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Experiences with Use of Chemical Control for CBB

Content

Summary assessment of criteria for methods using chemicals

Criteria	**Chemical Controls**
How effective is it in controlling CBB?	Can be very effective if a recommended insecticide for CBB is applied correctly and at the right time to kill borers before they enter the bean. But farmers also report ineffective applications and if rain occurs shortly after spraying, a repeat application may be needed. 44% of Colombian farms interviewed are using insecticides (mainly chlorpyrifos) as part of their CBB control. 50% of Central American non-organic farmers interviewed have used endosulfan in the last 5-8 years. 38% of global survey respondents rated chemical use *Very Effective* and 38% as *Reasonably Effective*.
How much does it cost?	Not necessarily cheaper than other methods, especially if full costs of spray equipment, maintenance, personal protective equipment and medical checks for spray teams on large farms taken into consideration. Calendar-based spraying without sampling for CBB levels or position risks wasting money on unnecessary application. *Colombia*: Approx. US$10 in product + US$22 in labour per ha on a large farm for one application of chlorpyrifos. Conventional farms may make 2-3 general applications per season. Certified farms only apply on hotspots, sometimes only once per season. *Central America*: Approx. US$7-15 in product depending on dose + US$20 in labour per ha on a large farm for one application of endosulfan. Conventional farms may apply 2-3 times per season. Small farms can find chemical use unaffordable.
How much labour time does it need?	*Colombia*: Approx. 2-3 person/days per ha on large farms for mixing and spraying. *Central America*: Approx. 1.5 person/days per ha on medium farms and 4.25

	days per ha on large farms for mixing and spraying. Labour time for monitoring CBB incidence levels to assess need for control and assessing whether borers are within chemical contact should also be included.
How easy is it to implement?	Easy in terms of farmers and workers already familiar with spraying procedures. Not always easy to identify precise time for effective targeting of CBB or for organising spray operations in time over a large farm. Manual work of carrying 20 litre sprayers is hard and risky when using hazardous pesticides, even with protective clothing. Certification standards require considerable efforts in pesticide storage, recordkeeping, handling and disposal procedures.
Does it need much training before it can be used?	For well-timed and effective application, farmers and workers need training in monitoring techniques and proper application methods. For reduced risk pesticide handling, workers and managers require training and procedures need supervision.
Other key points	Experience and/or fear of poisoning workers or family members using endosulfan or other hazardous insecticides is a frequent reason cited by farmers to reduce or eliminate pesticide use. Others are concerns to avoid harm to wildlife and the environment and to comply with certification requirements. Over 50% of non-organic certified farmers interviewed in Colombia and Central America are not using insecticides for CBB. Several farms have greatly reduced or eliminated insecticide use in recent years, using a combination of IPM methods, while maintaining or even improving coffee quality.

Summary of use from interviews in production zones with continuous flowering (Colombia)

Table 1 summarises information on previous and recent use of insecticides for control by Colombian farmers. Over half of farms visited have not used insecticides for controlling the borer for at least 5 years or more, some as long as 10 years. None of these are organic farms and some of the farmers do use fungicides, small amounts of herbicide or occasional insecticide applications against other coffee pests. Generally, they expressed concern about insecticide hazards, especially of endosulfan, (see separate project document on 'Endosulfan Poisoning and Other Issues' for farmer views about pesticides and poisoning issues) and a reluctance to use chemical control unless absolutely necessary.

Of the 4 farms that do use insecticides, 2 farms (both large estates) have specific aims to reduce chemical use, or eliminate it if possible, and have already made major reductions. They have replaced reliance on insecticides with a combination of use of Beauveria products, physical methods and more frequent and improved monitoring and cultural controls, with remaining insecticide use focussed on hotspots only. Chlorpyrifos is the insecticide they all reported using, with one farmer also applying cypermethrin. Chemical control was considered effective, if timed correctly when the borer is outside the berries or only in the berry flesh, and not expensive. However, farmers stressed that it should be used as a last resort, when other control methods are no longer sufficient.

