Experiences using traps with methanol-ethanol attractant for CBB control and other physical control methods

Content

Summary assessment of criteria for methods using traps

Criteria	**Physical Control based on traps with methanol-ethanol attractant**
How effective is it in controlling CBB?	Can capture large numbers of emerging CBB adults and reduce attack rate and reproduction on the new season berries BUT only in regions with a defined 'off' or dry season when no developing berries are present in the grove for several weeks. 46% of farms interviewed in Central America are using methanol traps since 2011 with very satisfactory results. 22% of Colombian farms use traps but only for monitoring borer flight periods or for capturing CBB at processing stations. 26% of global survey respondents rated trap use *Very Effective* and 32% as *Reasonably Effective*.
How much does it cost?	Much cheaper than insecticide application cost if home-made trap type (empty, plastic bottles), rather than commercial type, used. *Central America*: Alcohol attractant + dispenser approx. US$0.29-0.60 each, equivalent to US$ 5-13 per ha for home-made traps, at recommended densities. Commercial traps cost US$2-4 each, incl. attractant. On large farms, trapping costs US$14-20 per ha for trap + labour, compared to US$ 70-84 for standard 2 applications of endosulfan (product + labour only)
How much labour time does it need?	Labour includes making traps from empty plastic bottles, inserting attractant, placing in grove. Then checking traps every 2-3 weeks to empty water and dead insects and refill dispenser if necessary. Approx. 1-1.5 days per ha for trap production, placement & checking.
How easy is it to implement?	Very easy once farmer and workers have been shown how to manage the traps. Much less arduous and much safer work than handling pesticides. Methanol and ethanol are not available for public retail due to ingestion hazard

	so attractant dispensers can only be obtained from technical support organisation or farmer co-operative. Supplies must be stored out of reach of children or alcoholics. Empty 1-3 litre plastic drinks bottles easily collected and trap construction requires only simple tools and materials.
Does it need much training before it can be used?	Not really. Farmers quickly understand the idea and will adapt trap density and distribution, e.g. to increase coverage in CBB hotspots or next to abandoned plots. Use of traps to monitor CBB flight patterns and estimate numbers requires some training on use and interpretation of results.
Other key points	Good cultural controls are the backbone of any effective IPM strategy. Traps will not work well or cost-effectively without grove sanitation. If post-harvest clean-up is poorly done, traps may be insufficient to keep CBB population levels under control at the start of the following season. CBB females will always prefer developing berries to the attractant so the traps won't work for mass capture if green berries are already present. Traps must be placed in plots before CBB females start to emerge (at the start of the rainy season in Central America) and at the correct height (around 90cm) to target CBB flying up from berries on the ground. Several farms have successfully reduced or eliminated endosulfan use by adding trapping to cultural controls in the last 3 years.

Criteria	**Other physical controls**
How effective is it in controlling CBB?	These include: closing or covering sacks of berries at field collection points and pulping station, often with plastic smeared with grease or oil, to capture adults emerging from harvested berries; plastic or other smooth lining to delivery bins at pulping machine (so no borers trapped in crevices to escape later); filters on waste pipes to capture any live adults in pulp; trap trees or greased plastic sheets near processing station and pulp pit to capture any flying adults. Paths between plots, field weighing points and pulping/processing stations often have high levels of CBB. These methods can help reduce numbers of CBB escaping from picked berries or pulp and reduce re-infestation of other plots. 77% of Colombian farms interviewed are using some form of physical methods at processing stations and during picking.
How much does it cost?	No cost info but methods require very little expenditure. Small farms can easily afford plastic coverings.
How much labour time does it need?	A little for initial installation of filters, coverings, etc. and minimal maintenance.
How easy is it to implement?	Very easy.

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Does it need much training before it can be used?	No. Farmers can easily learn the techniques from illustrated leaflets. May require some worker instruction and supervision as part of good picking practices.
Other key points	Not a major control method but farms aiming to minimise CBB damage, especially if reducing chemical control, highlight the usefulness of these small measures to stop preventable CBB movement from one site to another during normal operations. Maybe of more importance in regions with continuous pickings and frequent movement of bored berries.

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

Using methanol attractant traps as a control method (rather than for monitoring CBB flight activity) was only reported from farmers in Central America. Trapping to reduce CBB colonisation of developing berries only makes sense in regions where there is a definite dry season and one main flowering period. The traps can attract significant numbers of colonising CBB in the dry season when there are no green berries at the right stage for attack. As soon as green berries at the attractive stage or ripening berries are present, CBB will be more attracted to these than the methanol in the traps.

In Colombia, where there is more continuous flowering and therefore at least some berries at the attractive stage in most of the year, CBB will not be much attracted to traps. Traps in Colombia are only really useful as monitoring tools to identify when high numbers of CBB are flying.

Table 1 summarises use of traps among the 13 Central American farms visited. Five of these are regularly using traps and a sixth has used them several times in earlier years. Overall, 46% of those interviewed have made use of traps. All but one of these have only recently begun trapping in the last two years, through promotion programmes by farmer co-ops or exporters. In addition, the Salvadoran export company interviewed is using traps on its own estates. Users include large, medium and small-scale farmers.

Trap types and placement

All farms regularly using traps have opted to make their own trap containers, using empty soft drinks bottles, rather than the commercial traps available. The reasons are partly due to (i) cost, as the commercial traps cost US$2.00-4.00 each, and (ii) also to problems experienced with theft or deliberate damage. The red plastic Brocap® commercial traps are seen as attractive by children and farmers recount incidents where workers, children or other local people have taken traps from the trees to play with or use for other purposes (e.g. the

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funnel). Farmers report that collecting and making the home-made traps from drink bottles is quick and simple.

Farmers are either collecting empty drinks bottles of 1-3 litres themselves, or paying a very small amount (US$0.04 per bottle) to local people or schoolchildren to collect these, if they require large numbers.

