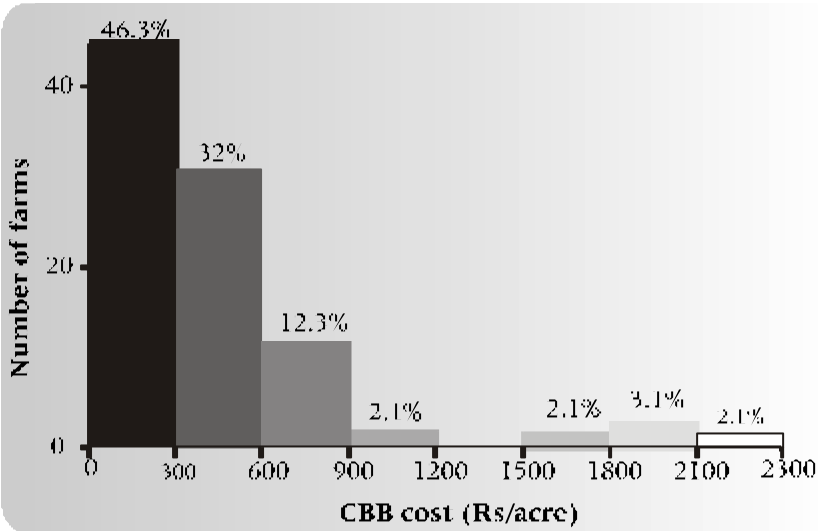
5.1.2 Cost of controlling CBB

Although it is always difficult to establish a standard cost of CBB management, in the survey with extensionists at Kalpetta we tried to estimate it. They reckoned the average cost per hectare at about Rs 2,800 but with a skewed distribution (Figure 7).

So if we assume that the CBB management cost is about Rs 2,500 with potential losses of around Rs 7,000 if damage rises to 20%, it is quite profitable to carry out the pest control. In a subsequent study carried out by the Coffee Board (Setti *et al.*, 2001) and analysed by Duque (2002), the real costs of CBB management tend to be lower than those calculated by the extensionists (Figure 8). It is likely that the declining coffee prices between the two studies had caused farmers to reduce costs further and that this to some extent explains the discrepancy.



■ **Figure 7.** Cost per hectare of CBB management; extensionists point of view in Kalpetta.



■ **Figure 8.** Cost of CBB management, farmers' cost estimates.

It is evident that to find coffee growers investing more than 1,500 Rs/acre when controlling CBB is now rare. The majority of the farmers tend to spend up to 600 Rs/acre, with 78.3% of the sample is placed in that range. The average cost for CBB management was 426 Rs/acre/year, which equals US$22.6/ha/year.

On average the share of CBB management of total production costs was 3.8% which is lower than in other countries studied, e.g. Colombia where the share is about twice that. The CBB cost also varies with farm size. Table 23 shows the CBB cost estimated for three farm size categories.

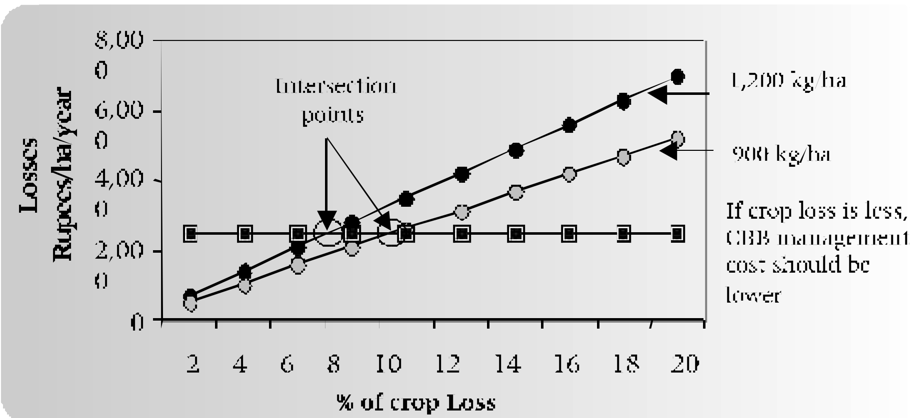
■ **Table 23.** Cost of CBB management according to farm size.

Farm Size	Group	CBB cost (Rs/acre)	CBB cost (Rs/ha)	CBB cost (US$/ha)
Up to 4 acres	1	321.4	803	17
4 to 7 acres	2	501.6	1254	26.7
7 to 14 acres	3	621.6	1554	33.1

If we take into account that the survey was carried out in year 2000-2001 before the subsequent fall in prices, it is likely that farmers are currently prepared to spend less to control CBB, leading to increased levels of infestation.

In order to establish the case for control, costs have to be less than estimated losses. This is best done graphically and Figure 9 depicts potential losses together with the CBB control cost. It should be noticed that when the loss line crosses over the CBB cost, an equilibrium point is reached, meaning that for this particular loss, the cost of the IPM strategy matches the loss. Using a graph of this sort can help to make a rational decision on whether to control or not, assuming that the farmer can estimate future losses. In reality the farmer does not resort to a graph but may make some form of mental calculation which approximates to this. It would be interesting to know more about how farmers arrive at their control decisions since this might guide future extension efforts as well as research aimed at helping them to come to the right decision.

In practice, because farmers do not sample, and extrapolation some months ahead to harvest losses is difficult, they will probably tend to expend too much on control. Over



■ **Figure 9.** Crop losses and estimated average CBB management cost (horizontal line).

several years they may well begin to get an idea of how much damage at various stages of the crop cycle relates to final harvest yields. This could be an area for future participatory research, presumably a few farmers become experts at knowing when and when not to apply control.

It should be stressed that CBB control is a function of productivity because if the latter is high, potential losses are correspondingly higher. Conversely if productivity is very low there could be less interest in carrying out sound control. We will see an example of this now from Honduras.

5.2 Economics of CBB in Honduras

Figure 10 depicts potential losses according to different levels of CBB in parchment coffee. This simulation (for three different yields per hectare) is based on a price of 600 lempiras/Quintal (US$40/qq = US$0.40/lb parchment coffee), and a 1% price penalty for 3% damage.

At a meeting at La Fe research station in Honduras, we estimated the cost of CBB management at about 600 lempiras/ha/year (US$40). To make the management of this pest worthwhile, the cost/benefit relationship should be higher than zero, but from Figure 10, we can see that this would be achieved only if the practices carried out reduce damage levels by 6 or more percentage points. And it would seem risky for the small farmer to try to achieve the export (Coex) standard of 2%, since he could invest a lot of resources to try to achieve the standard but still fail. Hence an "all-or-nothing" quality standard could discourage farmers trying to improve quality.

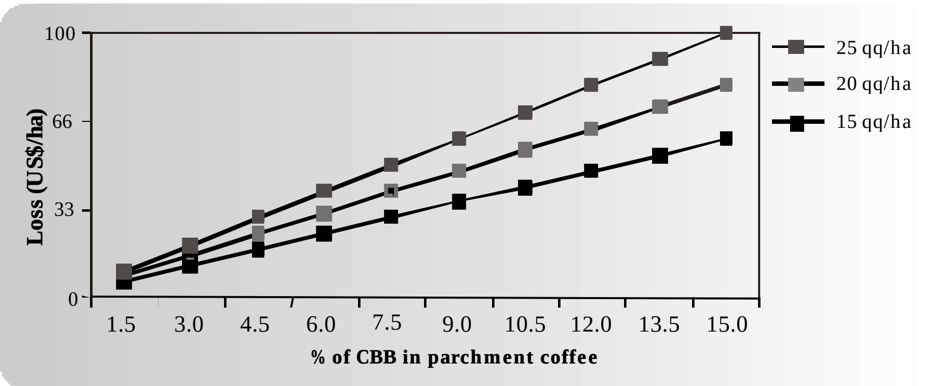


Figure 10. Potential losses due to different levels of CBB for different yields (Honduras)[16]

[16] Exchange rate: 1 US$ = 15 Lempiras

5.3 Economics of CBB in Guatemala

Several experiments and studies about economic aspects of CBB have been developed in Guatemala, e.g. Decazy (1989), Ochoa *et al.* (1989), Zelaya *et al.* (1989), demonstrating that this problem has received considerable attention there.

5.3.1 Losses due to CBB

Ochoa *et al.* (1989) found that losses in weight increased proportionally as infestation level rose. They estimated losses at two different altitudes, the first at 457 m above level sea and the second at 762 m. The average function over 3 harvests for the higher altitude was as follows:

Where:

$$Y = 0.34\ X$$

Y = % of total losses in the harvest (including all parchment coffee qualities, by weight)
X = % of beans perforated by CBB

If we take the case of Santa Isabel, a large Guatemalan coffee estate as an example, according to Mr. Bartolo Lacan the manager, the average productivity for the last three years would be around 45 quintals (qq) of parchment coffee / ha.

For this productivity we can simulate potential losses due to different levels of CBB in coffee fields following Ochoa's function assuming a price of US$42/qq of parchment coffee.

Figure 11 shows the losses per manzana (0.7 ha) and the cost of the cultural control, assuming this is constant at 136 Quetzals/manzana (US$17 at 1999 farm prices). Because we know losses for different levels of CBB, a loss function can be estimated in this case, which is as follows.

Where:

$$Y = 6.46\ X$$

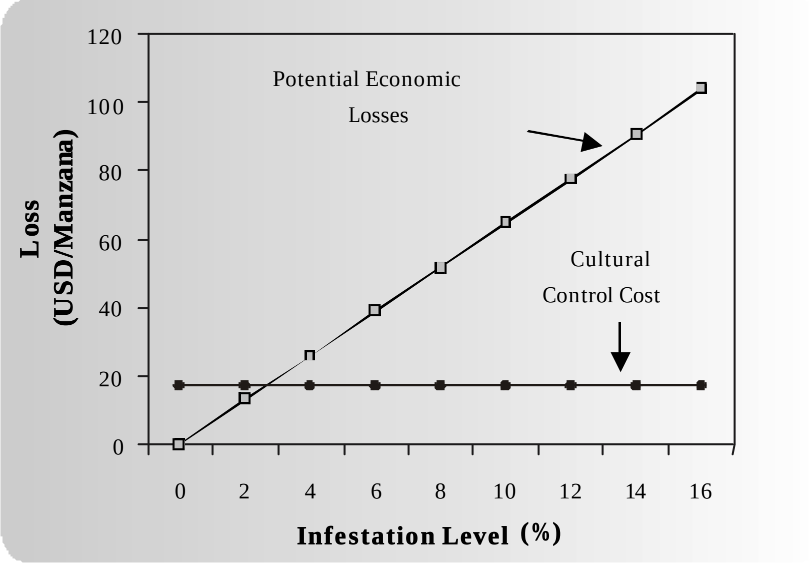
Y = Loss in US$ per manzana
X = % of beans perforated by CBB
So we have now two functions. On the one hand the loss function as estimated and

on the other hand we can also estimate a cost function for cultural control, which would be:

Where:

$$Y = 17.7$$

Y= Cost of cultural control in US$.



■ **Figure 11.** Losses due to CBB, with cultural control costs.

If we make both equations equal, we can obtain the infestation level (X), at which losses and costs are the same. In this case it is 2.7%, which is a low infestation level. So if the farmer allows CBB to rise above this threshold, losses will be higher than the cultural control cost, and so this control starts to become profitable. However we also have to consider the dynamics of CBB populations because the ideal control moment may be long before harvest and even a small population could cause economic damage some months in the future. In addition, variations in coffee price and/or productivity can change the threshold percentage. For instance, if the coffee price shifts to US$65 per quintal, the new threshold will be 1.7%. So CBB management is very sensitive to change in prices and productivity. The key point here is that in CBB management the coffee farmers should be aware of the infestation level in order to take better decisions because economic losses due to this pest can be large. Even so, interpreting what they have measured is not always easy and this inevitably makes this sort of technique more difficult to promote.