In terms of cost/benefit comparisons with other CBB control methods, one farm manager highlighted that the full costs of using hazardous pesticides should be taken into account, not just the product, spray equipment and labour cost. These full costs include: cost of proper protective clothing, regularly renewed; cost of medical check-ups for workers and regular

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cholinesterase blood level testing (a requirement of several standards to assess spray operator exposure to organophosphate and carbamate pesticides); and the cost of any ill health incidents.

Table 1. Summary of chemical control use by farmers interviewed in Colombia

Farm (size)	Any recent use of insecticides for CBB control?	Active ingredient, dose rate and frequency	Estimated costs & other comments
A (small)	No. Not used for at least 10 years.		
B (small)	No. Not used for 7 or 8 years.		Chlorpyrifos can be used in cases of very serious attack but he's never needed to.
C (medium)	No. No longer uses insecticides for any coffee pests, thanks to mulching and mixed cropping.		
D (medium)	No.		
E (medium)	Yes.	Chlorpyrifos applied on very limited hotspots in some plots once this season.	Only applies if cultural controls alone are insufficient and always on agronomist's advice and based on borer position assessment in the berry.
F (large)	Yes but very limited now as farm aims to eliminate chemical use.	Chlorpyrifos at 1.5 litres per barrel of 200 litres. Requires 2 barrels per ha (i.e. 3 litres of product) in older plots. Never a generalised application.	Cost approx. US$10 per ha in product + US$22 in labour for one application. Must be timed correctly or it won't work properly. Has greatly reduced chlorpyrifos applications in recent years, replacing with Beauveria applications 3 times per season and better monitoring and cultural controls.
G (small)	Yes but only as a last resort if cultural controls fail to keep CBB levels acceptable.	Cypermethrin + chlorpyrifos. Uses 2 litres chlorpyrifos + 2 litres cypermethrin for one application on 5ha farm.	Cypermethrin costs US$9.86 per litre and chlorpyrifos US$8.77. Considers costs quite economical and products effective. Spraying can usually be avoided if frequent ReRe pickings always done in good time.
H (large)	Yes but much reduced and none this year as farm aims to eliminate chemical use.	Chlorpyrifos. In hotspots and never general application.	No info on costs but cost: benefit assessment should include costs of protective kit, cholinesterase testing for workers, medical checks. Insecticides won't work well without good cultural practices too. Have almost eliminated chemical use, replacing it with biological products, very efficient cultural controls and very regular monitoring.
I (medium)	No. Not used for almost 10 years. Farm aim is to use only ecological methods.		Replaced with intensive sanitation around hotspots and focussed application of Beauveria products.

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Several farmers, along with some technical support organisations, highlighted that poorly timed or badly applied insecticide applications can be a waste of money, as well as contaminating the environment and posing risks to farm workers. As certified farmers, they were aware that standards, such as Fairtrade, prohibit use of several pesticides and they must make sure not to use pesticides on these prohibited lists. Some drew attention to the need to only use products authorised by the national regulatory agency and to ensure that workers use protective clothing.

Information on efforts of farmer co-operatives and support organisations to phase out endosulfan use before and after its prohibition in Colombia is given in the synopsis on Endosulfan Issues.

The National Coffee Growers Federation (FNC) has for many years recommended farmers to carry out IPM practices for CBB, with emphasis on monitoring, cultural, biological and physical controls as far as possible. Its research institute Cenicafé has tested efficacy of more than 50 active ingredients for borer control and currently only recommends use of 3 organophosphates found as effective as endosulfan: chlorpyrifos; fenitrothion; and phenthoate. Products containing these insecticides cost around US$16-27 per litre.

Cenicafe recently collaborated with agrochemical companies to trial two new insecticides with better human health and ecotoxicological profiles than the organophosphates and found these effective and with longer-lasting control than contact insecticides with mainly 'knock-down' action. One of these, cyantraniliprole, is now registered by the Colombian authorities and for sale since April 2013 by DuPont as Preza® product, with a high profile marketing campaign. It is very expensive in terms of unit price (equivalent to around US$137 per litre). The company's cost analysis estimates that using Preza® once per season works out to a similar total cost as common farmer practice of 3 chlorpyrifos applications. Appendix B gives more details from company literature of the cyantraniliprole product and its recommended use.