Salvadoran research institute PROCAFE explains that home-made traps will not be as effective in trapping CBB as the commercial model so they recommend to increase the density from 17 per ha (about 24 metres apart) to 26 per ha (about 14-15 metres apart) if using home-made versions. One farm is using at 28 per ha, a second at 17-20 per ha. In Nicaragua, the co-op's recommendation is for 22.7 per ha. One farmer is using this density, while two others have increased numbers to 25-28, with one using 35 per ha in a few hotspots. Most place traps throughout groves with trees of an age likely to suffer borer attack and three farmers use more traps in pest-prone areas or where CBB invasion is likely from poorly managed or abandoned neighbours' plots.

Costs and labour requirements

Costs for the methanol-ethanol attractant and dispenser in El Salvador are US$0.40-0.60 each, equating to around US$13.00 per ha at the recommended density of home-made traps. In Nicaragua, SOPPEXCCA co-op supplies methanol and ordinary plastic medical syringes at US$4.73 per hectare use, equivalent to US$0.29 per trap.

Labour requirements include making the traps, hanging these in the trees and checking regularly to clean out water and dead CBB and refill the dispensers with attractant if necessary. Farmers report they check the traps every 2-3 weeks and may need to refill dispensers between one and three times over the trapping period.

Estimates for time required for all these tasks vary from around 0.9 to 1.4 days per ha equivalent. For example, one medium farmer estimates that for 360 traps it takes 2 person/days to make traps, 6 days to place them out and a further 5 for checking and refilling.

All farmers considered the labour requirements to be quite low and especially in comparison with the labour-intensive nature of insecticide application, which can take 5 person/days to spray 1 ha. In total cost terms, farmers all highlighted the cheapness of trapping. Large estates estimated trapping costs of around US$14-20 per ha for product and labour, compared with US$35-42 for one application of endosulfan (excluding equipment costs, PPE and diesel for motorised spraying). Many farms using endosulfan will apply twice per season. Two farmers emphasised that trapping delivers a more certain effect than insecticide spraying, which may need to be repeated if incorrectly timed or washed off by rain.

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Trapping results

Farmers all reported good or excellent results from trapping, with visible results in terms of large numbers of CBB caught. One large estate has been able to eliminate endosulfan use since using traps and, in combination with cultural controls, has reduced CBB incidence, which used to be quite high, and no longer has coffee quality problems. One large, uncertified estate interviewed has reduced their endosulfan use to half dose application since using traps.

Two medium farmers reported that using traps has helped enormously in controlling CBB on their farms where infestation levels were quite severe, even when spraying endosulfan. One small farmer has found trapping a simple, effective and affordable method for people like herself who cannot afford to buy insecticide. It should be noted that all farmers are adding trapping to their existing cultural controls.

Availability and hazard considerations

All farmers using traps are obtaining the methanol-ethanol through their co-op or the export company buying their coffee and providing technical support. Availability of the attractant is one constraint for farmers who are not part of an organisation's trapping promotion campaign, as it cannot be purchased in retail stores, either agricultural or pharmaceutical. Two other farmers met would be keen to use traps if they could get hold of the attractant.

Methanol can be very harmful if ingested and for this reason its public sale is restricted. In El Salvador the promoting organisations add colourant to reduce risk of accidental ingestion and an emetic to induce vomiting. There is an issue that alcoholics may steal methanol and care needs to be taken to keep even the small amounts of methanol needed stored under lock and key. Some farmers apply only 2cc per trap to avoid any theft problems.

Table 1. Central American farmers' use of trapping

Farm	Trapping use?
Farm A (medium)	Has heard of BroCap traps but has never used
Farm B (medium)	Has never used traps but some people locally use them
Farm C (small)	Has used 6 commercial traps in recent past
Farm D (medium)	Has heard of traps but has never used
Farm E (medium)	Has heard of traps but has never used
Farm F (small)	Has never used
Farm G (small)	Aware of traps and would like to use but attractant not available in his area
Farm H (small)	No mention of traps

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Farm I (large) Uncertified	Using traps since 2012 and these are combined with endosulfan use (reduced)
Farm J (large)	Using traps since 2011 and these are now an important part of his IPM strategy
Farm K (small-medium)	Using traps since 2012 and these are now an important part of her IPM strategy
Farm L (medium)	Using traps since 2012 and these are now an important part of his IPM strategy
Farm M (small-medium)	Using traps since 2012 and these are now an important part of his IPM strategy

Summary from on-line survey responses (global)

Trapping of adult female CBB when they disperse to bore new berries is reported in numerous countries in Africa, Asia and Latin America, with varying effectiveness. None of the survey respondents recommend trapping alone as the best way to control CBB, but many indicate it can play a very useful role, especially when combined with cultural controls.

Most methods use home-made or locally made traps from empty soft drink PET plastic bottles (2 or 3 litre size), using some form of alcohol as a scent attractant for the female beetles. Bottles may be painted red as an additional visual attractant. Most countries use methanol or ethanol or a mixture as the bait, although in Tanzania farmers now use local banana beer. In Peru, users also add coffee essence to the alcohol.

Bottles are hung around 1.2-1.5m height and part filled with water or soapy water to drown the trapped females. CIRAD research institute in France is promoting its Brocap® superior trap design with special dispensers for the attractant, notably in El Salvador and Indonesia. Respondents from Honduras and Mexico report using a CBB attractant, sold commercially.

Traps are placed generally after harvest to trap females emerging from any bored berries left on the ground and around 60 days after the main flowering period, when the next generation of females will start to emerge during the first rains. Respondents are using widely different trap densities in different countries and even within countries (see Appendix C) but the average seems to be around 20 traps per hectare.

All respondents mentioning use of traps, with the exception of those in Colombia, discuss their effectiveness, or not, as a control method. The Colombians say that trapping does not reduce CBB levels but is very useful as a decision-making tool, to know when females are dispersing and therefore help in accurate timing of insecticide or biopesticide application. Respondents' views of whether trapping is an effective control method vary considerably. Of 31 responses mentioning trapping, 8 rank it as 'Very Effective'; 10 as 'Reasonably Effective'; 5 as 'Not Very effective'.

Costs for the traps and attractants vary but most respondents view trapping as a very low cost and easy to use method, affordable by smallholders in most cases (with the exception of some Indonesian respondents using the commercial traps).