5.4 Economics of CBB in Mexico

Using the same Guatemalan studies by Decazy (1989), Ochoa *et al.* (1989), Zelaya *et al.* (1989), we can apply them to a Mexican case of a small producer from Ejido Santa Rosalia, to estimate losses. Mr. Amado Bartolon is the owner of a small farm whose productivity is about 13 qq of parchment coffee/ha/yr. For this productivity we can simulate potential losses due to various levels of CBB following the Ochoa *et al.* function, assuming a price of US$52 per quintal of parchment coffee.

From Figure 12, losses vary depending on the level of CBB attack, ranging between US$0 and US$69/ha/year when CBB reaches 30%. Hence losses can be important; US$69/ha/yr is equivalent to 22 days work/year in Mexico, approximately one month's basic salary, a lot of money in the context of this peasant economy.

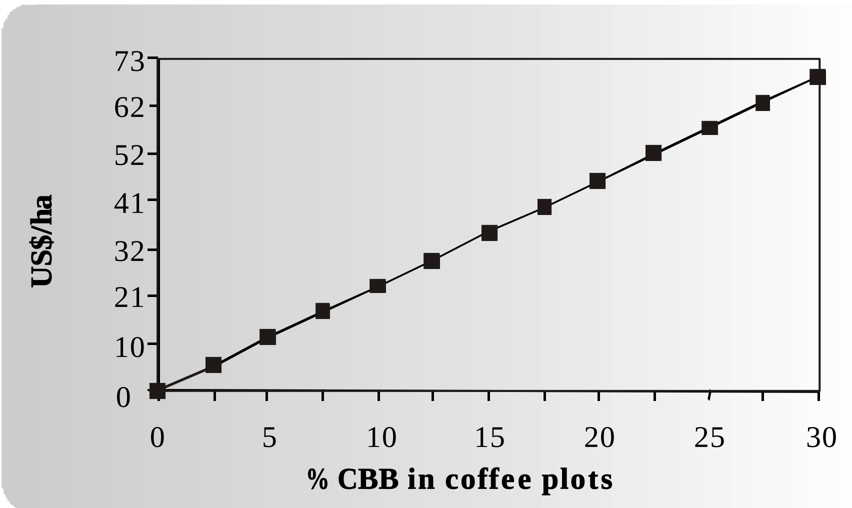


Figure 12. Yield losses due to CBB attack.

Cultural control seems the most appropriate IPM component for the smallholder's case. According to the coffee farmers from Santa Rosalia, on average they are collecting about 1 coffee box (18 kg of dried coffee) when doing *pepena* (removing remaining coffee from trees after harvest), involving about 4 days labour costing about US$12.5. This could save up to US$69, equivalent to the expected loss when CBB reaches 30% infestation. This looks like a good return on investment, with a large safety factor.

5.5 Economics of CBB in Colombia

In Colombia, the area infested by CBB is about 715,000 hectares. CBB was considered to be one of the main reasons for the decline in national production from 13 million to 11.5 million bags, at an estimated cost in excess of US$100 million (Duque, 2000).

Consider the impact of the level of sample defects on the benchmark "*Tipo Federación*" parchment price of Col$26,150/arroba of parchment being paid at the Chinchiná Co-operative on 24 January 2002. To give a simple example, a sample containing 6.5% defects would earn Col$25,366 /arroba, 3% less than the "Federation" price, while a sample containing 25% defects would earn Col$20,266/arroba, 23% less than the "Federation" price.

5.5.1 Potential losses due to CBB

Table 24 relates the economic losses (due to quality penalties) from CBB defects per unit of parchment coffee to the average yields of two production modes (intensive and traditional). The table shows that the economic impact of CBB depends on productivity: with CBB defects of 4% of the parchment sample, intensive growers would lose US$64.8 per hectare while traditional growers would only lose US$24.3. A 20% defect level would result in a loss of US$387 per hectare for intensive growers compared to US$145 for traditional ones.

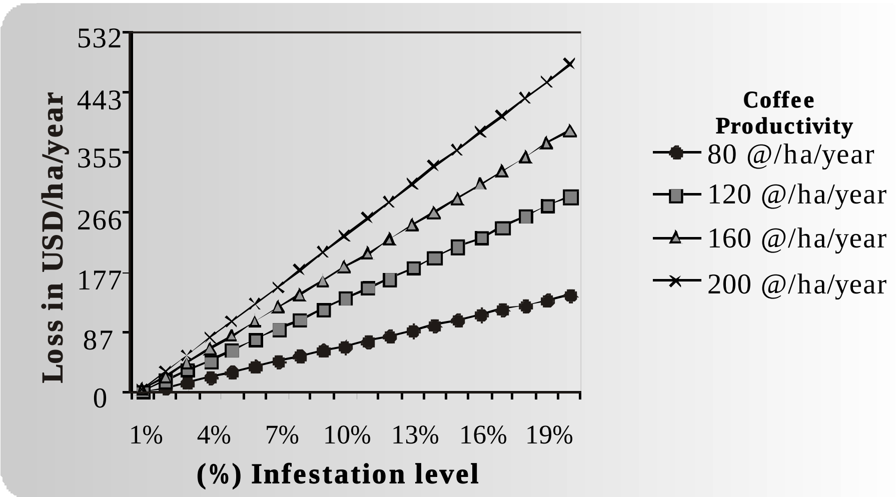
Table 24. Average total (quality penalty) economic losses according to CBB defects by production mode, 2002 (US$/hectare).

CBB defects (%)[17]	Traditional (60 arrobas/ha)	Intensive (160 arrobas/ha)
4	24.3	64.8
5	31.9	85.0
6	39.4	105.2
7	47.0	125.4
8	54.6	145.5
9	62.1	165.7
10	69.7	185.9
12	84.8	226.3
14	100.0	266.6
16	115.1	307.0
18	130.2	347.3
20	145.4	387.7

[17] Keeping constant the other defects

For the same percentage of CBB the potential economic losses are obviously much higher when the farms have intensive rather than traditional production systems. Because of greater potential losses they may thus resort to too many control activities, especially excessive spraying.

Figure 13 shows for instance the case of a coffee farm with a productivity of 80 arrobas/ha, where levels of 20% of CBB in the parchment coffee would present losses of about USD$145/ha. For the same level of CBB but on a farm producing 200 arrobas/ha, the loss would correspond to USD$484/ha.



■ **Figure 13.** Potential economic losses due to CBB for different productivities.

5.5.2 CBB management costs

Since CBB management can vary widely between farms, Cenicafé has developed a theoretical model that analyses these costs. Two assumptions are made, firstly the cost of the management can vary depending on the age of the coffee plot and secondly, the coffee plantation should be split into five plots with ages of between 1 and 5 years, corresponding to the recommended 5 year life cycle of the crop in Colombia. Table 25 describes the pattern (Duque, 2001).

The model additionally assumes intensive control of CBB which would only be justified in cases of severe attacks. It further assumes that the cost of the IPM strategy during the first two years of the plantation is very low and that as the plot ages the costs markedly increase.

From the costs presented in the table those corresponding to cultural control should be considered as fixed costs of CBB control and therefore should be executed independently of the infestation level. However the other costs (biological, chemical, etc.)

■ **Table 25.** Theoretical model of CBB cost management, 2001 (US$/ha)[18] .

Age of the Plot	Cultural Control	Biological Control *B. bassiana*	Chemical Control Insecticides	Machinery and Equipment	Total Cost per hectare
0– 12 months	0	0	0	0	0
12– 24 months	47	0	0	0.9	48
24– 36 months	17.3	16	25	3.1	152.1
36– 48 months	149.8	30.3	41.3	4.9	226.4
48– 60 months	149.8	30.3	82.7	7.1	270
Average	**91.0**				**139.7**

should taken as variable costs and their execution will depend on the results obtained when measuring the infestation level and the position of the CBB in the berries. In this way the decision to spray insecticide for instance and therefore of incurring more costs will be subject to an action threshold.

5.5.3 CBB impact at the national level – a simulation for Colombia

After we visited all the countries involved in the project ICO/02, it was clear that Colombia has a sound structure for buying coffee. Currently the set of rules established for buying coffee are clear and transparent for any coffee farmer who should be able to understand how the rules establish the price to be paid. The fundamental rule is that when the coffee quality is high the price is also higher. Therefore it is in Colombia where we have the best chance to estimate the full effects of the pest. In other countries the problem is confounded with other causes of quality loss, such as poor processing.

The Colombian norms are established according to the national strategy with the aim of producing the best coffee quality attainable. The quality assessment is complex and includes:

- A determination of the ratio of green coffee produced from a given quantity of parchment coffee.
- Presence of traditional defects ("*pasilla*") such as broken and vinegar beans.
- Presence of beans perforated by CBB.
- Bean size.

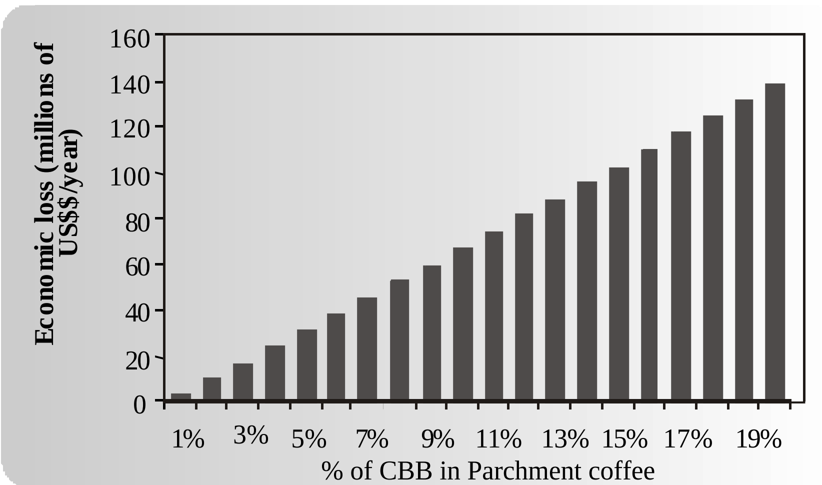
[18] Exchange rate 1 US$ = $ 2,200 pesos

Because of these factors it can be difficult to isolate the true national economic impact due solely to CBB attacks because variables interact and affect the price. However it is possible to carry out a simulation of the CBB impact, in economic terms, based on a *ceteris paribus* analysis, i.e. to analyse the effect of one variable (in this case CBB), it is isolated from the influence of other factors, which should remain constant (Hill, 1990). Hence we make some basic assumptions about the coffee quality variables that remain constant whilst the CBB damage varies. It should be noted that this scenario is developed in absence of any control costs against the pest.

Thus we first estimate that the annual Colombian coffee production as about 10.5 millions sacks and the internal price at US$0.38/lb (US$10.4 per arroba[19]) of parchment coffee. Then by keeping the percentage of traditional defects constant as well as the yield of green coffee from parchment coffee, we can simulate the national economic loss due to CBB alone.

The economic loss is estimated as the income not received by the coffee farmers due to quality reduction and it is depicted in Figure 14, with the infestation level on the parchment coffee plotted against losses expressed in millions of dollars. As can be seen the economic impact is very significant because if the national production would face only 3% CBB damage on average, the loss would be equivalent to about US$16 millions. For CBB damage of 10%, the income lost would rise to US$66 millions.

But the economic losses seen generally in Colombia are those resulting from efforts to control CBB. If CBB were not controlled at all in Colombia we estimate that there



■ **Figure 14.** Simulation of economic impact of CBB country-wide. (Expressed as income reduction through loss of quality).

[19] Arroba = 12,5 kg

would be at least 25% of damaged beans, equivalent to a loss of US$180 million. In fact the cost would probably be higher because sorting could not remove all the damaged beans and the international status of Colombian coffee would suffer as a result, leading to a lower market price. If we estimate that the mean cost of controlling CBB down to, say, a level of 5% is US$100/ha and 500,000 ha are currently controlled, this leads to CBB control costs of about US$50 million. If we add to this value the losses incurred despite control, including weight and quality losses, the total cost of CBB could be at least US$ 75 million. Since this problem has been widespread in Colombia for about 10 years, current accumulated losses must be around three quarters of a billion dollars.