FNC chemical control recommendations are to only apply insecticides for CBB during critical control periods (from 120 DAF) and if plot sampling shows CBB levels over 2% and if more than 50% of borers in the berries are in positions A or B, i.e. still within the flesh and not yet penetrating the bean. Depending on specific farm situations and seasonal climate, application frequency can vary from zero up to 5 sprays per year. Cenicafe emphasise that insecticide use will only be cost-effective if recommended cultural controls are also carried out. Chemical control alone would require many more applications per year.

The information collected during the interviews demonstrates clearly that it is technically and economically feasible for farms, both large and small scale, to manage CBB effectively without endosulfan use. All certified farms in Colombia are using good cultural controls and careful monitoring as the backbone of good borer control. Some are also using *Beauveria* biopesticides, others are using chlorpyrifos in hotspots. Several farms have greatly reduced chemical use, by making more intensive use of cultural controls and applications of *Beauveria*.

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Summary of use from interviews in production zones with defined flowering and one main harvest period (Central America)

Table 2 summarises the information on chemical use by farms interviewed in Nicaragua and El Salvador. Over 80% of farmers interviewed in Central America have not used endosulfan or other insecticides for CBB control in the last 5 years and some have never used them. These include not only the five organic farmers interviewed but also four non-organic farmers. Two other farmers (one large estate and one small-medium farm) were regular users of endosulfan until quite recently when its use was prohibited by the standard under which their farms are certified. Both farms have successfully replaced endosulfan use with methanol trapping in the last three years, supported by the export company or co-operative they supply. Both are very satisfied with the trapping method and find it cheaper, easier and safer than spraying endosulfan (see guidance document 'Experiences with Using traps and other physical controls'). COEX export company has also eliminated endosulfan use on its own estates, now using trapping, good cultural controls and biological products (see the COEX case study comparing costs and resources required for endosulfan use with those for trapping, presented at the project workshop in Oct. 2013).

One non-certified large estate still using endosulfan was interviewed to compare CBB control methods with the certified estates. The farm manager has also introduced methanol trapping and is gradually reducing endosulfan use, now applying half the dose of former times and usually only one application. He samples plots annually and sprays in plots exceeding 5% CBB levels, starting with the most heavily affected parts. In his view, endosulfan is '100% effective' compared with biological products but also costs more than other control methods, notably trapping. Farmers and support organisations described that endosulfan use remains common among non-certified farms, especially in El Salvador, with 2 or 3 applications at full dose quite usual and often without sampling to check CBB levels.

Of the interviewed farmers who have used endosulfan, two find it effective while one often experienced poor control of the borer, noting it was difficult to apply it at exactly the right time. One farm manager no longer using endosulfan highlighted its operational disadvantages of being prone to rain wash off or not always achieving good kill. Many farmers stressed the issue of endosulfan poisoning risk (see document on 'Endosulfan Poisonings and Other Issues').

Endosulfan was legally for sale in both Nicaragua and El Salvador at the time of the interviews in July 2013. In August 2013 the Salvadoran government announced plans to prohibit its use but it is not yet clear whether this will turn into law. No other chemical active ingredients for CBB were mentioned by farmers, agrochemical stores or support organisations.

Endosulfan was the only insecticide active ingredient mentioned by farmers for use against CBB. Prices varied somewhat from US$6.60 per litre in one Nicaraguan agrosupply store to US$11 in another in a more remote town. Collaborators' estimates for current price of products in El Salvador were US$9-10 per litre. Appendices A and B give information on agrosupply stores' advice on use and label instructions on the most frequently recommended brand.

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The information collected during the interviews demonstrates clearly that it is technically and economically feasible for farms, both large and small scale, to rapidly eliminate endosulfan use without incurring penalties in terms of productivity or quality. Certified farms in Nicaragua and El Salvador have managed to stop use of endosulfan, and indeed any other insecticide, for CBB control, by using traps baited with methanol/ethanol, in conjunction with good cultural controls. Some are also using *Beauveria* biopesticides.