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Some respondents report trapping in wide use (Table 2) but it is hard to judge whether this is overall within a country or within a specific IPM programme or company project in which they are involved.

Table 2. Promotion of trapping reported from different coffee countries

Tanzania	Widely taken up by both estate and smallholder sectors.
Mexico	10+ years' promotion and subsidy by federal/provincial Depts. of Agriculture. Big claims for success of cultural control and trapping in eliminating insecticide use
Brazil	Seems more of a smallholder method, reported as cheap and easy.
Colombia	National recommendation but as a decision-making tool only.
Honduras	Promoted by national coffee institute IHCAFE.
Peru	Promoted in context of 'almost organic by default' smallholder, shaded production.
Indonesia/Vietnam	Recent introduction/promotion, but cost and time for almost daily checking [why so frequent?] seems an obstacle to wide uptake.
CIRAD institute	Promotion in El Salvador, Indonesia, Guatemala as part of specific non-chemical IPM strategy for shaded coffee with tall trees, along with branch stripping, shade regulation and grove hygiene.

Other forms of trapping or other physical control methods

Six of the 9 Colombian farmers interviewed mentioned using some form of trapping during picking, at the pulping stations or as a monitoring tool (Table 3). Central American farmers did not mention these methods.

Table 3. Colombian farmers use of traps and other physical control methods

Farm	Methods reported
Farm A (small)	At harvest time uses a piece of black plastic smeared with burnt oil to cover the baskets full of cherries at the pulping station or field collection points, to prevent live CBB dispersing. Lines wooden berry delivery funnel at pulping station with plastic so that easily washed and no cracks for live CBB to hide in. Has used a few home-made traps, with methanol facilitated by exporter group, in the past for monitoring and a little control.
Farms C & E (medium)	Use plastic-lined or tiled delivery funnels at pulping stations [rather than unlined wooden boards] and take care to wash these down after each pulping to remove any CBB.
Farm H (large)	Use methanol traps in pulping station to trap any flying CBB in pulp. Plant a coffee tree 5m from pulping station as a trap tree, leaving all the berries to attract any CBB from collected berries or pulp. Then apply *Beauveria* regularly to tree to kill these.
Farm G (small)	Uses one methanol trap for monitoring purposes to identify when CBB migration period is taking place in grove.

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Several survey respondents also reported physical control measures during picking and at processing stages. Some recommend that the farmer soaks the berries first to identify and separate out any 'floaters' which should then be burnt or boiled to make sure any surviving borer adults, larvae or eggs are killed. Several mention controls for pulp, e.g. keeping pulp in plastic bag for at least a period of two weeks to kill any CBB emerging and then using it for compost.

One survey respondent mentioned a new physical control method under testing in Hawaii. This method uses kaolin (a type of clay) to control CBB. Kaolin WP (wettable powder) is mixed with water, adding a surfactant to improve coverage, and sprayed on the young berries at near-drip volumes. This seems to discourage the female CBB from entering them, possibly related to the clay masking the attractive odours released by the berries. Latest results from farms at different altitudes have proven very promising, with CBB level reductions of 28-79%. Results will be published on the Hawaii university website via www.ctahr.hawaii.edu/site/CBB.aspx

Views of experts consulted and issues for consideration

PROCAFE Coffee Research Institute, Santa Tecla, El Salvador. Dr Adan Hernández, Technical Researcher (IPM).

PROCAFE have been experimenting with traps in collaboration with French research institute CIRAD for over 10 years, refining design and investigating effectiveness. The principle behind the trapping method is that adult female CBB is attracted to the odours released continually by coffee berries. The trap attractant [methanol+ ethanol] substitutes for this attractive odour – but only if you place traps in the grove when no berries are present. If developing berries are present, the borer will always be more attracted to the berries than to any traps.

PROCAFE promote trap use as part of their CBB IPM strategy and sell BroCap® traps and methanol-filled dispensers.

Attractant used: mixture of methanol and ethanol. They obtain ethanol in bulk from a national sugar refinery and the methanol from pharmacy companies which import it. In PROCAFE's labs they mix the two alcohols and add fuccinic acid (the pink colorant used in histology labs to colour tissue sections) as a warning signal and a bittering agent to stimulate vomiting, in case of accidental or deliberate ingestion.

Trap type: Supply commercial traps developed from CIRAD BroCap® design and methanol dispensers. Trap funnel is red as CBB proven in trials to prefer this colour. You'll still trap with a clear plastic one (as long as the attractant is there) but you'll trap more using a red trap. Large estates, as well as smallholders, may opt to make their own traps using plastic drinks bottles.

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Density: With BroCap® traps, they recommend 17 per ha (about 24 metres apart) but if using home-made ones, you should increase density to 26 per ha (about 14-15 metres apart).

Positioning: Traps need to be hung about 90cm above the ground, irrespective of the height of the individual coffee tree. If you put them near ground level or too high they won't capture many borers. You need to get the trap blades at the level the CBB is flying so it will hit the blades and fall in (natural defensive behaviour to curl up and 'play dead' on sudden impact).

Timing of trap placement: You need to target CBB flying in their migration period, from flowering onwards till 90 days after flowering. After 90 days there will be lots of berries maturing in the grove so the traps won't work anymore as CBB will be more attracted by the berries. Traps should be put out before the first rains, which trigger the main flowering period. In El Salvador this means during Mar-Jun.

Cost of traps and attractant: Dispenser of methanol-ethanol costs US$0.60 each.

Maintenance: Best to check water and replace every week, if possible, but some people do it once a fortnight. Takes around 2 months for alcohol to evaporate but depends on size of hole you puncture to activate dispenser. Farmer has to make a hole in each dispenser top with a needle but if it's a big hole, it will evaporate more quickly.

Labour requirements: Considers fairly low.

Effectiveness: Number of CBB captured is highly variable: 5,000-12,000 per trap maybe. The more berries left on the ground after harvest, the higher number you'll trap. Effective in helping to control CBB due to very defined flight period with 6 months rainy and 6 months dry seasons in El Salvador, and only 3 flowerings, one of which is the main period. In other countries with continuous flowering, traps would be for monitoring purposes only.