5.6 Conclusions

- Despite some detailed studies in several countries, the true economic costs associated with CBB are not transparently obvious to all stakeholders in all countries.
- The full cost of CBB to a country's coffee industry, in terms of yield, quality and control costs, have mostly not been calculated.
- There have been no studies on the various externalities of insecticide use, including water pollution, medical costs, days off work, negative effects on natural resources, etc.
- More work needs to be done to develop simple ways to help farmers assess full costs of CBB.
- More effort should be made to ensure a full understanding by the farmers, of the economic implications of CBB damage on both quantity and quality.

CHAPTER 6

CBB: towards a socio-economic synthesis

Pest control needs to be viewed within the context of farmers' goals – which are not necessarily the maximisation of yields.

[Croxton, 1994]

We have attempted to show that CBB is a very complex pest with many factors affecting both its abundance and control. In the following analysis we will integrate all the information we have gathered to formulate a strategic view of the problem.

6.1 IPM strategy

According to the International Pest Management Institute (2002), IPM is: “a system using multiple methods, a decision making process, a risk reduction system, information intensive, biological based, cost effective and site specific”. If this is a widely accepted definition it is very clear that IPM is a complex strategy to be understood and carried out by farmers whatever their socio-economic conditions. This approach implies a concerted effort by farmers to comprehend the relationships between the different components and concepts of IPM. We broadly support this approach to pest control but it needs to be made clear that IPM is neither easy to understand nor easy to carry out.

Indeed we submit that the above description meshes uneasily with our own perceptions of resource-poor farmers’ present capabilities. Either IPM has to become easier to undertake or farmers will require intensive re-skilling.

6.2 How IPM strategy clashes with socio-economic reality

If we look at the requirements of IPM against farmers’ needs and abilities, we deduce that smallholder coffee farmers are not ready for IPM. It presupposes a certain level of education that is frequently lacking and a way of looking at things that is foreign. Intrinsically it is a very modern concept, a “knowledge intensive” solution and we believe it is emblematic of smallholders’ problems as they try to survive in a global economy, on the wrong side of the ‘digital divide’.

IPM principally depends on measurement of pest levels and then calculations to estimate crop damage and then a decision by the farmer on whether to control or not, and if so which method to use. In its original form, it is predicated upon the farmer having at least secondary education and a fairly sophisticated knowledge of pest biology so that he can apply the correct control at the moment when the pest is at its most vulnerable or before it is at its most damaging. It is rooted in a certain ethic, where the farmer invests in knowledge, equipment and extra labour in the expectation of it saving him more in the long run than he expends.

The problem is that this reasoning is not readily transportable to smallholder farmers with at most primary education, less than perfect confidence in experts and limited resources. What is worse, many scientists and extensionists who serve these farmers, have been taught about IPM as though it is an established fact and not something that is necessarily work-in-progress, questionable, negotiable or subject to revision.

Because of inadequate training, we maintain that many researchers and extensionists neither fully understand the economic and cultural limitations of farmers, nor the shortcomings and costs of the techniques they are implementing. This severely limits their capacity to advance a farmer-friendly IPM strategy. We have seen cases where extensionists have drawn up more than a dozen actions that the farmers should take to control CBB. Not surprisingly in such a case, farmers end up not adopting IPM because they find it too difficult and costly and are unsure about its worth.

IPM, almost by definition, consists of a range of techniques. The problem is that some are more effective than others, and some are easier to understand. Each element needs to have coherence and be viably cost-effective, or if not, it has to be bundled with another element so that the two can work synergistically.

6.3 How the local market affects CBB management

A salient factor we found during the project was that most local coffee markets do not reward for coffee quality. The exception is Colombia where internal coffee markets are well organised and have a sound mechanism to analyse and reward for high quality coffee and to penalise it when it is below standard. Table 26 summarises the factors that we believe contribute to the determination of coffee price in the countries studied.

■ **Table 26**. Main factors intervening in price definition, ✓= present.

Country	Weight	Quality
India	✔	X
Ecuador	✔	X
Honduras	✔	X
Guatemala	✔	X
Mexico	✔	X
Colombia	✔	✔

From Table 26 it is evident that the main criterion for price definition is coffee weight. The only country where coffee is always bought by both weight and quality is Colombia. We saw some evidence for quality evaluation in both India and Mexico but there is no standard national system.

In the Colombian case the negative impact of CBB on quality is linearly reflected in a price reduction. Hence the market plays a key role in promoting CBB control because coffee farmers are fully aware of the economic benefits of controlling it. We believe that when the local market lacks quality standards, coffee farmers are less inclined to control CBB because of the lack of incentive. Table 27 is our estimation of the degree of internal market development for the countries visited.

■ **Table 27.** Internal market structure and development.

Country	Degree of development
India	Medium
Ecuador	Very Low
Honduras	Low
Guatemala	Medium
Mexico	Low
Colombia	High

In the table, a high degree means a well structured coffee market, organised co-operatives, where quality standards are operating and coffee quality is established, there are transparent rules for buying coffee, etc. A low degree means poor market development, quality is often not rewarded, the intervention of various intermediaries is significant, and CBB present in the coffee is normally ignored at the point of purchase from the farmer and consequently universally low prices pertain.

6.4 Coffee productivity and diversification

Coffee productivity is another key aspect that is important in CBB control. From the simulations made in the Chapter 5 we could see that when productivity is higher the CBB impact in terms of absolute economic loss is higher as well. Thus under low productivity conditions we suggest that there would be less favourable conditions to encourage CBB control.

We deduced that when the production system is more diversified, and hence income also, interest in CBB control is reduced. The possible reason is that when there are labour constraints, people usually prefer to use it to more directly generate extra income rather than on controlling CBB (especially if markets are not rewarding for quality).

Table 28 describes coffee productivity and our estimation of diversification for all the countries involved in the project.

■ **Table 28.** Estimated productivity and diversification of the production systems.

Country	Coffee Productivity (Parchment coffee kg/ha)	Diversification
India	1,080	High
Ecuador	600	High
Honduras	800	Medium
Guatemala	1,000	Medium
Mexico	630	Low
Colombia	1,125	Low

6.5 Rural wages

Since CBB control largely depends on cultural control and cultural control depends on labour, this factor should play an important role when analysing how farmers can afford to intensify this control measure or not. Table 29 describes the rural wages paid when controlling CBB.

Table 29. Average rural wage in countries visited (2001 prices).

Country	Wage US$/day
India	1.31
Ecuador	1.50
Honduras	3.00
Guatemala	4.00
Mexico	2.50
Colombia	6.00

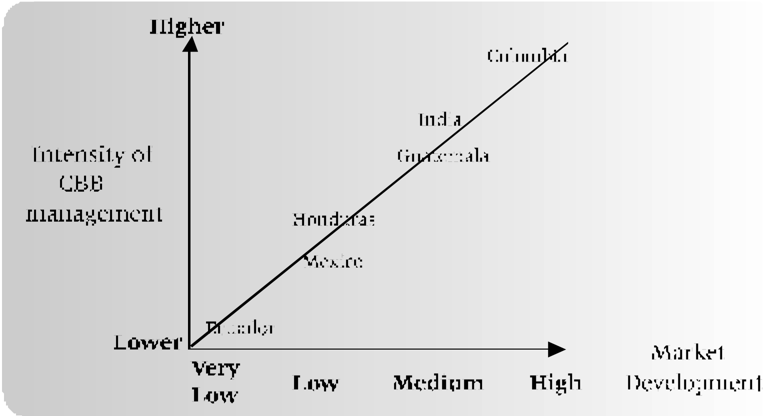
From the table, it is clear that rural wages are highest in Colombia and lowest in India. This we believe might be an important factor in farmers' approach to CBB control.

6.6 Generating hypotheses on factors favouring CBB control

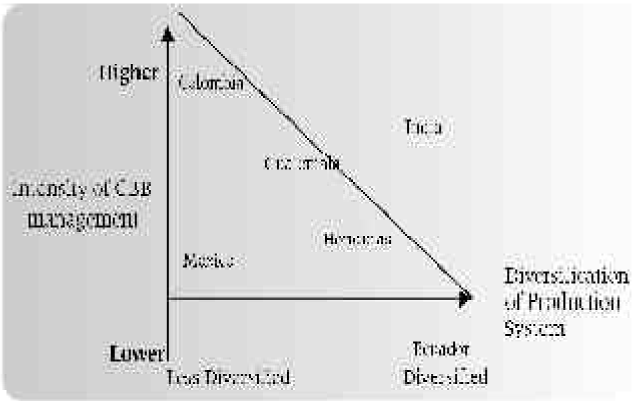
From the concepts mentioned above and the possible interactions between them, we can start to pose some hypotheses to guide us in development of CBB management in relation to broader issues of the coffee industry in producer countries. What follows is based on our visits and examination of the available data, it is an exercise in hypothesis generation rather than a statement of fact. On the following graphs, lines depict our hypotheses and country names our estimation of the true position in these countries.

Hypothesis 1: there is a direct relationship between the state of the internal coffee market and the level of CBB management. We believe that if quality were rewarded at the farm-gate, coffee farmers would have more interest in controlling CBB. We suggest, from our in-country studies that the current situation can be approximated by Figure 15.

Hypothesis 2: there is an inverse relationship between the degree of diversification of the farm and intensity of CBB management. Ellis (2000) indicates that there are several determinants for livelihood diversification such as seasonality in income, coping and risk attitudes, labour markets, etc., which are all ways of facing difficulties involved in agricultural production. Figure 16 shows our assessment of the status of within-farm diversification for the countries studied.



■ **Figure 15.** Hypothetical relationship (line) between state of the internal market and CBB management and an estimate of the current situation (names).



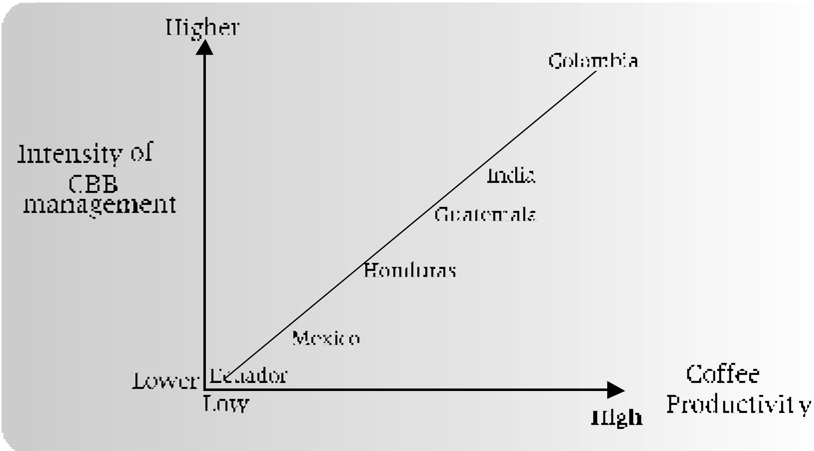
■ **Figure 16.** Hypothetical relationship (line) between diversification of production systems and CBB management and an estimate of the current situation (names).

Thus when a coffee farmer has several ways to generate income, CBB management is only one of several priorities and he may not be able to devote the resources that this requires. A typical example of this is Ecuador where production systems include several crops such a short cycle crops (beans, maize, rice, etc.) and long cycle crops as well (banana, cocoa, etc.). This contrasts with Colombia where many farmers rely entirely on coffee and purchase most or all of their food, even coffee.

In this case there are two outliers from our hypothetical linear trend. In India there is more CBB management than the state of diversification would suggest. We put this down to the availability of relatively cheap labour and the efforts of the Indian Coffee Board, which the Indian Government has continued to fund more adequately than many other coffee countries. The second case is Mexico where CBB management is less than we would expect from the level of dependence on coffee (at least in the Soconusco area that we visited). Here the Mexican Government has taken the opposite course to India and dismantled state funded extension services and reduced research.