Table 2. Summary of chemical use for CBB control as reported by farmers interviewed in Central America

Farm	Any recent use of insecticides for CBB control?	Active ingredient, dose rate and frequency	Estimated costs & other comments
Farm A (medium)	No. Never used.		
Farm B (medium)	No. Never used.		
Farm C (small)	No. Never used since converting to organic in 1999.		
Farm D (small-medium)	Once since converting to organic in 2004	Calcium sulphate fungicide	Applied this once in a year of unusually high CBB attack and it seemed to have some repellent effect.
Farm E (medium)	No. Never used, even in one outbreak year.		
Farm F (small)	No. Not used since converting organic in 1997.		
Farm G (small-medium)	No. Not used since converting organic in 1998.		
Farm H (small)	No. Not used since converting organic in 2007.		
Farm I (large)	Yes. Regular use for many years. Used to apply at full dose but has been able to reduce dose after introducing methanol trapping method on farm since 2011.	Endosulfan at half dose of 0.5 litre per manzana (=710ml per ha). Adds 200cc of sticking agent per barrel, to protect against rainwash. One application during Jul-Aug period is sufficient. This year applied preventative spray in Jun in plots with early-maturing variety, which is more susceptible to CBB.	Cost at least US$26.96 per ha (US$6.39 in product + US$20.57 in labour) + cost for sticker. Endosulfan application is considerably more expensive than using traps. Applies endosulfan based on annual plot sampling (5 trees per ha, counting 20 berries per tree) where CBB incidence exceeds 5%. At 3-4% you need to wait and see if attack worsens.

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		Starts spraying on most infested plots according to sampling around 90 DAF, and least affected plots done last. Takes 4.26 person days to spray 1 ha.	Best to spray when borer is just entering flesh, as it's harder to kill once inside the bean.
Farm J (large)	Not since 2011 when endosulfan prohibited on Rainforest-certified farms.	Dose used: 1.5 litres endosulfan per ha for coverage of dense groves. Used to apply endosulfan twice per season: in early Jun when the berries filling out and then 4-6 weeks before harvest. You must not spray endosulfan just before harvest or the beans will be contaminated and possibly rejected by mills for residue problems.	Costs for 2 applications per year using 4.26 person/days per ha in labour for each spray: US$68 (US$30 in product + US$38 in labour) Considers endosulfan use expensive, although it can be very effective. Two disadvantages experienced: Endosulfan easily washed off by rainfall, meaning a repeat spray needed, at further cost. Effectiveness not always reliable if CBB 'becomes resistant' & further application needed if % level increases. Considers trapping much more reliable, cheaper and easier.
Farm K (small-medium)	No.		Not used endosulfan or other insecticides for CBB as too expensive.
Farm L (medium)	No. Used endosulfan only once some years ago when CBB outbreak in zone. Occasionally applies cypermethrin for mealybug control in a few trees.	Dose at least 0.7 litres per ha. Those farmers who use endosulfan apply 2-3 times per season.	Cost US$10.65 per ha per application, incl. labour but excluding diesel for motorsprayer and equipment maintenance. Considers cost expensive in comparison with trapping. One fellow co-op member was expelled for repeatedly spraying endosulfan after it was prohibited by Fairtrade.
Farm M (small-medium)	No. Used to apply endosulfan until it was prohibited by their co-op.		He often found endosulfan ineffective, despite claims of salesmen. It's not easy to apply at exactly the right time, when CBB is flying or attacking berries but not inside the bean. Experience is that trapping is much more effective and cheap.

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Summary from on-line survey responses (global)

Only 13 of the 50 survey responses mentioned use of chemical control (either synthetic insecticides or botanical products).

Insecticide active ingredients reported in use for CBB

A relatively short list of insecticides are mentioned by respondents as in use, including seven synthetic insecticides (endosulfan, three organophosphate compounds, two diamides and one pyrethroid) and one botanical preparation. Chlorpyrifos was the most frequently reported (8 of 13 respondents) while two reported endosulfan. Appendix C summarises the active ingredients reported, their pesticide groups and countries reporting their use. One Brazilian respondent mentioned producers were replacing endosulfan with chlorpyrifos and sulphur (a fungicide so its use in CBB control is unlikely) but this was much less effective than endosulfan.