Views & perspectives:

- Methanol is harmful if ingested and it's not available 'over the counter' to the public for this reason. PROCAFE have equipment to safely fill dispensers. To address risk of anybody ingesting it by mistake, they add pink colouring to alcohol and an emetic to stimulate vomiting if swallowed.
- Adoption of trapping has been widespread in El Salvador and some other Central American countries, through joint PROMECAFE promotion work.
- One issue is the commercial traps are seen as very attractive and people steal them to cause problems, or maybe resell them.

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:

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- Trapping only measures ambient CBB populations -after a long dry season, there could be large populations in fallen berries waiting for rain to emerge. When they do emerge they will be trapped, and potentially in large numbers. The study by Bernard Dufour of CIRAD (Dufour et al., 2004) mentions catches as high as 15,000 per trap per day! That study suggests that they mostly have a good impact on borer populations but trapping seemed to be most effective where little other control was being made.
- Although the farmers interviewed didn't mention it, it is very likely that they are also using their traps as CBB 'monitors' [i.e. to see where they have problems and to what level] which might affect their other control operations.

- Regarding one of the Nicaraguan farmer experiences, who mentions each traps catch up to 250 CBB in the peak period, this is not a lot really. With 26 traps/ha that works out at one trap/190 trees, so this means trapping only around 0.1 CBB/tree/day. Trapping might still be cost effective though, but how much does it cost to trap one CBB?

Dr Bernard Dufour, expert on CBB trapping, from French overseas agricultural research institute CIRAD was also consulted. CIRAD promotes its patented BroCap® trap and attractant in several countries and carries out research on how best to integrate trapping with other CBB IPM methods across a range of coffee production contexts.

Experts' responses to questions about trapping

Peter and Bernard kindly provided responses to a set of questions arising about trapping during the project:

Question: *It seems from the survey responses that trapping + cultural controls are very effective in Mexico and these alone have allowed many Mexican farmers to eliminate insecticide use. What is it about the Mexican situation that makes this possible?*

Bernard Dufour: I don't know exactly the current situation in Mexico. But you can get information by asking Juan Francisco Barrera, CBB specialist at ECOSUR (Tapachula). His email is: jbarrera@ecosur.mx We currently co-direct a PhD on the subject of CBB dispersal.

Peter Baker: It could be that because of weather conditions, broca were only a minor problem anyway. A study in Mexico by Barrera et al (2006) could find no overall effect of mass trapping. They suggest that mass trapping is only effective when populations are already low, though Dufour's work seems to suggest the opposite.

Question: Is it correct that CBB sex pheromones (chemicals released by one sex of an animal species, usually the female, to attract the other sex for mating purposes) are being

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used in traps? Sex pheromones were mentioned by 1 Indian, 1 Honduran and 1 other respondent.

Bernard Dufour: To my knowledge, CBB is not attracted by a pheromone, but by one or more kairomones. There is often confusion between the words pheromone and kairomone. The kairomone most used in trapping is methanol which is synergized by ethanol.

Peter Baker: I don't think so, there are no long range sex pheromones known – why should there be when mating occurs mostly incestuously [inside the bean]?

Question: Do you agree that traps are only useful for monitoring purposes in the Colombian context? Why does trapping seem to work, at least partly, as a control method elsewhere across a range of cropping and agroecological contexts?

Bernard Dufour: CBB trapping in Colombia is probably ineffective for one reason: the coffee trees produce flowers and fruits throughout the year (due to the equatorial climate). This facilitates the continuous dispersion of CBB (dispersion over very short distance e.g. fruit to fruit). So trapping efficiency is not as good as in the tropical region, where the dry season is very long and where the peaks of migration are very high. Currently I am working on CBB trapping in Indonesia (equatorial). I face the same problem [continuously available berries] as in Colombia but I try to adapt the control depending on environmental conditions. My objective is to build a project in several climatic zones in order to adapt CBB control based on agro-climatic factors.

Peter Baker: Yes – the most likely reason in Colombia is that because of more continual rain, there is no single mass emergence when broca are out looking for scarce berries and encounter only traps. Colombia is fairly unique in this, there are multiple flowerings and year-round picking. For this reason too their broca problem is frequently severe.

Question: What is the likely reason for good or reasonable trapping effectiveness in some places and poor in others? Is this mainly related to sporadic or concentrated flowering period or other factors?

Bernard Dufour: We know that there are differences in effectiveness between trapping in equatorial and tropical regions, related to the phenology of coffee (production of flowers and fruits).We know that trapping in "full sunlight" cultivation is less effective than under shade (see ASIC 2010 presentation). We also know that in coffee cultivation under shade, it is necessary to involve trapping and complete elimination of residual berries on branches, in early dry season. Thereafter, the levels of infestation can be very low (see CIRAD leaflet on *Triple Action IPM*). In contrast, when branch stripping [removal of berries on branches after harvest] is not rigorous, infestation levels remain high. I had the opportunity to see it in Jamaica, where trapping associated with stripping performed at 50% (or less), generated very high infestations.

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Peter Baker: I don't know, the Brocap® traps seem to be superior because they include a couple of un-named terpenoids I believe.

Question: How useful could trapping be to enhance IPM strategies, especially in Brazil, to reduce insecticide use?

Bernard Dufour: The case of Brazil is very special: a large country with both equatorial and tropical zones. We find all sizes of plantations. So, trapping may be suitable for small and medium-sized plantations, preferably in combination with shade trees. Under these conditions, and in tropical zones, the triple-action IPM [promoted by CIRAD, see CIRAD leaflet on this method] should give good results.

For very large and highly mechanized farms, one can imagine a mechanized removal of residual berries, both on the ground and on the branches, without resorting to trapping. For others farms, new control techniques should be developed.

Peter Baker: Certainly for monitoring, they are useful, but I'm less certain about mass trapping. Proven cases of efficacy of mass trapping in insects are relatively rare, and in nearly all of these a sex pheromone is involved. At best I think we can say that mass trapping is worthy of further study for each locality.