Hypothesis 3: coffee productivity and level of CBB management are positively correlated. As we explained, the most severe economic effects due to CBB attacks can be seen where coffee productivity is high where the potential losses are also higher.

In this case (Figure 17) the most contrasting countries are again Colombia and Ecuador.



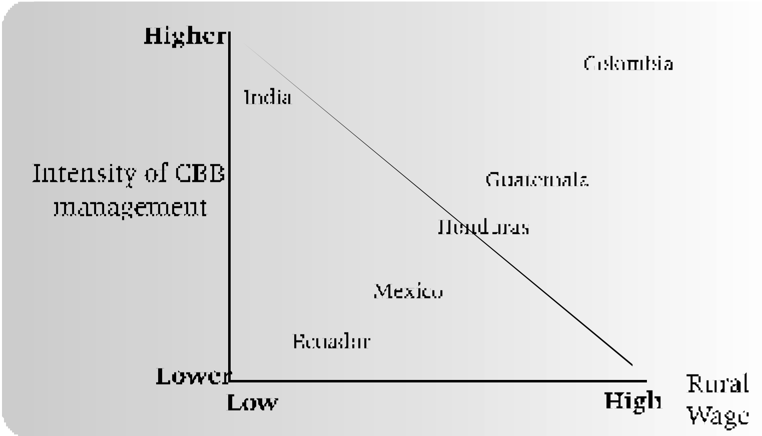
■ **Figure 17.** Hypothetical relationship (line) between productivity and CBB management and an estimate of the current situation (names).

Hypothesis 4: the intensity of CBB management is inversely related to the cost of labour, since IPM methods require more manual labour because of dependence on cultural control.

Here, in Figure 18, we see considerable variance between theory and practice. We conclude that wages are a less important determinant than productivity and internal market development.

6.7 Conclusions

From this exercise we conclude that the state of internal markets and productivity are the most important determining factors in CBB IPM uptake, followed by the diversification of the production systems. We do stress that the above exercise is to generate ideas for future testing, since these relationships are not proven and there may well be other factors at work. We invite researchers in this field to test the hypotheses and to try to disprove them.



■ **Figure 18.** Hypothetical relationship (line) between rural wages and CBB management and an estimate of the current situation (names).

CHAPTER 7

Conclusions and recommendations for CBB control policy

Quality of the product, quality of the environment, and quality of life for the farmer are inseparably bundled together.

[G. Baldwin, SCAA Chronicles, July/August 2000]

Coffee seems to be splitting into two sectors. One is the bulk sector (i.e. a true commodity) supplying standard blends that increasingly contain large amounts of Brazilian arabicas and Vietnamese robustas. In neither of these countries is CBB a major constraint because of climatic factors and indeed a general lack of serious pest problems in these countries has probably contributed to their competitiveness. The other sector is the quality market, including specialty, Fair Trade and organic markets, where cup quality and/or social and/or environmental quality are of paramount importance.

Our main concern is with the future of smallholder coffee farmers and from what we have learned through our studies, we believe that the best way for their enterprises to survive is through production of high quality coffee, but only if they receive a fair premium for so doing. This would give them the extra funds to invest in sustainable technologies such as IPM and sufficient to make an adequate living from coffee. But to do this implies a level of knowledge, both technical and entrepreneurial, that presently they largely lack. Their problems with CBB are indicative of these deficiencies.

This book is very much an account of work in progress, we have tried to broaden the approach of CBB IPM but are aware that much more needs to be done. In this final chapter we now resume the role of the various players in this field, the problems facing them and some pointers for how we think these could be overcome.

7.1 Institutions

It was perhaps in the area of institutions that we found the greatest differences between countries. These ranged from on the one hand Mexico, where neo-liberal inspired policies mean that the state now contributes little to coffee research and extension, to the other hand India, where government funding remains firm. Smaller countries such as Honduras and Ecuador have apparently never had very well developed institutions whereas Colombia is again different; there the coffee farmers have self-financed a very significant research and extension effort for over 60 years.

We found that the current price slump had caused difficulties to all institutions both financially and in their relations with farmers, many of whom tend to blame national bodies for poor coffee sale prices. The crisis has led to emergency measures, for instance in both Mexico and Colombia, governments have been subsidising the price paid to growers.

In general, the institutional situation gave us cause for much concern (Baker *et al.* 2002) and in the absence of significant political intervention, it seems inevitable that coffee institutes will become smaller and less significant than previously.

Until now the efforts of countries afflicted by CBB have been mostly piecemeal and apparently not part of any overarching national coffee strategy. Existing mechanisms and policies have adapted the best they can to the problem but from our visits to coffee countries, we were generally unconvinced that they have thought strategically about the problem. We also feel they have been slow to react to the rapidly changing face of world coffee and to formulate coherent integrated procedures to develop and maintain a viable coffee sector. All too often coffee institutes seem to react to change rather than to instigate it. This is in no small part due to the decline in the power of these institutes as post-pact policies have taken effect.

We suggest that coffee institutes will increasingly be expected to help farmers comply with standards such as:

- IPM for pest control
- HACCP (Hazard Analysis and Critical Control Point) for ochratoxin management
- Compliance with ISO standards
- Organic compliance (Soil Association, Biodynamic)
- Shade coffee certification
- Starbucks Preferred Supplier Program verification

We believe that institutes as they are presently constituted and funded, will not be able to achieve competence in all these fields and that they will have to concentrate on a few of the most important aspects that confer the most benefit on the greatest number of farmers. Foremost amongst these aspects will be the production of quality coffee which, independent of any scheme, will tend to find a better price.

In order to improve this state of affairs, the first requirement should be a systematic review of the whole coffee production process to determine critical points that affect economic viability for farmers. From our interactions with institutes, we have seen little evidence of a commitment to such a rigorous procedure.

Research: in most countries IPM research lacks a clear strategy, neither guided by a clear understanding of farmers' needs nor underpinned by a rigorous economic analysis of the sector's requirements. Too many researchers follow a special interest to the exclusion of all other factors and though many have a sincere desire to promote sustainable coffee growing, all too often they fail to make significant advances. In their endeavours, poor infrastructure and lack of funds hamper their work.

Whereas many of their economic problems are beyond their immediate control, researchers need to develop a more open and participatory approach to understanding the realities of modern rural life. They need to devote at least a part of their resources to short-term and pragmatic research aimed at solving small and solvable problems that can demonstrably show an improvement in the plight of the rural poor.

Extension services: to be effective, IPM strategies need a set of robust techniques, knowledge and measurements. Through all this process, extensionists should participate actively in teaching the coffee farmers about how to manage the pest.

Transference of IPM strategies implies a specific approach because IPM is more than a set of practices to be directly employed, it is a different and unfamiliar way of reasoning for many farmers. So extensionists must be aware of this key difference in order to promote and teach IPM effectively (including alternative methods such as participatory techniques). Perhaps the most difficult concept to transfer is the economic injury level (EIL).

From the socio-economic characteristics of many coffee growers that we have recorded in this book, it is difficult to find farmers using IPM tools without considered advice from the extension services. Unfortunately we found that in almost all the coffee countries, due to the present economic circumstances, the extension services have been seriously weakened both in terms of economic resources and number of active agents. So the service they provide now is quite unsatisfactory because of the large number of farmers per extension agent. For instance in the Guatemalan case there are 61,000 coffee farmers attended by 66 extensionists, 925 farmers per technician; in Ecuador the ratio maybe closer to 2,000 farmers per extensionist. We suggest that to work with more than about 500 growers per technician is not cost effective. Thus to improve the adoption of IPM strategies in coffee, more and better informed extension agents are required if we want to see an improvement in technology uptake.

In future, if extensionists are to be effective, they will have to be better prepared and better paid to attract people who will effectively become facilitators and knowledge brokers for a wide range of farmers' needs. The extent to which they will be able to do this will depend on the future remit of coffee institutes; will they continue to be technology driven or will they develop a wider social remit?

Donors: although funds have been donated by national and international bodies to help solve the problems of coffee communities, their effects have been limited because of their generally short duration and lack of continuity. Many meetings and reports on the coffee crisis have been prepared over the last two years and many interesting ideas have been aired. Little concrete has been achieved however and we feel that there needs to be concerted action by donors, by working together, to make their funds count better towards bringing about sustainable change.

7.2 IPM

Labour issues

- CBB management for smallholder coffee farmers is based on cultural control and is reasonably effective, but the current low price climate is incompatible with high wage costs. Hence as a long-term strategy it may be flawed and if coffee is to prosper, either labour-saving technologies or high quality premiums will be required.

- Labour may become scarcer in some countries, thus studies are needed to project labour requirements and relate this to birth, death and migration rates.

- A more complete socio-economic characterisation of small coffee farmers is needed in most countries to adjust IPM programmes to rural realities.

Quality

- Coffee quality is not rewarded by the complex and opaque market structure in several countries. This discourages farmers to improve CBB management and makes life more difficult for neighbouring large estates.

- The internal coffee market in Colombia does reward for good quality. In this country CBB is a quality issue, the economic losses caused justify control measures and farmers understand this.

Extension

- Lack of education in the smallholder sector is a major obstacle to improving production, coffee quality and CBB management.

- The low coffee price has led to considerable lack of motivation of small farmers. In these circumstances, transferring IPM or any other new technique is especially difficult.

- CBB management by small producers should predominantly be based on cultural control until better methods become available. To be optimally efficient it needs to be combined with sampling to determine frequency and intensity of this control. This combination would be a first approximation to IPM.

- A good entry point with smallholder farmers may be to concentrate on weight loss of the bean due to CBB. When they fully understand this and its economic consequences they may become more interested in controlling the pest.

- Pest sampling should be re-examined, perhaps by developing in a participatory way simpler and more adoptable methods of estimating pest levels and predict ing future losses. Farmers need simple ways to estimate costs and losses; scientists should learn how farmers gain information about their crop; extensionists should help them.

7.3 The quality imperative

The current situation, with an abundance of low quality coffee including ochratoxin problems[20] has caused renewed efforts to improve quality by instigating a quality scheme (Article 407), passed by the ICO council in February 2002, and initiated in

[20] Ochratoxin is a poison formed by some fungi most notably *Aspergillus ochraceus* which attacks poorly processed coffee; at least two of the project countries have had coffee shipments refused due to this problem

October 2002. The provisions of the scheme demand that an exporting member of the ICO shall not export coffee that:

- for arabica coffee, has in excess of 86 defects per 300g sample
- for robusta coffee, has in excess of 150 defects per 300g
- for both coffees, has below 8% and above 12.5% moisture content

Until now the emphasis has been on destruction of poor quality stored green coffee. Here we suggest that another way to combat the problem should be to reward farmers for producing good coffee, so that much less poor quality ever enters the coffee chain. We believe this is a more sensible way to invest funds than paying for costly storage, destruction of coffee after it has been processed and monitoring teams to ensure this has been done.

We suggest that the coffee industry needs to examine the in-country links of the coffee chain from a quality control viewpoint and this needs to be more than an aspiration, it needs to be a logical system based on quality management according to systems developed in other industries, for example the system and philosophy of J Edwards Deming (Neave 1990).

The fragmentation of the coffee market and the consequent collapse of institutions over the last few years make this task particularly difficult. But if the coffee industry is serious about improving sales through quality, it needs to invest funds to solve the problem of wasted coffee quality. Too much potentially good coffee is being spoilt before it is exported because farmers lack the skills and incentive to produce the best from their land. The liberalisation of world coffee markets has not improved the industry as a whole. If the coffee industry believes in liberalisation, it must surely also believe that this liberty comes with obligations to ensure a strong and plural coffee supply.