Hazard data of these active ingredients are provided in a separate document ('List of chemicals reported as in use or under registration and their Highly Hazardous Pesticide status'). Of the eight compounds reported in use, five qualify as PAN Highly Hazardous Pesticides (for a range of acute, chronic or environmental hazards), with the exception of the botanical ingredient azadirachtin and the two new diamide family products. The latter two are very new products, only registered in US and EU since 2008. They are now registered and on the market in Colombia, while their Brazilian registration is still in process.

Application frequency and dose rates

In terms of application frequency, most respondents reported one or two sprays per coffee season, with a couple stating that up to four or five applications might be needed. Appendix C summarises the information on frequency and dose rates reported.

Note that almost all the respondents highlighted the need to monitor the coffee groves to check CBB infestation levels and to use some form of economic threshold or other tool to decide on whether CBB levels warrant an application. In Brazil and Colombia CBB levels exceeding 2.5% to 3%, as determined by field sampling, trigger action but also depend on the position of the CBB female within the berry (if the beetle has already bored into the developing bean, the damage has been done and there is little point in spraying. Few insecticides are able to kill CBB once they are inside the bean, as opposed to tunnelling through the berry flesh). Other respondents mention spot treatments or other means of deciding on whether chemical control is needed.

Clearly, respondents are well aware of the need to limit insecticide use and employ good field monitoring for decision making. How well farmers themselves may be doing this is another question, especially as sampling for CBB can be complicated, time-consuming and requires good, practical training.

Application costs

It is hard to obtain good estimates of pesticide application costs from such a short on-line survey. Appendix C summarises the little data received. Most respondents just give a cost per litre of product or per hectare application but do not include labour costs of the spray operator or any equipment hire or depreciation. Some also mentioned use of sticking agents or other adjuvants into the spray mix to improve application effectiveness. Pesticide

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purchase costs will vary considerably between countries according to many factors. None of the respondents mentioned cost as being an obstacle to farmers' use of pesticides.

Effectiveness of chemical control

Views on the effectiveness of chemical control varied, with equal numbers of respondents reporting 'high' and 'reasonable' effectiveness across different compounds (Appendix C). It is interesting that the same compound can receive different rankings even within a single country. Both respondents reporting endosulfan ranked it as 'Highly Effective'. For the most frequently reported insecticide – chlorpyrifos – rankings varied from 'Highly' to 'Reasonably' to 'Not Very Effective'.

Respondents' reasons for their rankings are not known and could relate not only to their experiences in CBB management, the type of farmers they work with but also their personal views on the desirability or not, of pesticide use. Several highlighted that effective chemical control can only be achieved with good equipment, well-trained staff and with careful pest monitoring, especially accurate timing to spray when the beetles are in a position susceptible to chemical exposure. The importance of cultural controls as the key IPM tactic was stressed by one respondent.

Views of experts consulted and issues for consideration

Dr Peter Baker from CABI Bioscience provided feedback on draft project summaries and to specific questions, based on his lengthy experience working in Colombia and elsewhere on CBB IPM:

- It is important for full costs to be considered for chemical (and biopesticide) applications. This should include labour, spray equipment costs, maintenance, etc. In terms of labour, costs may increase considerably for plots far from a water source. Hundreds of litres of water may have to be transported manually per spray round.
- Regarding the new cyantraniprole product promoted in Colombia, on the face of it, it seems implausible that one treatment would be enough, especially for Colombia that has a bimodal harvest. That would seem to suggest that it has a very prolonged systemic effect which would therefore end up in the harvested bean. This needs further clarification by DuPont but at US$137 per litre, it's not very plausible that anyone would use it.
- The vapour activity of endosulfan is probably part of its success as a CBB control chemical, because it can kill CBB even with a poorly conducted application, using bad equipment or incorrectly timed. In other words, you can manage to get control with a lousy application, which would not be effective if you were using other insecticides.