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

Cenicafe's Brocarta extension leaflets published jointly with the National Coffeegrowers' Federation provide useful advice (in Spanish) on various physical controls which farmers can carry out to help reduce CBB dispersal and proliferation in their farms. These include cheap and simple actions such as:

- making sure sacks of berries at field collection points and weighting stations are closed tight to prevent any CBB escaping
- putting sticky plastic traps and coverings up at pulping stations
- fitting fine mesh filters onto pulp waste water outlets
- 'solarising' berries picked in sanitary collections, using plastic sheeting, to kill any live borers

Relevant *Brocarta* leaflets:

No. 40: How to avoid CBB dispersal during picking and pulping operations

No.37 Trapping adult CBB with attractants

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Suggestions for follow-up:

The farmers interviewed in Central America who have recently adopted trapping all reported very good experiences with these, in medium and high CBB pressure zones and on small, medium and large-sized farms. However, they have only been using traps since 2011 and generally in Central America these last three years have not suffered serious CBB attack. It would be useful to see how well the traps work in years of more serious CBB problems.

- ✓ Recommend multi-country trials with farmers on trap effectiveness, following a strict, standardised protocol and well monitored to ensure traps are set in the right way at the optimum time..
- ✓ It would be useful to make an assessment of CBB levels and bean damage levels at harvest in groves with and without traps. To make the comparison valid, groves would need to be very close together in very similar micro-climates and under identical agronomic practices.
- ✓ Get more data from a range of participating farms to understand the costs of trapping. For an effective IPM strategy it is important that each component pays for itself.

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Appendix A: Details of Central American farms' experiences with trapping

A1. La Consentida, Nicaragua (small farm, certified organic & Fairtrade, member of local co-op affiliated to PRODECOOP). Mrs. Maritza Colindres, Owner.

Trap type: Commercial

Density: every 10m in hotspot areas. Has just 6 traps for her 2.8ha farm [*equates to just 2.1 traps per ha, c.f. PROCAFE recommendation of 17 commercial traps per ha for whole plot coverage*].

Timing of trap placement: In September when some CBB emerging from berries and in March, after harvest.

Position: about 1m height

Cost of traps and attractant: US$2.00 per trap in 2011. No cost estimate given for methanol.

Labour requirements: Not much work needed but needs to be careful and methodical.

Maintenance: check once a week

Effectiveness: Good and they trap lots of CBB. Traps are not a major component of this small organic farmer's IPM strategy and cultural controls and *Beauveria* applicatio are more important for her.

Years experience in trapping: several

Views & perspectives

- Sometimes people will knock them over or take the trap

A2. San José, Nicaragua (small/medium farm, certified Fairtrade. Member of local co-op affiliated to SOPPEXCCA co-op). Francisca Gutierrez**,** Owner.

Trap type: home-made using empty 1-2 litre drink bottles, with 4 windows cut. Adds soap or detergent to water.

Density 22.7 traps per ha [this is density recommended by technical staff from SOPPEXCCA co-op]

Positioning: across whole farm

Timing of trap placement: May-Jun when coffee starts to flower and new berries begin to form. Traps capture CBB flying up from fallen berries.

Cost of traps and attractant: Equates to US$4.73 per ha, for methanol, supplied on credit by SOPPEXCCA co-op, along with syringes as diffusers. Zero cost for using empty drinks bottles, collected or saved.

Maintenance: Checks traps every 3 weeks to clean out and refill methanol and water.

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Labour requirements: Quick and easy to make approx. 100 traps for her 5.6ha farm.

Effectiveness: Good results -captures lots of CBB. She first used traps in 2012 and had fewer bored berries in her coffee harvest in 2012 and seems little CBB incidence so far in 2013 season after trapping.

Years experience in trapping: two years

Views & perspectives

- Received training via SOPPEXCCA co-op technicans on how to manage CBB and co-op members were encouraged to instal traps.
- Considers trapping a very good method and likes the fact that you can see lots of dead CBB.
- Trapping is cheap, very affordable for poor farmers like herself and you easily can make them yourself, collecting discarded bottles.
- Makes new traps each year as some get damaged, especially when bananas in her plot are harvested.
- Recommends farmers to start with trapping as a simple, cheap method to stop using endosulfan. Larger farmers are starting to use the method too.

A.3 Hermanos López, Nicaragua (medium farm, Fairtrade certified. Local co-op member affiliated to SOPPEXCCA co-op). Mr Bernardo López, Owner.

Trap type: Home-made using empty 1.5-3 litre bottles, with 4 windows cut. Adds detergent to trap water and doses syringe with 5-6cc methanol, using a string to suspend syringe.

Density 22.7 per ha is recommendation from co-op technical staff but farmer now placing closer - at 25.6 per ha - and increasing up to 35.5 per ha in most infested parts.

Positioning: Uses on 14ha of his 19ha farm. Puts traps closer in CBB hotspots, low-lying spots or where there's little wind to ventilate and as close as every 10m in rows next to neighbours' abandoned or poorly managed plots, to reduce CBB invasions. Important to make sure bottles are hanging perfectly straight and not leaning against branches, to avoid any CBB crawling out.

Timing of trap placement: in the dry season. Will catch only a very few CBB in rainy season as these will prefer the ripening berries.

Cost of traps and attractant: Pays US$0.04 per empty bottle of 1.5-2.0 litres. Methanol and syringes obtained on credit from co-op [at US$0.21 per trap worth]. Total cost for inputs at his density used =US$5.33 per ha.

Maintenance: Check traps every 15-20 days to empty and see if methanol needs refilling.

Labour requirements: For 360 traps on 14ha, estimates 2 person/days to make traps and 6 days to place them out. Trap checking and refilling needs 5 person days, equivalent to 0.93 days per ha. Labour costs equivalent to US$4.65 per ha (at US$5 per day).

Total cost for first year's use at this farm's increased density = US$10.02 per ha for traps and labour.