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APPENDIX A

The coffee growers

Indian coffee growers

Farmers and size of holding: in India there are about 140,000 coffee farmers while the total area planted in this crop is about 350,000 ha; so the national average is 2.5 ha of coffee per farmer. This figure is similar to that found in other countries such as Colombia, Honduras or Mexico. Table 30 below describes the distribution pattern of holdings in different states of India (Coffee Board, 2000).

■ **Table 30.** Distribution of holdings in India, by state.

Size (ha)	Karnataka	Kerala	Tamil Nadu	Others	Total
I. Small Holdings		**Number of holdings in each category**			
0-2	27,109	71,245	11,396	10,502	120,252
2-4	6,580	2,995	1,246	6	10,827
4-10	4,160	1,676	728	-	6,564
Total	37,849	75,916	13,370	10,508	137,643
II. Large Holdings					
10-20	1,020	342	156	3	1,521
20-40	445	63	49	4	561
40-60	150	27	36	-	213
60-80	87	19	15	-	121
800-100	46	7	9	2	64
Above 100	107	19	29	15	170
Total	1,855	477	294	24	2,650
Total India	**39,704**	**76,393**	**13,664**	**10,532**	**140,293**

From Table 30, 98% of farmers have less than 10 hectares and the 86% have 2 ha or less. It is important to understand size distribution since adoption of technologies can be affected by the farm size. Duque *et al.* (2000) found in Colombia that the adoption of IPM in CBB management was higher in the medium and large farmers rather than the smaller (less than 5 ha in coffee). If this is true for other coffee countries, the strategy for transferring IPM should be designed to promote good adoption levels despite socio-economic barriers. If we take the cumulative percentage of farmers and coffee areas we can quantify this as the Gini coefficient[21] (Tascon, 1980). This indicator gives a measure of land concentration, which in the case of Indian coffee has a value of 0.48, which compares to 0.57 for Colombian coffee and 0.43 for Mexico, i.e. land concentration is lower than Colombia but higher than Mexico. Land concentration can be seen from different points of view e.g. land reforms etc., but also for IPM management. Resources to dedicate to technology transfer are always limited and it is important for planning purposes to understand both the distribution of land and the relative contribution to total coffee production. Smallholders in India account for 60% of the area under coffee (Table 31), which is very significant. Hence even if large producers are more productive, coffee smallholders in India constitute an important sector, not only for social reasons but from economic and environmental standpoints as well.

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[21] If Gini coefficient equals 1, there is total land concentration (one person owns all the land); if it equals 0, everyone has an equal area.

■ **Table 31.** Area and share of the production of coffee under different sizes of coffee holdings in India[22]

Size (ha)	Area under coffee		Share of Production
	Area (ha)	% of total	
I. Small Holdings			
0-2	129,091	42.2	
2-4	29,978	9.8	
4-10	40,379	13,2	
Total	199,448	65.2	60%
II. Large Holdings			
10-20	26,613	8.7	
20-40	17,131	5.6	
40-60	11,624	3.8	
60-80	9,483	3.1	
800-100	7,036	2.3	
Above 100	34,567	11.3	
Total	106,454	34.8	40%
Total India	**305,902**	**100.0**	**100%**

Labour requirements and rural wages: 67% of total Indian labour works in agriculture. Data from the present project (Table 32) shows typical labour requirements in coffee for 3 Indian states regions Kogadu, Wayanad and Tamil Nadu (without labour for harvesting coffee).

■ **Table 32.** Standard labour requirements/ha /year.

Activity	Robusta	Arabica
Weeding	60	90
Manuring	45	45
Shade Regulation	10	20
Trenching	30	30
Shot hole borer	15	20
Dadap thug	10	0
Apply of Lime	10	15
Scuffling	50	50
Insecticide Spraying	5	5
Miscellaneous	40	40
Total	275	315

These are high requirements in comparison to other countries, but even so are less than other Indian estimates (Coffee Board, 2000). ICO (1997) calculates that coffee production in India employs about 367,000 persons, which equals about one labourer per hectare. Labour costs show differences between the producing states. Table 33 indicates the labour cost in four states of India.

22 Coffee Board, India 2001

Hence a contracted temporary worker could expect an annual income of around US$250 if he works all the year. In comparison to many countries labour is therefore very

■ **Table 33.** Labour wages in different states of India, 2000 prices.

State	Rs/day	US$/day [23]
Karnataka	56.25	1.25
Kerala	71.74	1.59
Tamil Nadu	46.50	1.03
Andhra Pradesh	61.70	1.37

cheap in India, and explains why labour is a smaller proportion of the total production cost structure than other countries. IPM strategies often demand greater amounts of labour than other methods (e.g. a calendar spray regime for instance) hence the low cost of the labour in this country could facilitate the adoption of IPM strategy for managing CBB.

Farmers' income: income from coffee is very seasonal in India, with just one peak of income per year, which can be worrying for the farmer. In order to minimise the effect of seasonal variations, farmers may be expected to try to spread flows of labour and harvest production throughout the year. Upton (1996) points out that there are various strategies, such as diversification of agricultural production, to establish different on- and off-farm activities, storing food, seeds and animal fodder, etc. Seasonal income will have different effects depending on the period of the year when income is scarce because some activities have to be delayed to attend to a more important activity. The farmer has to manage different labour requirements and availability to optimise his gross income. In the case of CBB management, practices that can easily be accommodated by the farmer will be more easily accepted by him.

In order to diversify their income, Indian coffee farmers have developed production systems to involve more than one crop in order to get income from different sources and in different periods of the year. In a project survey carried out on coffee farmers of Karnataka it was found that 95.6% of them had pepper as an inter-crop. In many cases the inter-crop allows generation of an important part of the total farm income. For instance in an interview carried out during the visit to Wayanad region we met Mr. Vijayakumar who has a small farm of about 1 ha. He told us that his income was depending on three sources,- coffee, pepper and areca nut. The individual participation of each of them to his income was coffee, 50%; areca, 29%; pepper, 21%.

Thus other crops are important to the income composition of a normal coffee farm. It is quite possible that sometimes this alternative income becomes a relevant source to cover costs related to CBB management, whilst at others it could become a source of competition for the farmer's resources.

23 Exchange Rate US$1 = Rs 45

Ecuadorian coffee growers

Main characteristics: coffee farmers number about 150,000 in Ecuador. According to a survey carried out in this project, 95% of those questioned were men and only 5% women owner-occupiers. The majority (56%) were more than 50 years old, whilst just 7% were less than 30 years old. 88% of them had only primary education, 9% secondary and only 2% tertiary education. These figures suggest that functional illiteracy may well be high amongst Ecuadorian farmers, which is a disadvantage since it is well known that increasing educational levels correlate well with improvement in farm management. This is especially the case for an IPM strategy where measurements have to be taken and recorded, and a decision made after careful analysis.

On a more positive note, farmers' experience of coffee must be considerable, since 68% of them have been growing coffee for more than 10 years, with just 13% having less than 5 years experience. And regarding family size, 60% have more than 5 members, which should mean that availability of family labour is good. Some farmers mentioned that in recent months (in 2000) there had been a significant migration of rural labour, especially to Spain. They suspect that if this trend continues, they will face a lack of this resource in future. Despite family size, the level of contracted labour is high, with 41% of farms employing labour, 33% using both contracted and family labour with just 25% having sufficient family labour to carry out all coffee-related activities.

During our meetings, cattle, cocoa and banana/plantain frequently appeared as more important to farmers. The extremely low prices that many of them get for their poorly processed coffee probably contributes to this position. It was clear that in most cases their income is diversified and this kind of scheme plays a very important role in their livelihood. More research is needed to understand how they view coffee and how they rank it in importance as part of their livelihoods; we suspect many of them see it as a cash earner which provides the occasional bonus payment when prices rise.

Rural wages: the daily wage for a farm worker ranged between US $1 and $2 in the period 2000-01. The lower amount is paid for carrying out activities such as weed control, applying fertiliser etc., while the latter is common during the harvest season. This labour cost is cheap compared to other countries, especially Colombia. If this state of affairs continues, Ecuador would have a competitive advantage in traditional shade and organic coffees but would need to improve quality considerably to benefit from this trade sector.

Honduran coffee growers

Main characteristics: according to La Central (2001) there are 109,000 coffee farmers in Honduras. From the project survey, farmers' average age is 43 years old. 42% are 21 to 40 years old, 38% between 40 and 50 and 20% are over 50 years old. But this means that 80% are relatively young (50 years old or less) so this could be seen as an advantage to try to implement IPM programmes. However the education level is not high; 73% of them have no more than primary education. For this reason Muñoz *et al.* (2000) consider that the technical information should be presented very simply in order to get a better uptake.

Hence the extension strategy would have to be very carefully thought out, to achieve good comprehension, adoption and improvement of farm management. This especially because an IPM strategy implies measurements of infestation levels which have to be taken and recorded, and decisions made after careful analysis of this information. All this effort could act as a key barrier to both IPM understanding and adoption. Farmers' experience in coffee must nevertheless be considerable, 64% of them have been growing coffee between 5 and 15 years and 16% more than 15 years. 55% have between 1 to 5 family members, 25% of them have between 6 to 10 members and 20% more than 11. But despite these large families, Honduran coffee farmers consider that there is a labour shortage, mainly during harvesting time. During this period most of the labour must be transported from the villages where they live to the coffee fields early in the morning and then back in the evening, a significant extra cost.

Coffee farmers' income is seasonal since coffee is harvested over a short period of the year as in all Central American countries. Hence they plant crops that can give both income and food in other seasons. Examples of these are banana, plantain, maize, beans and sugarcane.

Rural wages: the daily wage for a farm worker during the project was about US$3 (45 Lempiras [24]), for workers carrying out activities such as weeding control, shade regulation, etc. However for harvesting they are usually paid piece-work by volume of coffee collected. For year 2000 coffee farmers were expecting to pay about US$1 per *galón* (equivalent to a US gallon) and on average a coffee picker could expect to gather between 5 and 8 *galones*/day. Hence the rural wage at harvest time would be between US$5 to 8. Although the normal rural wage in farming activities is low in comparison with other countries of the region the cost of collecting berries is almost equal to that of Colombia which is very high. Hence Honduran coffee farmers might well have problems in future because of the cost of labour involved in coffee picking could reach something approaching 40 to 50% of the total production costs. It is surprising to find this apparent paradox of both high poverty and high labour costs and we believe this requires further study.

Guatemalan coffee growers

Basic data about coffee farmers: according to official Anecafé figures, there are about 61,600 coffee farmers in Guatemala. With a total coffee area of about 262,500 ha, the national average is about 4.2 ha/farmer. This value is somewhat higher than

[24] Lempira is the national currency. The exchange rate is US$1 = 15 Lempiras

Colombia or Honduras for instance and may be due to the greater land concentration with a very few farmers having very large estates; we were told that the largest coffee farm in Latin America is situated in Guatemala.

A smallholder description: for the present project, a survey was carried out to typify smallholder coffee farmers (García, 1998). This diagnostic was done in 1998 for 62 farms in the departments of Suchitepequez, Retalhuleu and part of Quetzaltenengo, and included 31 farms from "La Chocola" community. Mean farm size was 1.1 h, average farmer age was 46 and 84% of them had only incomplete primary school education. These figures suggest that functional illiteracy may well be high amongst Guatemalan coffee farmers. If confirmed this is an important disadvantage since it is well known that increasing educational levels correlate well with improvements in farm management.

The average size of coffee farmers' families was five. Again if confirmed nationally, this could mean that the traditional notion of abundant labour availability does not apply any more; during the visit several extensionists commented on labour scarcity in coffee regions. The survey showed that 55% of the farmers relied solely on family labour while in the remaining 45%, the farmers contract farm labour. Since IPM strategies involve many activities and interventions in order to manage the pests, this implies extra labour needed to carry out the control measures proposed. If rural labour becomes scarce, this would increase difficulties in controlling CBB.