Peter also gave responses to questions arising during the project:

Question: Some farmers talked about CBB becoming resistant to endosulfan because an application was not effective. Is this the likely reason and how widespread is any CBB resistance to this insecticide?

Answer: There is some evidence of endosulfan resistance in New Caledonia coffee (Pacific islands). It could be there is some resistance in El Salvador where this farmer has had efficacy problems, especially if there is a long history of regular use. However, we would expect any endosulfan resistance genes to spread very rapidly through the CBB populations, because the borer mates incestuously, and there doesn't seem to be any evidence for very rapid spread of resistance in the field.

The much more likely reasons for cases of ineffective applications are to do with badly timed spraying [i.e. the borer is already out of reach inside the bean], poorly calibrated spray equipment which does not give adequate coverage or of poor quality or even fake products. There is very widespread concern among farmers in general of the quality of agrochemicals including fertilisers.

Dr Carmenza Góngora from Cenicafe research institute in Colombia has worked on various aspects of CBB control (see her presentation at the project lessons workshop for more details):

- Be aware that insecticides and fungicides affect biological control agents for CBB including parasitic wasps, predatory insects and fungal pathogens such as *Beauveria*.
- Cenicafe research in 1995 found that the above organophosphate family insecticides were as effective as endosulfan. Currently Cenicafe recommends only 3 active ingredients for CBB control: chlorpyrifos; fenitrothion; and phenthoate, and *Beauveria* biopesticide. Always following extension advice on calibration and spraying practices.
- During 2010-2013 they collaborated on trialling a range of new molecules and found that two of these are as effective as the recommended organophosphates with the longest effect duration and lowest toxicological category. These are:

  Cyantraniliprole (diamide family). Activates rianodine receptors which are important in the process of muscle contraction and opening of sodium channels. It triggers paralysis in insects and this stops feeding activity and then causes death. Product Preza® with the branded ingredient Cyazypr®.

  Chlorantraniliprole (diamide family). As above. Product contains the branded ingredient Rynaxyzypr®.

  Thiamethoxam (neonicotinoid family). Affects acetyl-cholinesterase neurotransmission processes. Product VoliamFlexi® contains Rynaxyzypr 200 + Thiamethoxam 100.

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Appendix A: Experience and advice from technical support organisations and pesticide retailers

COEX estates & coffee traders, El Salvador: Endosulfan used to be their first recommendation for CBB control, when levels exceed 5%. It was simple and effective, applying 1.4 litres per ha, or possibly reduced to 700cc, with 1-2 applications per season. Since Rainforest standard prohibited endosulfan in 2011, certified farms have had to look for alternatives. CoEx has not found any effective chemical substitute which can be used without problems with the standard requirements. Using organophosphates, such as chlorpyrifos, is not a solution for certified farms as it's merely replacing one hazardous chemical with another. *Beauveria* biopesticide is the only viable alternative for spraying.

Many uncertified farms in El Salvador still spray endosulfan, regardless of whether they have CBB at problem levels or not, often without even sampling plots but by calendar in May-June. Agricultural stores sell it without even the legal restrictions. CoEx has found trapping works out much cheaper than using chemicals, from experience on their own estates and on certified farms who sell to them. Endosulfan use is not cheap – at least US$42 per ha per application, plus costs for spray equipment and protective gear for the workers. Use has dropped a little in the country with current low coffee prices but it is still the main control method for many farmers. CoEx recommendations are now to use cultural methods, traps and maybe some *Beauveria*, and only consider chemical use as a last resort.

***Exportadora Atlantica, Nicaragua*:** They recommend general monitoring for all pests and diseases. Certified farmers need to keep CBB levels below 5%, preferably less than 3%. The pesticide requirements of the certification schemes, along with the Nespresso programme which demands zero endosulfan use, are all helping to reduce endosulfan use and of other pesticides prohibited by private standards in this coffee production area, not just among the certified farms but more widely. The company advises all its client farmers not to use endosulfan because of the health risks and insists on justification of any pesticide application. Their technical staff will check the agrochemical stores of any non-certified farms to make sure they have no endosulfan containers in use. They've noticed far less endosulfan on farms recently than in earlier times. The company promotes good cultural controls, use of trapping and good monitoring as the main methods to combat CBB.