Comparison with insecticides: one endosulfan application estimated at US$10.65 per ha incl. labour, but excluding diesel for motorsprayer. [Farmer underestimated current endosulfan prices.

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Current cost for his estimate of 0.7 litres endosulfan and 1.42 days labour per ha is around US$12]. Some farms would spray endosulfan twice or even 3 times per year, i.e. three times this cost. Trapping is zero health risk for workers compared with high risk of poisoning using endosulfan.

Effectiveness: Good results. Can catch up to 250 CBB per trap in peak trapping periods (compared with 4 or 5 caught if traps left up in rainy season).

Years experience in trapping: two years

Views & perspectives:

- Trapping is a method that doesn't harm anybody, neither the person consuming the coffee nor the person worker in the field. There have been several worker poisoning cases with endosulfan in farms in this area.
- Trapping system has solved the problem of risk using hazardous insecticides and he no longer needs to apply any insecticides.
- His work team much prefers working with traps as less arduous than insecticide spraying..
- Very easy to obtain sufficient empty bottles, he pays a local youth to bring him bottles at US$ 4 cents equivalent each. Farmer takes part in making traps and setting them out and usually does maintenance himself.
- He's not had any problems with anybody drinking the methanol but did have 0.5 litres go missing from his storage shed.
- Views commercial traps (cost about US$ 1.60-2.00 each), as rather expensive. Another problem with commercial traps is because they're attractive and red, kids will often steal the ones visible from the roadside. With home-made versions, nobody steals those made from old bottles.
- One large estate nearby of 84ha now uses them and runs a 6 man team to make, place and maintain them. He first learnt about the traps from this estate, before his co-op started promoting them.

A.4 Linda Vista, Nicaragua (small-medium farm, Fairtrade certified. Local co-op member, affiliated to SOPPEXCCA co-op). Mr Henry Zelaya, Owner.

Trap type: home-made using empty 1.5-2 litre bottles, with 3 windows cut.

Density: now placing 28.4 per ha (higher density than 22.7 recommended by co-op).

Positioning: across entire farm but places traps closer in hotspots and next to neighbours' poorly managed plots.

Timing of trap placement: end Feb-beginning Mar, in dry season.

Cost of traps and attractant: pays US$0.04 per empty bottle of 1.5-2.0 litres. Methanol and syringes obtained on credit from co-op [at US$0.21 per trap worth]. For his farm and density used, costs are US$6.86 per ha.

Maintenance: checks every 15 days during dry season and refills if necessary (usually 2 o3 times). Majority of traps and syringes can be used the following year if you look after them carefully.

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Labour requirements: takes one person around 3 days to make and place the 200+ traps on his 8.4 ha farm. Equivalent to around 0.4 days per ha.

Comparison with insecticides: Considers much cheaper and better than spraying chemicals (as he used to do until three years ago). Endosulfan was not always effective.

Effectiveness: Excellent results. CBB now under good control on his farm, using cultural controls and traps. Using traps has helped enormously in controlling his earlier problems with borer damage. Infestation levels were quite severe before he used the trapping practices, even when spraying endosulfan. In the first year of use, he counted up to 200 CBB per trap in some plots and majority of traps were full. Now fewer numbers caught as pest is better controlled.

Years experience in trapping: 3 years

Views & perspectives:

- Traps are easy to use and risk-free, unlike chemical products
- Using traps and cultural methods he's been able to reduce considerably CBB infestations.
- Considers traps are better than spraying endosulfan because you don't have the problem of trying to time the insecticide application and the risk of wasted effort if CBB is already inside the bean. As long as the traps are in place in the dry season, they will start catching CBB before they attack the new berries.
- With the local Agriculture Ministry office, he's talked at meetings to convince more farmers to change to trapping.

A5. Miramar estate, El Salvador (large farm still using endosulfan, no certifications, sells coffee to COEX). Mr Alfonso Argueta, Farm Manager.

Trap type: home-made using empty drinks bottles.

Density: 28 per ha [this is a little higher than PROCAFE recommendation of 26 home-made traps per ha]

Timing of trap placement: immediately after harvest

Cost of traps and attractant: obtains methanol in dispensers from COEX exporters [PROCAFE cost is US$0.60 per dispenser of methanol therefore approx. US$16.80 per ha]

Maintenance: makes new traps each year.

Labour requirements: one person to make the traps and a couple of people for 2 weeks each to place them out, for this 43 ha estate. Equivalent to 0.6 days per ha + maintenance checking.

Comparison with insecticides: Endosulfan use is considerably more expensive. He applies endosulfan at half-dose, costing US$6.39 per ha + 4.26 days' labour per ha at US$4.83= US$20.57. Total endosulfan applications costs at least US$27 per ha labour + diesel for sprayer + cost of 284cc sticking agent.

Total cost of making and placing traps on this estate around US$19.70 per ha + maintenance checking.

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Effectiveness: He is beginning to replace endosulfan since 2011, with the traps -now uses only a half-dose (around 700cc per ha) and just one application per season, but it's a gradual process.

Years experience in trapping: 2 years, since COEX began promoting it.

A.6 Belmont estate, El Salvador (large farm, Rainforest certified, sells coffee to COEX). Mr Abelino Escobar, Farm Manager.

Trap type: home-made empty drinks bottles with 2 windows cut, with dispensers of methanol supplied by Coex. Puts 2cc methanol-ethanol attractant into each dispenser. Uses the same traps the following year. Uses 1 litre, 2 or 3 litre bottles, it doesn't matter what size, but less than 1 litre is too small to suspend dispenser properly.

Density: placed 1,200 traps in 2013, equivalent to 17-20 traps per ha [this seems lower than PROCAFE recommendation of 26 home-made traps per ha but not clear how many ha he places traps in].

Positioning: across all plots except those recently renovated. Hangs at 90-100cm height irrespective of tree height. Increases density near neighbours' uncontrolled plots and where sampling reveals hotspots. Sometimes changes trap position into different trees halfway through dry season.

Timing of trap placement: Feb to Jun. In later part of this period will move traps to hotspots identified by sampling developing berries.