Despite Anacafé's efforts, just 22% of these smallholders were trained in coffee management and this is a key barrier to promote IPM strategies. Moreover, only 38% of them had had access to credit, with another 38% responding that they had not requested it and the other 24% stating that they could not obtain credit. This situation could be due to both lack of collateral and possibly also high interest rates. A common occurrence is to sell coffee cherries through intermediaries. Almost 94% of them use this channel to sell their coffee despite the Chocola community having infrastructure to carry out the post-harvesting processing. This decision has implications for the gross income of the farmers, which will be lower than if they process the coffee themselves. Coffee farmers diversify their income by growing and selling bananas: almost 50% of them had this extra income.

Rural Wages: the legal cost of a day's labour is 31.50 Quetzals[25], equivalent to US$4.0. However some farmers do not pay this salary and many rural workers give up the bonus, incentives and the payment corresponding to Sunday, in order to get a job easily. The day's wage is structured as follows:

a.	Wage =	21.62	Quetzals
b.	bonus + incentives =	5.38	Quetzals
c.	7th day =	4.50	Quetzals
	Total =	31.50	Quetzals

25 Quetzal is the Guatemalan currency, US$1 = 7.7 Quetzals

But the most common real wage ranges between 21 to 23 Quetzals, equivalent to US$2.7 to 3.0.

Mexican coffee growers

Farmers and areas: there are estimated to be 282,000 coffee farmers in Mexico and the total area planted in this crop is around 750,000 ha; so the national average would be 2.6 ha of coffee per farmer. This figure is similar to that found in other countries such as Colombia or Honduras. Table 34 describes the coffee areas in Mexico as well as the number of coffee producers (Consejo Mexicano del Café, 2000).

Table 34. Coffee areas and farmers in Mexico.

Ranges (ha)	Coffee farmers	%	Hectares	%
0.01– 2.0	194,719	69.0	247,485	32.5
2.00–5.0	64,617	22.9	229,624	30.2
5.01–10.0	17,706	6.3	133,880	17.6
10.01–20.0	4,311	1.5	65,639	8.6
20.01– 50.0	815	0.3	25,992	3.4
50.01– 100.0	245	0.1	18,286	2.4
> 100.0	180	0.1	40,260	5.3
Total	282,593	100	761,166	100

If we take the cumulative percentage of farmers and coffee areas we can calculate the Gini coefficient (Tascon, 1980). This coefficient quantifies the degree of land concentration, which in this case has a value of 0.43, which is lower than many other coffee countries. This value must be due at least in part to land reforms programmes carried out in this country.

Socio-economic description of Soconusco's coffee farmers: as a part of the present project, Jimenez (1999) carried out a study called "Small-scale coffee growers' knowledge and activities related to control of the coffee berry borer in Chiapas, Mexico", which involved a basic socio-economic description of the coffee farmers. Jiménez found that the average age of the Soconusco's coffee farmers was about 52 years old (range 18 to 85 years old). Table 35 presents percentages of farmers according to age categories.

Table 35. Age groups of Mexican coffee farmers in the Soconusco region.

Age category (years old)	% of coffee farmers
Up to 40	19.8
> 40 up to 49	19.8
> 49 up to 59	29.8
Over 59	30.6

As can be observed, 60% of farmers are over 49 years old. This average age could be a barrier to IPM adoption as found by Duque *et al.* (2000), for coffee farmers in Colombia. On the other hand, in an appraisal of the national coffee programme carried out by the Mexican Coffee Council (2000) it was reported that the average family composition was about 10 members distributed among children, young people, adults and elderly people. Additionally, Jimenez (1999) found that the level of formal education was very low, 75.3% of the coffee farmers either had no education or had not finished primary school. Again, for high adoption of IPM, a good level of education is desirable because included in the strategy are concepts such as sampling, mathematical calculations etc.

Land tenure: the salient factor in the Mexican case is that 95% of farmers own their farms and 61.5% have been farming them for more than 10 years. Land reforms in Mexico have guaranteed that most of the farmers have clear property rights on land they cultivate, though using this as loan collateral is often not easy because of strict laws about disposing of this land.

Labour needs & rural wages: agriculture and related sectors (forestry, fishing, etc.) currently employs about 22% of the national labour. Related to wages, it was possible to observe at least two basic kind of payments: for *Ejidos*[26] coffee farmers were paying $20 Mexican pesos[27] per day's labour (US$2.08/day), plus two meals. On larger farms the salary was about $30 per day (US$3.12).

According to the Mexican Coffee Council (2000), family members carry out coffee activities, covering approximately 90% of the annual farm needs. Figure 19 shows the

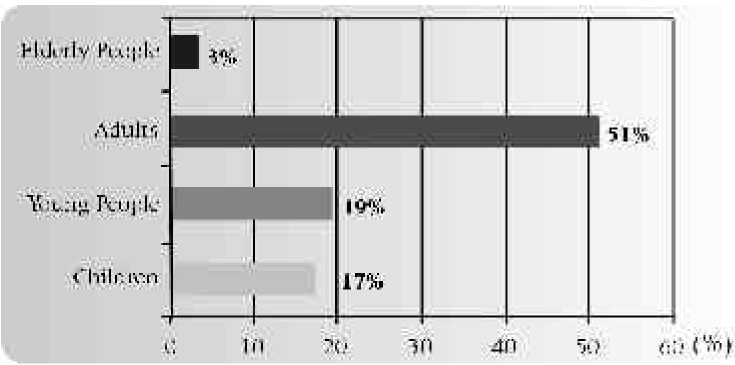


Figure 19. Family contribution to labour needs for Mexican coffee.

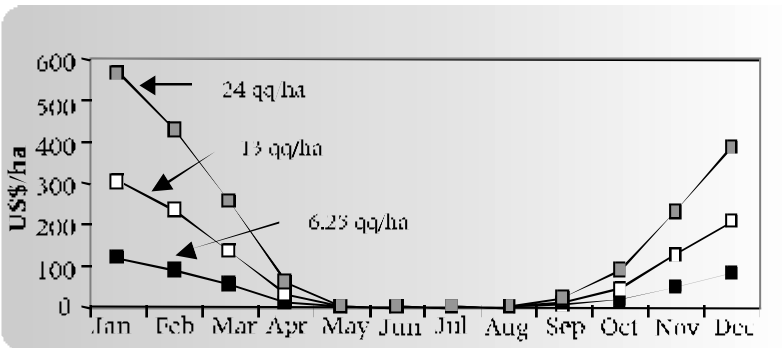
[26] Ejido is a type of land tenure that appeared after land reform programmes were implemented. A large farm was divided into small plots that were allocated among small coffee farmers; they own their lands according to Government laws.

[27] Exchange rate: US$1 = $9.6 Mexican pesos (2000)

contribution by family member type to the total farm needs; these needs are about 220 labour days per farm per year, including coffee harvest.

On average a typical coffee farm needs to contract just 10% of the total labour needs in order to carry out all of the activities needed for crop management. If a typical family in the coffee sector were composed of about 10 members, according to the participation of different age groups, this family would have about 3.4 adults, 4.3 children, 2 young persons and 0.3 elderly people. If we assume that there are 20 days of work per month per person, family labour can supply the labour needs to carry out the farm activities for 7 to 8 months per year. However in the harvesting period there is a labour deficit. This point should be taken into account when analysing CBB[28] management and suggesting additional labour inputs.

Farmer's income: coffee farmers' income is seasonal in Mexico, which is a risky situation especially if pickers become scarcer through emigration, as some farmers' fear. In order to minimise the effect of these seasonal variations, farmers can attempt to spread flows of labour and harvest production throughout the year. Upton (1996) points out that there are various strategies, such as diversification of agricultural production, to establish different on- and off- farm activities, storing food, seeds and animal fodder, etc. From experience in other countries, this situation also suggests that they would be especially risk-averse and perhaps unwilling to try new crops or varieties. Seasonal income means that money is scarce for labour at certain times, or that certain activities such as crop hygiene might be delayed because of other more urgent tasks. For instance we can take three of the production categories proposed by Moguel & Toledo (1996), subsistence, medium technology and intensive technology. These categories produce 5, 13 and 24 Quintals of green coffee/ha/year. If we assume an expected price in 2000 of about $650 Mexican pesos per quintal of parchment coffee[29], we can estimate the monthly income following the harvest distribution, as appears in Figure 20.



■ **Figure 20**. Gross income distribution according to coffee productivity (S. Mexico)[30] .

28 CBB = Coffee Berry Borer (*Hypothenemus hampei*)

29 Expected price this year. Roberto Esquinea, Union Ejidos Lazaro Cardenas. Cacaohatan, September, 2000

30 Mexican Coffee Council, 2000

Analysing Figure 20, we see that income can vary substantially among these three types of production. For instance, in January the gross income per hectare is about US$580 for the highest technology but it is barely above US$100 in the subsistence group. It is clear that at least during May, June, July and August there is no income derived from coffee which could adversely affect any investment in crops or any other enterprise during that period. Also, pest management may be limited due to lack of money just at a phase of the crop cycle when it is most needed. The subsistence group seems to be very vulnerable during this period.

Pests and diseases, - farmers' perceptions: the Mexican Coffee Council (2000) carried out a survey among coffee producers. One of the topics analysed was pest and disease management. Table 36 describes the main control strategies used and the percentage of farmers involved in each of them.

■ **Table 36.** Main control strategy used against pests & diseases.

Control Strategy	%
Cultural control	56
Chemical control	8
Biological control	4
Integrated control	2
No control	30
Total	100

Table 36 shows that the two main strategies used against pest and diseases are cultural control and no control. This circumstance could have several explanations. Firstly, coffee farmers might lack information about pest and disease management. Secondly, the control measures proposed might not work properly so they have not adopted them, or conversely that they see no economic advantage in using them, or that they have insufficient resources to carry out the control measures (Norton & Mumford, 1993). More research is needed to understand what is happening here but it may be related to the almost total absence of extension support.

Research carried out in Chiapas by Jiménez (1999) found that coffee farmers considered that the most important phytosanitary problems were coffee leaf rust (*Hemileia vastatrix*) for 87% of farmers and CBB (*Hypothenemus hampei*) for 92% of them. Thus the CFC-ICO/02 project focused on a key sanitary problem for Mexican coffee farmers.

Colombian coffee growers

Socio-economic description: the following comes from the study carried out by Duque *et al.,* (2000) on technology adoption of IPM strategy by Colombian coffee farmers, 13% of whom were women whilst 87% were men. The majority were owner farmers (66%) most of the rest were managers (29%).

The average farmer had 23 years farming experience (modal value 30), 87.5% of them were more than 35 years old, with an average age of 46 (range 17 to 81). 72.8% of them did not complete primary school education - in Colombia is has been estimated that coffee farmers average only 3.6 years of formal education. This level of education is not adequate for adopting a technology such as IPM whose essence is as much conceptual as practical. Metcalf (1974) for instance, comments that the rate of acceptance of an innovation depends on the educational status of the farmers.

The average size of a family was 5, with few having more than 6 members. From this we conclude that family labour is no longer abundant as many had supposed and this must impact on their ability to adopt labour intensive control methods.

Income generation: most coffee farmers surveyed (76%) did not have additional off-farm activities to generate extra income generation and/or risk through income diversification.

Land tenure: most were owner-occupiers with clear property rights to their land. In this case land plays a key role as collateral, facilitating access to rural credit.

Rural wages: Colombian rural wages vary depending on the region and time of year. In S. Colombia where labour is normally abundant, rural wages tend to be lower than in the central coffee regions where the most intensively farmed coffee in Colombia is situated.

In the case of short-term workers a normal wage in the central zone is about $13,000 to $14,000 Colombian pesos per day (US$5.9 to 6.4, 2002). This wage is normally paid for unspecialised activities such as weeding, shade regulation, pruning, fertilisation, etc., including some coffee collections when carrying out cultural control for CBB management. For other activities such as main harvest periods, wages tend to rise because payment is by weight of berries collected. Under this scheme good workers could increase significantly their income, up to US$10 per day.