SOPPEXCCA co-operative, Nicaragua: The prohibition of endosulfan by Fairtrade since 2005, along with some other pesticides, was the stimulus for the co-op to work with their members to stop use and start exploring other IPM methods for CBB. They have promoted methanol trapping in the last three years with excellent results in districts where cultural controls alone may fail to keep CBB under 10% levels in some seasons.

Formunica agrochemical supplies company, Jinotega town, Nicaragua: Salesperson recommends only endosulfan for CBB control and no other insecticides. Endosulfan is restricted to coffee use in Nicaragua and not for other crops. Company formulates their own endosulfan product Endosulfan Formunica® 35EC from technical material from King Tech Corp, China. Retail price is US$6.60 per litre. The store's recommended dose is 0.5 litres per half manzana (1.42 litres per ha). Product label recommends 1.4-2.0 litres per ha. Salesperson usually recommends just one application, around late July when first berries start to suffer attack. Cautions that this is a toxic product and farmer must take care to prevent worker exposure, especially when using motorised sprayers.

Agrocanales agrochemical supplies company, Jinotega town, Nicaragua: Salesperson recommends endosulfan for CBB control, Fenix® brand 35EC from Biochim Costa Rica. The store's recommended dose is 0.5 litres per half manzana (1.42 litres per ha). Product retail price is US$8.33 per litre. This product is very popular and fertiliser can be tank-mixed in same application. They also sell this endosulfan product for mealybug in coffee and for caterpillars in onions and tomato. Caution

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that care must be taken and follow instructions. Salesperson is aware that some coffee farmers report quite good results with dimethoate and cypermethrin products against CBB but the store does not recommend those products. Store sells filter face masks and protective clothing and some coffee farmers buy these. Cost of full protective kit (mask, gloves, eye shield and cloak is US$27).

ProAgro supply store, San Juan town, Nicaragua: Recommend endosulfan for CBB, Fenix® brand 35EC from Biochim Costa Rica. Retail price is US$11.66 per litre or available at a cheaper unit rate in 20 litre packs. Person minding store while owner was out could give no information on use.

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Appendix B. Information on newly available insecticide cyantraniliprole in Colombia

DuPont Colombia's newly launched product Preza® (active ingredient cyantraniliprole) is recommended for CBB control at 1.5 litres per ha, with one application per season, from 90 days after flowering. The company recommends application when CBB levels exceed 2% but before the borer enters the bean.

Cyantraniliprole's mode of action disrupts muscular function, affecting many of the insect's activities, including boring, feeding, locomotion, egg-laying and flight. This insecticide works most effectively by ingestion or contact with its mouthparts when the borer tunnels its way through a small amount of treated berry tissue, as well as by contact with treated surfaces. Unlike chlorpyrifos or other contact insecticides, it won't kill CBB immediately but takes around 3 days. However, within 2 hours of ingestion, insects will stop boring and become unable to fly away. The sales literature for Preza® highlighted that farmers will not see the immediate death of borers affected and many borers hit will simply 'disappear' by falling off berries as their movement becomes disabled. These observations should be considered when assessing whether an application has been effective or not.

The DuPont technical salesman interviewed explained that at US$137 per litre, Preza® costs ten times more per litre than many chlorpyrifos products, however, dosage is only 1.5 litres per ha, rather than 3 litres for chlorpyrifos, and one well timed application may be sufficient if the farmer also does good cultural controls. He reported that many farmers reliant on chemical control will spray 2-3 chlorpyrifos applications per year and some make even more preventative applications of chlorpyrifos, up to once a month during susceptible periods, indicating they are not managing their chemical control strategy efficiently.

Other advantages promoted by DuPont are that this systemic product will not suffer rain wash; it poses minimal oral exposure risk for humans; and won't affect *Beauveria* fungus or parasitic wasps useful for CBB control. It is promoted as compatible with CBB biological control agents and with minimal oral exposure risk for humans but it is highly toxic to bees and must not be used during major flowerings or when bees are active.