Cost of traps and attractant: US$10.20-12.00 per ha for attractant [using PROCAFE costs of US$0.60 per methanol dispenser]. Obtains bottles for free.

Maintenance: checks every 2-3 weeks**,** cleaning out trap water and refilling dispenser if necessary. 2cc of methanol lasts around 3 weeks. Removes 'soup' of dead CBB from each trap and pours into a bucket and then buries to avoid any dispersal of possible live insects.

Labour requirements: workers can easily make 150-200 traps in a day, using a penknife to cut the windows, a hot wire to make holes to thread the wire hanger through and putting the dispenser inside. Two men can put out 200 traps in a day, covering 7-10.5ha per day at cost of US$9.00 labour.

Comparison with insecticides: Very easy, very cheap and very effective. Endosulfan application is at least 700cc per barrel, at cost of US$9-10 per litre. Labour cost for 2 men is 2 days each to spray one barrel i.e. US$18.00, for one manzana (0.7ha). For older trees, need 1.5 barrels. This estate used to make 2 applications per year so using endosulfan could be US$8.94-13.41 in product and at least US$25.56 in labour, totalling US$70-76 for 2 applications (+ diesel if motorised).

Approximate costs per ha for trapping: US$10.20-12.00 in inputs + US$1.80 in labour for preparing and placing traps, totalling US$12.00-13.80 [+ maintenance labour].

Effectiveness: excellent results, 'millions' of CBB captured and he has not needed to apply any endosulfan since using the traps. Using traps and cultural controls has reduced CBB incidence, which used to be quite high, and estate no longer has coffee quality rejection problems.

Years experience in trapping: 2 years

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Views & perspectives:

- Using traps is cheaper, easier and far less dangerous than using chemicals. For workers, it's much easier to put a little water in the traps than having to carry a heavy knapsack or motorised sprayer.
- People can get splashed handling endosulfan solution and workers used to almost collapse with suffocation wearing all the protective kit. With traps you don't need any special clothing or kit - you just walk round placing traps in suitable positions.
- Method is much more economical for the farm and less labour-intensive than spraying. They've made considerable savings in control costs.
- Emphasises that two men can prepare and hang out 200 traps, for around 10 ha in 2 days, whereas spraying endosulfan they would only cover 0.7ha in the same number of days.
- With endosulfan spraying if it rains shortly afterwards, you can lose the product and waste the money spent because it gets washed off with the rain. But with traps, when it rains, you don't risk losing control or needing to repeat an application.
- Considers it a more effective method than endosulfan because sometimes when CBB attack is strong, you find incidence goes up again to 5-8% so you need to spray again (thinks this is due to pest developing resistance).
- Started with 500 traps in 2012 dry season and found good results, so they've increased this year.
- Easy to collect sufficient bottles, by providing collection point for bottles discarded by their 200-300 workers during peak picking season and a collection point at local street stall. Also benefits environment by encouraging people not to just throw away bottles but recycle them.
- The more traps the better. They put up more traps along the borders with farms where owner is not controlling CBB.
- They don't put more than 2cc methanol in each dispenser because of an issue with alcoholics searching for full dispensers to drink.
- Trapping is more certain than insecticides, you don't need to worry about poisoning risk or whether your spray application has worked or not.

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Appendix B: Experience and advice from organisations promoting trapping

COEX exporters and growers, El Salvador. Mr René Fontan, Head of Agriculture.

See also René's detailed cost comparison for trapping versus endosulfan based on data from their company estates, in his presentation to the project lesson-learning workshop in Colombia in Oct. 2013 (available on the 4C project webpages).

COEX have collaborated with PROCAFE research institute on trialling different CBB IPM methods for some time. The prohibition of endosulfan use under Rainforest and Utz standards from July 2011 spurred COEX to make immediate changes to their former recommendation and use of endosulfan and they now use traps and *Beauveria* on their own estates, along with cultural practices. All of the certified farms that sell their coffee via COEX have also now adopted trapping, with technical support from COEX agronomy team.

Trap type: COEX no longer use commercial traps but home-made ones from drinks bottles, with same type of methanol dispenser as used by PROCAFE. COEX obtains bulk supplies of methanol and ethanol and mix these and add warning colouring to provide filled dispensers for use on their estate and for sale to their farmer clients.

Density: 14-17 per ha.

Timing of trap placement: with first rains

Cost of traps and attractant: US$0.40 for dispenser with alcohol, bottles for free or very small cost. Cost per ha US$ 5.6-6.8.

Labour requirements: Estimate US$500 (100 person/days) for an estate of 70ha, approx. US$7.00 per ha in maintenance

Maintenance: One or two workers per farm to check the traps, refill the dispensers and the water and collect at end of trapping season and wash them to reuse in following season.

Comparison with insecticides: Cheaper than endosulfan use. Spraying requires 5.6 men per ha, at US$5.00 per day, =US$28 + 1.42 litres endosulfan at full dose at US$10.00 per litre =14.20, totalling US$42.20 per ha + costs for spray equipment, diesel, PPE. Some farms apply endosulfan twice a year so cost would double.

With traps, total cost is around US$14.00 per ha.

Effectiveness: Very good results, in conjunction with other IPM methods.

Years experience in trapping: 2

Views & perspectives:

- No longer using the commercial traps, because they're too appealing and people take them or use them for other things.
- COEX estates have made traps part of their social programme, collaborating with local schools, as part of their company profile. Pupils collect empty bottles for a very small payment and the craft teacher helps them to cut the windows and produce ready-made traps.

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- Using traps also help COEX fulfil its ecological obligations under the certifications, by not using endosulfan or organophosphate insecticides, which are all hazardous.
- COEX estates give trap placement and maintenance work to pregnant women or elderly men, as it's very low risk work compared with any other farm task. This helps company fulfil its social obligations. Poisoning risk is high with endosulfan and any other hazardous chemical, especially with very low use of PPE in El Salvador.
- Method is much cheaper than insecticide use and combined with good cultural controls and use of *Beauveria* biopesticide has enabled COEX estates to keep well within the maximum permitted levels of the coffee mills of 1-2% bored beans.
- He has seen experiments using disposable plates covered with glue and with an attractant, similar to sticky traps used for whitefly control. It would be cheaper than the current traps so COEX plans to do a few experiments using these in 2013.