Other types of labour involving specialised activities such as spraying, post-harvest processing and so on is normally done by permanent workers where the wages are higher because some social security payments are included.

Thus from our surveys, it seems that Colombia pays some of the world's highest wages for coffee. This explains why coffee growers there are always particularly sensitive to agricultural recommendations that involve extra labour as in the case of CBB control.

APPENDIX B

The role of coffee in the countries studied

This appendix reviews the economic importance of coffee in six countries, as a contributor to GDP, exports and as a generator of foreign exchange.

Coffee production has increased in most of the countries studied, most notably in the 1970s and 80s with the advent of new varieties and production subsidies. Surprisingly though, yields are still poor in many parts of all countries. This is because coffee is still produced by a large number of smallholders who have mostly not benefited from the technology on offer.

In all the six countries, coffee is of declining economic significance, both as a percentage of GDP and of foreign earnings, a circumstance that is a natural consequence of the development of their mostly city-based industries. But if we take into account its continuing importance as a generator of employment, coffee's importance remains mostly unchanged. From this we conclude that coffee is now of more social significance than pure economics may suggest. Thus a recent report (Ramírez *et al.*, 2002), analysing the coffee institutions of Colombia, states that the coffee sector has developed into a social issue of very high importance which has a role in national stability. Indeed because of the secular decline of agriculture, coffee may now be more important than previously, for when it suffers a downturn there are few alternatives for members of this already depressed rural sector. We believe that such societal externalities must lead to hidden extra costs that are still to be calculated but which are beyond the scope of this book. We merely note that of the six countries studied, four have faced significant rural-based guerrilla activities in recent years, all of which have included coffee-growing zones.

India

The agricultural sector contributes 25% of the country's GDP although this participation is declining. E.g. in 1947, 85% of the population depended on agriculture, which contributed to 70% of the Indian GDP; currently 75% of the population still depend on agriculture. The main agricultural products are rice, wheat, oilseed, cotton, jute, tea, coffee, sugarcane, potatoes, and a range of livestock. Coconut, cashew nuts, and vegetables are also important.

Agricultural exports have fluctuated between 12 and 20% of total exports, though in dollar terms they remain relatively constant, suggesting a gradual transition from a predominantly agricultural production base to a broad-spectrum of industry and services. The major agricultural exports are cereals, spices, cashew, oilcake/meal, tobacco, tea, coffee, and marine products. Coffee exports have remained above US$400 million over recent years with the exception of 1999-2000 (US$315 million) and 2000-01.

Menon (2001) points out that the fall in international prices of robusta coffee as well as pepper has adversely affected the coffee farmers from Karnataka and Kerala states. Pepper is an important extra income for many coffee farmers but its productivity has been low (275–300 kg/ha). Additionally the price has seen reductions from Rs 22,600/

qq[31] in 1999 to Rs 12,000/qq in 2000. A similar situation has occurred with areca nuts where prices fell from Rs 154/kg in September 1999 to Rs 78/kg a year later. The key point here is that the Indian agricultural sector is facing a difficult period that is affecting many crops, coffee included.

Coffee planted areas have increased markedly in India over the last half century. In 1950/51 there were 92,523 hectares; in 1999/00 the total area had grown to 340,306 ha. We see in Figure 21 a very significant increase in total area during the 1970s and 1980s. Arabica increased by about 100,000 hectares whilst robusta rose by 146,000 ha. Areas planted in arabica and robusta are now roughly equal.
Coffee production in India: for the year 1950/51 it was estimated at about 18,893

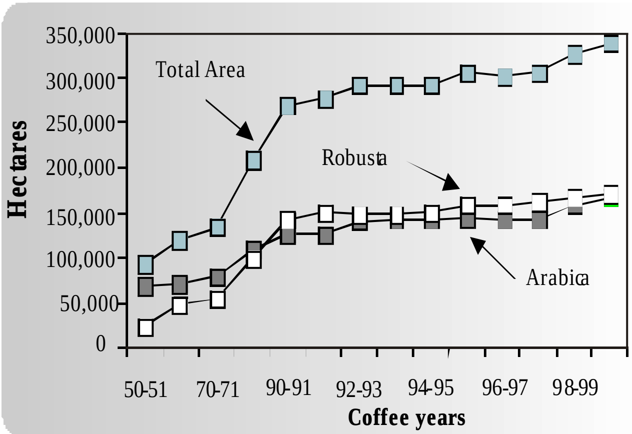


Figure 21. Area planted in Coffee. India, 1978 – 1992[32].

metric tonnes while in 2000/01 about 295,000 metric tonnes (Coffee Board, 2000).

Coffee productivity in India: in 1950-51 it was about 255 kg of parchment/ha while in 2000-01 the expected productivity was about 1,084 kg of parchment/ha. This suggests that crop technology has been responsible for this change in productivity. So even without expansion in area, there may still be considerable scope for an increase in total production.

Arabica and robusta are classified according to the post-harvesting method: “washed” and “non-washed” (naturals), and are classified into 25 grades based on the size of the bean and on the total number of defects or imperfections (ICO, 1997). Apart from this system, specialty coffee is now the fastest growing segment and India hopes to

[31] Rs 48 = US$1 (2001)
[32] Source: Coffee Board, India, 2001

export about 20,000 tonnes (something like 6.7% of total coffee exports) per annum in the next few years. Organic coffee is also of increasing interest especially for coffee grown on tribal land, which represents about 42% of the coffee area in India. Here coffee is managed in a less intensive traditional way, which is close to organic production guidelines (Central Coffee Research Institute, 2000). Some of the grades of specialty coffee and value added coffee are Mysore nuggets EB, Monsooned Malabar (AA, PB, C), Monsooned Arabica AA, Rob Kapi Royale.

The states of Karnataka, Kerala and Tamil Nadu contribute 92% of Indian coffee grown but also in small sectors of the states of Andhra Pradesh and Orissa and some of the North Eastern states, coffee can also be found. In Andhra Pradesh at least, its is becoming a significant crop to tribes who formerly practised 'slash-and-burn' agriculture.

Ecuador

At US$100 million per year in 1999 coffee was about third in importance in agricultural exports of Ecuador, after fruit (mainly bananas) and shellfish and fourth in importance of all exports. Hence coffee provides a significant contribution to export earnings of this small and poor country. More importantly, the employment coffee traditionally provides makes it a crop of strategic and social importance. Both coffee and cocoa sustained pronounced falls for the period 1995-1998, whilst fruit and fish remained relatively stable. Part of the decline may be attributed to the El Niño phenomenon in 1998, but it is clear that in the case of coffee the fall predates this event. From 1994 to 1999, coffee export earnings fell by a stunning 81%, though these figures may be distorted somewhat by illegal movements of coffee to and from Colombia, depending on the differential in internal prices between those two countries.

The 1983 national coffee census estimated that Ecuador had 460,000 ha of coffee but now it is reckoned to be only 305,000 ha. This reduction is most likely caused by abandonment of farms and changing to other crops as the world price of coffee has deteriorated. In order to measure the precise area, a coffee census is currently being carried out by INEC (Instituto Nacional de Estadística y Censos). Of this area roughly 45% (137,000 ha) is planted to robusta coffee and 55% (168,000 ha) is arabica coffee. Coffee distribution, by geographical zones, appears in the following Table 37.
The north-eastern zone of the country, corresponding to the Amazonian basin, is mainly

Table 37. Geographic zones and areas in coffee.

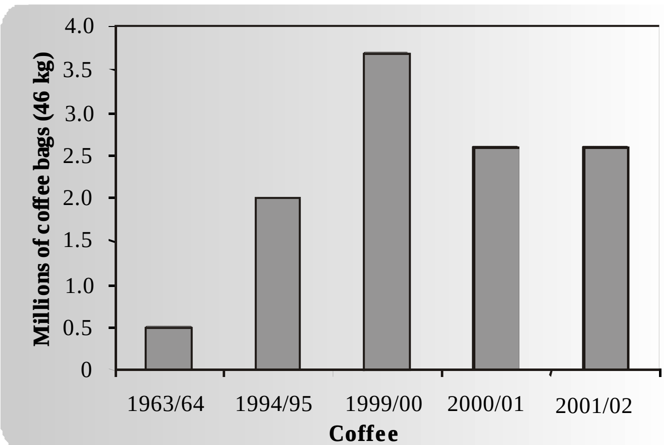
Zone	Area (ha)
North Eastern zone	80,000
Western zone	100,000
Southern zone	50,000
Central area	50,000
Other zones–dispersed-	25,000
Total	305,000

robusta since both amount and distribution of rainfall throughout year are favourable for this kind of coffee. There are estimated to be about 1,000 ha of new clonal varieties in this region. In the other zones, with more seasonal rainfall, arabica prevails. These are the western Pacific coastal zone (Manabí province), the southern states (mainly Loja and El Oro), the central area (Esmeralda and Santo Domingo). In these zones, all but 25,000 ha of arabica is traditionally grown (i.e. not intensive production), with no more than 2,500 coffee trees per hectare, shade trees, little or no fertilization and old trees. According to information collected during the project, Ecuadorian coffee productivity ranges between 800 kg/ha of parchment coffee in the case of more intensively grown crops and 700 kg in the traditional ones.

Honduras

This is one of the poorest countries in the western hemisphere, with a GNP per capita income of US$660[33]. Agriculture is very important in Honduras with 70% of the population linked to this sector. The main revenues come from exportation of bananas though coffee, cattle, sugarcane, lumber, tobacco and seafood, are significant contributors to the national income and foreign exchange.

Coffee production in Honduras has been expanding (Figure 22). At the beginning of the 1960s, total production was about 500,000 sacks (46 kg of green coffee), by 1994/1995 it was 2 million and during the year 1999/2000 the exports rose to about 3.7



■ **Figure 22.** Expansion of coffee production in Honduras over the last 40 years.

million sacks. For the period 1985 - 1989 coffee exports were 25.6% of total exports (Palma *et al.*, 1997). Coffee exports were valued at US$174 million for the coffee year 1993/94; these figures demonstrate the key importance of the coffee sector to the

33 World Bank, 1996 figures.

national economy of Honduras. Between 1970 - 1987, coffee represented 37% of agricultural production growth, more than twice any other crop. Bananas were for a long time the primary exported product but after Hurricane Mitch, a substantial number of plantations were damaged, which are now recovering. This caused coffee exports to assume first place. Thus in 1998, coffee exports were US$433 million whilst for bananas for the same period the value was only US$157 million

According to Oseguera[34] (2000), current productivity levels are a result of a project supported by USAID (Agency for International Development - US Government) 10 years ago. This project focused on increasing coffee productivity based on new varieties, such as Catuai and augmentation of the density of trees per hectare from 1,700 to 3,500. At that time IHCAFÉ lines of credit were supported by USAID, but currently all credit supplied to Honduran coffee is from the private sector. According to information from the Honduran Coffee Institute (IHCAFÉ), it is estimated that the total area planted in coffee crops is about 260,000 ha. The whole area is planted to arabica. The coffee areas are located from the centre to the northern and north-western parts which have a higher rainfall than the area to the south near El Salvador. Table 38 lists the different coffee regions in Honduras.

■ **Table 38.** Principal coffee regions in Honduras.

Region	Departments (main)
Southern	Choluteca, La Paz, Intibula
Western	Santa Barbara, Copan, Comayagua
Eastern	Morazan, Paraiso, Olancho

The average national coffee area per farm it is about 2.5 hectares with an estimated number of 105,000 coffee farmers. According to Suazo[35] (2000), 85% of the farmers have less than 5 hectares in coffee. But it is estimated that the other 15% are responsible for producing 45% of the country's coffee with the remaining 85% of coffee farmers producing the other 55%, hence suggesting a considerable concentration of production in relatively few hands.