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Appendix C: Responses to on-line survey questions on chemical use

Table C.1. List of active ingredients mentioned by respondents

Active ingredient	Pesticide group	Countries
Azadirachtin	Botanical based on neem seed extract	Brazil; India
Chlorpyrifos	Organophosphate	Brazil; Colombia; India; Vietnam
Chlorantraniliprole	Diamide	Brazil *in process of registration*
Cyantraniliprole	Diamide	Brazil *in process of registration*
Endosulfan	Organochlorine	Brazil; Honduras
Etofenprox	Pyrethroid	Brazil
Fenitrothion	Organophosphate	Colombia
Phenthoate	Organophosphate	Colombia

Table C.2. Application frequencies and dose rates reported

Active ingredient	Frequency	Countries	Dose rate
Azadirachtin	Twice per season* 1-2 per year as spot treatments*	Brazil India	800 ml per ha Neem Seed Kernel Extract (5%) 50ml per l + Neem oil 5ml/ l + detergent powder 1gm/l
Chlorpyrifos	One per season* 1-2 per year 1-2 per year* 1-4 per year* 1-5 per year*	India Vietnam Brazil Brazil Colombia Colombia Colombia	600 ml per 200 l water 1 l per 200 l water. 2 l per ha 5-7cc per l 1 l per ha 6cc per l
Endosulfan	One per season* 1-2 per season*	Brazil Honduras	1.5 l per ha
Etofenprox	Twice per season*	Brazil	
Fenitrothion	According to monitoring*	Colombia Colombia	5- 7 cc per l 1 l per ha

**indicates respondent mentions monitoring and/or thresholds for decision making*

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Table C.3. Pesticide application costs

Active ingredient	Country	Cost in US$ equivalent
azadirachtin	Brazil	57US$ (R$ 128.00) per l
	India	6 US$ (Rs. 350/kg) per l
chlorpyrifos	India	6 US$ (Rs. 350) per l
	Brazil	US$20 per ha per application
	Colombia	US$13 (C$ 25000) in labour + US$ 18 (C$35.000) per l
endosulfan	Brazil	US$ 13 (R$ 30) per ha
	Honduras	US$ 34 per ha (500.00 Lempiras per mz)
etofenprox	Brazil	US$20 per ha per application
fenitrothion	Colombia	US$16-26 (C$30,000-50,000) per l

Table C.4. Respondents' views of effectiveness of insecticides

Country/Case	Effectiveness
India (a) and (b) (azadirachtin)	Highly Effective.
India: (a) and (b) (chlorpyrifos)	Reasonably Effective.
Vietnam (a) (chlorpyrifos)	Reasonably Effective
Brazil (a) (chlorpyrifos)	Highly Effective. Applied when CBB levels exceed 2.5% and adults in berry flesh.
Brazil (c) (azadirachtin)	Not Very Effective. Cannot achieve adequate level of control.
Brazil (d) (endosulfan)	Highly Effective. Gives approx. 99% control if applied when CBB levels exceed 3%
Brazil (e)(chlorpyrifos)	Not Very Effective. Results are just 40 to 60% of control, and it's more expensive than endosulfan
Brazil (f) (etofenprox)	Reasonably Effective
Brazil (g) (chlorantraniliprole; cyantraniliprole)	Highly Effective. Chemical application at the correct time is the most efficient method of CBB control.
Colombia (a) (chlorpyrifos; fenitrothion; phenthoate)	Highly Effective only if good cultural controls are carried out too. Relying on chemical control alone would require many sprays a year.
Colombia (b) (chlorpyrifos; fenitrothion)	Reasonably Effective. Equipment must be well calibrated and spray operators well trained and application timed well according to CBB position in berry.
Colombia (c) (chlorpyrifos; fenitrothion)	Reasonably Effective.
Honduras (a) (endosulfan)	Highly Effective

Colours refer to ranking of: Not Very Effective (red); Reasonably Effective (yellow); and Highly Effective (green).

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