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Appendix C: Details on trapping use, costs and effectiveness from responses to on-line survey

Table C.1. Trapping densities reported

Country/Case	Density (no. of traps per hectare)
Tanzania (a)	Varies depending on pest pressure
Tanzania (b)	No mention
Uganda (a)	22/ha
Kenya (a)	No mention
Indonesia (a)	No mention
Indonesia (b)	25/ha
Indonesia (c)	5-10 per 0.25 ha farm
Indonesia (d)	24/ha
Indonesia (e)	25/ha
Indonesia (f)	24/ha
Vietnam (a)	No mention
India (a)	10/ha
India (b)	60/ha
Thailand (a)	40/ha
Mexico (a)	16/ha
Mexico (b)	16/ha for Brocap traps
Mexico (c)	16/ha
Brazil (a)	10-12/ha
Brazil (b)	25-30/ha
Peru (a)	20-25/ha
Peru (b)	25-30/ha
Peru (c)	80-100/ha
El Salvador (a)	18/ha
Colombia (a)	40/ha
Colombia (b)	No mention
Colombia (c)	No mention
Honduras (a)	16-20/ha
Honduras (b)	*16-20/manzana*
Honduras (c)	*5/manzana*
Latin American (a)	22-25/ha
Latin American (b)	12/ha

Table C.2. Respondents' views of trapping effectiveness as a control method

Country/Case	Effectiveness
Tanzania (a)	Does not specify but widely taken up by estates + smallholders
Tanzania (b)	Reasonably but more follow-up needed
Uganda (a)	Can reduce CBB levels by 35-80%
Kenya (a)	Using Brocap for research only
Indonesia (a)	Effective in reducing CBB attack, in ICCRI trials
Indonesia (b)	Reasonably. Farmers interested
Indonesia (c)	Fairly good. Can trap 50-60 females per trap per day, 200 per week in peak periods
Indonesia (d)	Very effective.
Indonesia (e)	Effective but farmers don't trap continuously because they view it as expensive

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Indonesia (f)	Very effective. Can avoid residues in final coffee.
Vietnam (a)	Not effective- needs daily monitoring & attractant replacing every 2 days
India (a)	Reasonably. Needs to follow picking of fallen berries after harvest.
India (b)	No mention
Thailand (a)	Not very effective
Mexico (a)	Very effective. Can reduce CBB levels to 2% [*with or without cultural controls?]*
Mexico (b)	Very effective when combined with cultural control. Succeeded in eliminating endosulfan & chlorpyrifos use for over 10 years using these tactics.
Mexico (c)	Effective- reduced CBB levels from 16% to 2% within 3 seasons. Has helped eliminate insecticide use.
Brazil (a)	Doesn't specify- helps with monitoring and adult control.
Brazil (b)	Reasonably. Helps reduce CBB levels if combined with cultural & other tactics.
Peru (a)	Doesn't say
Peru (b)	Reasonably
Peru: (c)	Reasonably
El Salvador (a)	Don't know real effectiveness. Works well as part of CIRAD recommended Triple-Action IPM, with cultural controls.
Colombia (a)	Not very effective. Limited impact on CBB levels but useful for ID of optimal timing of control actions.
Colombia (b)	Only for pest monitoring
Colombia (c)	Not very effective. Only for monitoring or trapping at harvest collection stations. Traps can concentrate CBB infestation and generate more problems.
Honduras (a)	Reasonably. Needs good maintenance.
Honduras (b)	Very effective. If set at correct time and maintained/checked properly.
Honduras (c)	Reasonably if CBB attack level is medium.
Latin American (a)	Alcohol or pheromone traps used when needed, in addition to cultural controls. Around 80% of farmers use these methods.
Latin American (b)	Very effective. Used by farms in process of gaining certification.

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

Table C.3. Responses detailing costs of trapping

Country/Case	Cost per hectare in US$ or other value
Tanzania (a)	Almost 'zero' cost
Tanzania (b)	No mention
Uganda (a)	No mention
Kenya (a)	No mention
Indonesia (a)	No mention
Indonesia (b)	Trap costs 4$ and attractant < 1$. 4 bottles attractant per year [*so at 25 traps/ha ~200$/ha?]* Farmers interested but find cost high.
Indonesia (c)	~ 1$ [*for trap or attractant?]*
Indonesia (d)	15S/ha for attractant
Indonesia (e)	70-100$/ha for trap + attractant. Not implemented widely because farmers consider it quite expensive.
Indonesia (f)	No mention
Vietnam (a)	Not effective because need to replace chemical every 2 days *[is this a cost-related assessment?]*

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India (a)	~18$/ha (100 Rupees/ha)
India (b)	No mention
Thailand (a)	No mention
Mexico (a)	5$ for kit + 10$ labour during season [*per ha?]*
Mexico (b)	25$ per trap x 16/ha + labour ~455$/ha [*US$ or pesos?]*
Mexico (c)	Can't say since trapping funded by government
Brazil (a)	No mention
Brazil (b)	~15$/ha for trap (R$1 per trap ~ 30R$/ha)
Peru (a)	Average 20$/ha
Peru (b)	~38$ for attractant + 9.5$ for traps ~ 48$/ha. Alcohol volume sufficient for 2,500 trap fills.
Peru (c)	~1$/trap
El Salvador (a)	Don't know but project aims to reduce cost
Colombia (a)	12$ for trap + attractant, 4$ for trap alone
Colombia (b)	No mention
Colombia (c)	Economical but only for pest monitoring
Honduras (a)	50-60$/ha with attractant from national coffee institute
Honduras (b)	Very economical using home-made traps. Costs 1.5$/ha for attractant and dispenser
Honduras (c)	0.25l Pheromone attractant costs 7$ and sufficient for 3.5ha. No cost for recycled bottle traps. Labour cost for 3 days 37$
Latin American (a)	No mention
Latin American (b)	No mention

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