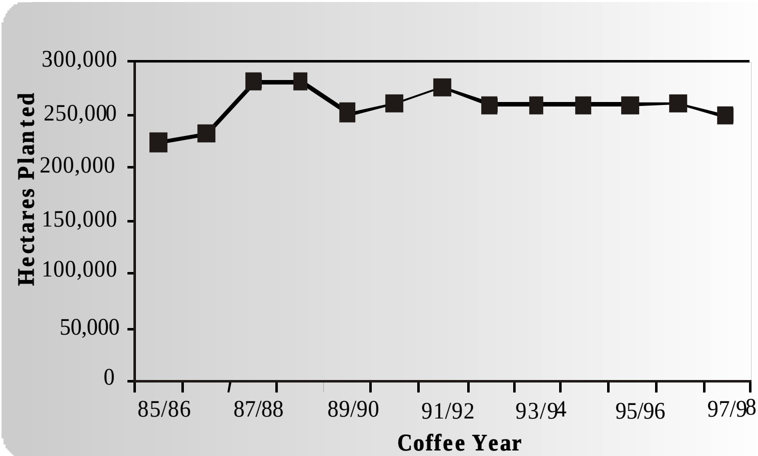
Guatemala

As in neighbouring Honduras, agriculture is the most important sector of the Guatemalan economy and one of its most important resources is its naturally fertile soil. Despite important mineral resources such as petroleum, antimony, lead, nickel, zinc, etc., Guatemalan agriculture still provides about 25% of GDP. The most important agricul-

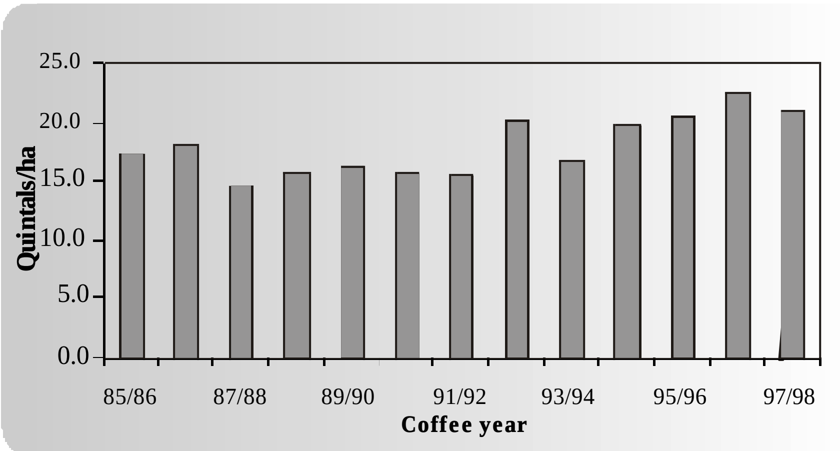
34 Oseguera, F. Director of the Agricultural Division, IHCAFÉ. Personal Communication, 2000
35 Member of the technical staff, IHCAFÉ, Honduras, 2000

tural products are coffee, bananas, sugar and cardamom. Other important crops are rubber, cotton and maize, the last of which is the staple food in Guatemala. Beans and wheat are other key crops followed by livestock. Over recent years coffee has often been first in importance in Guatemalan agricultural exports and makes up about 30% of the total exports, whilst representing only 13% of the agricultural area (Calvo, 1998).

Coffee production in Guatemala has been increasing despite the relatively constant area under production (Figure 23) and currently the country has about 262,500 ha[36] planted to coffee. Production has been increasing over the last 5 to 6 years. Between



■ **Figure 23.** Area planted in Coffee. Guatemala, 1985/86 – 1997/98[37] .



■ **Figure 24.** Coffee productivity in Guatemala, from 1985/86 - 1997/98.

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36 Dr. Francisco Anzueto. Research Manager, Anacafé. Guatemala, 2000

37 Source: Anacafé, Guatemala

1985 and 1992 the national coffee production remained fairly constant at 4 million quintals of green coffee but from that time there has been an increase to above 5 million quintals. The 1996/97 harvest was the highest ever, at about 6 million quintals. However the 1998/99 harvest dropped by 15% from 1997/98 harvest, due to severe drought.

The main reason for the increase is that the productivity per area has risen. Figure 24 shows that for 1985/86 productivity was 17.3 qq/ha and it rose to 22.3 qq/ha by 1996/97, which is roughly double that of Mexico.

With respect to the main difficulties that coffee is facing in this country, the technical staff[38] of Anacafé mentioned: low international coffee prices, lack of profitability, lack of credit, high financial costs, high input costs, high cost and lack of rural labour. Pest and disease problems include CBB and *Mycena citricolor*, a leaf fungal disease stimulated by humid tropical storms from the Caribbean.

Anacafé[39] provides services in seven main regions where coffee is grown. Table 39 shows these regions and the main cities in each of them.

The first 4 regions are in the Central-Pacific basin while V and VI are near the tropical regions of Chiapas (in Mexico) and El Petén in Guatemala. Region VII is near the border with Honduras.

■ **Table 39.** Coffee regions in Guatemala (Anacafé classification).

Region	Department	Main City
I	Quetzaltenango	Coatepeque
II	Suchitepequez	Mazatenango
III	Guatemala	Guatemala
IV	Santa Rosa	Cuilaya
V	Huehuetenango	Huehuetenango
VI	Alta Verapaz	Cobán
VII	Zacapa	Gualán

Mexico

Mexico is an industrialising nation and this is seen by the perhaps surprising fact that only 3.7% of exports are agricultural products and 25% of maize and 48% of wheat is imported (Mastretta, 2000). The leading agricultural exported products are coffee, cotton, sugar, fresh vegetables and fruits.

38 Francisco Anzueto, Armando Garcia & Arturo Villeda
39 National Coffee Association of Guatemala

Currently coffee represents 1.5 % of all Mexican exports. Although this figure is lower than the Guatemalan and Honduran cases it is still important. For year 2000, Mexico was the world's fifth largest exporter of coffee. The value of coffee exports has been very variable, with an average of about US$530 millions.

Mexico has a population of 100 million people, 71% living in cities and towns and 29% in rural areas. Hence almost 30 million people are still linked to a largely subsistence economy. The agricultural contribution to GDP has been decreasing from 16% in 1960 to 5.6% in 1998. This loss in importance has generated problems, for instance in a high rate of malnutrition. In the opinion of people interviewed during our field visit, food security is threatened because Mexican staples such as maize and wheat have to be imported. Mexico, like India is an example of a country where although coffee is not a major part of the economy, it is a significant factor in the economy of some poor rural areas.

The area planted to coffee in Mexico increased by about 80% from 1978 to 1992 when it rose from 400,000 hectares to over 700,000. Despite this expansion, total coffee production has not risen in proportion with this increase (Figure 25).

Despite a large rise in year 1999/00, coffee production on average has been around 4.9 million sacks, similar to the amount for 1989-90. This suggests that new areas are mostly traditional rather than intensive and it is possible that old areas are being abandoned or neglected as new areas are planted.

Whatever the reasons, yield per hectare is always below 12 qq[40] of green coffee per hectare. From the National Coffee Survey (1999-2000), of the total coffee area, 93.7% was in production, 1.3% was in new plantations in the pre-production stage and the 5% was dedicated to roads, buildings, rural paths, etc. (Consejo Mexicano del Café, 2000). Since such a huge percentage was in production and so little under renewal, this implies that the crop cycle is very long, another indicator of traditional coffee growing. The Mexican coffee sector employs about 3 million people (Moguel *et al.*, 1996) i.e. about 10% of the total rural population, which indicates that Mexican coffee is more important to the country than economic data alone might first suggest.

Colombia

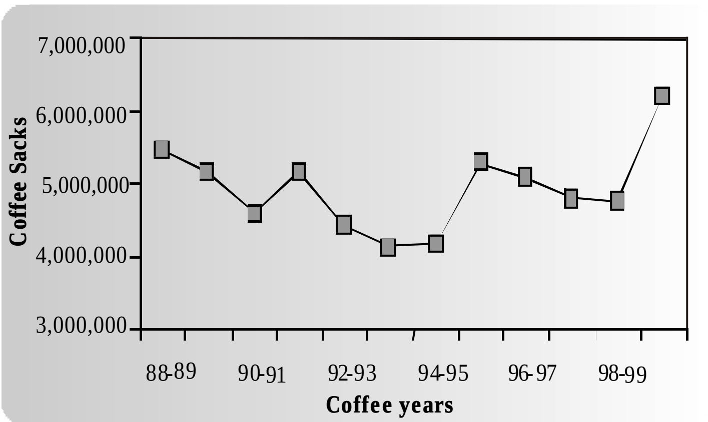
Coffee exports have long been a key provider of foreign currency needed for the growth of other sectors of the Colombian economy. As recently as 1994, coffee exports of US$1.99 billion represented almost a quarter of the country's total export earnings. However, since 1997, Colombia's export earnings from coffee have fallen by almost 70%, largely due to a sharp decline in prices. By 2000, coffee exports of US$1.08 billion represented only 8% of total exports, while in 2001 the figure is

[40] 1 qq = 1 Quintal = 46 kg

estimated at 6%. Colombia's principal export earners in 2000 were petroleum products (US$4.72 billion) and coal (US$1.09 billion).

Coffee growers in Colombia total 450,000 families and it is clear that many of them are living almost entirely from coffee. This fact makes coffee very important from the social point of view. Additionally coffee is believed to generate almost one extra direct employment per hectare per year which equals about 800,000 jobs per year. If we take into account the various indirect effects, total jobs due to coffee will be significantly higher than this figure.

Annual coffee production in Colombia has increased from 7.7 million bags in the 1960s to a peak of 18.1 million bags in 1991/92. Increases in plantings and production were encouraged by the Federation. However, due to a combination of the effect of low prices (both in the early 1990s and since 2000), rising costs of production and the impact of CBB, production has since declined. In 2000/01, production was 10.5 million bags, over 40% lower than in 1991/92, while the average yield was 877 kg per hectare (Figure 26). Yields have improved from the 1960s and 1970s level of around 600 kg per hectare mainly as a result of the increased use of higher yielding varieties, which are more densely planted and yield around 1,200 kg per hectare, compared to traditional varieties which may typically yield around 300 kg per hectare. Replanting and crop renovation have been supported by government subsidies since 1994/95, aimed at improving yields rather than increasing planted area. Over the last ten years, the coffee-planted area has declined from over 1.1 million hectares to 0.8 million hectares, while the area harvested has been 6-15% lower than this, depending on a number of factors, including crop renovation programmes.



■ **Figure 25.** Coffee production in Mexico, 1988-89 to 1999-00[41] .

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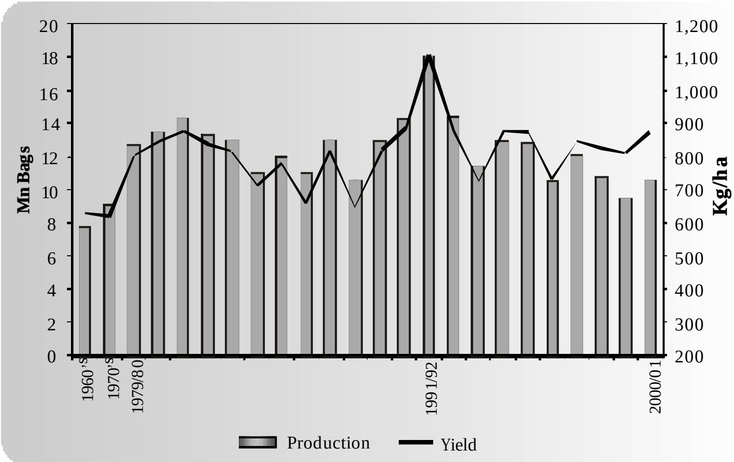
41 Source: Mexican Coffee Council, 2001

In 1997, the total coffee area of 869,158 hectares comprised 551,480 farms averaging 1.5 hectares of coffee. Coffee is grown more intensively in the six departments of the central coffee belt ("*eje cafetero*"), which account for over 60% of the total coffee area.



■ **Figure 26.** Coffee production and yields in Colombia.