

Experiences in Monitoring and Decision-making for CBB Control

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Summary assessment of criteria for monitoring and decision-making tools

Criteria	Monitoring & Decision-making
How effective is it in controlling CBB?	<p>Not a control method in itself but highly important in achieving effective CBB management, especially in medium-high pressure zones. Farmers will not be able to control CBB cost-effectively if they don't know:</p> <ul style="list-style-type: none"> (a) If CBB levels are high enough in a particular season to warrant extra control (b) Where CBB hotspots are in their plots (c) Whether borers can be reached by chemical or biopesticide contact or already out of reach inside the bean <p>89% of Colombian farms sample their plots at least once a season to assess % CBB levels. 77% record dates of flowering episodes to forecast when CBB controls may be needed on the new berries. 55% of Colombian farms assess borer position within the berries. Only 23 % of Central American farms sample to assess CBB % levels but almost all visit plots to identify hotspots.</p>
How much does it cost?	<p>None or very little in equipment. Labour effort in good monitoring is recompensed by gains from borer damage reduction and quality. Trained CBB pest scouts can be hired at US\$4 per ha in some parts of Colombia.</p>
How much labour time does it need?	<p>May take a trained person 2-4 hours per 1 ha plot to sample 30 trees to estimate % CBB levels and then dissect 100 bored berries to assess borer position.</p> <p>Little time needed to observe and record flowering episodes or to get an idea of CBB hotspots in plots (can be incorporated into ordinary plot visits or field operations).</p>

How easy is it to implement?	Colombian recommended monitoring is quite easy once farmer or worker trained, thanks to useful data recording calendars, field notebooks and guidance leaflets. Monitoring plots every 2-4 weeks helps large farms keep careful check on CBB population patterns and evaluate success of control actions for very well-organised management, especially if aiming to reduce chemical control.
Does it need much training before it can be used?	Farmers, managers and certain workers need to be trained, with practical demonstrations and some follow-up support till they become confident. Careful monitoring can be done by farmers without secondary education and irrespective of farm size.
Other key points	Most important in regions with continual berry development or highly unpredictable flowering patterns and CBB behaviour. Farmer experiences of ineffective spraying probably most often due to badly timed application, i.e. too late to prevent CBB damaging beans.

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

All of the Colombian farms visited carry out specific monitoring of CBB levels in the different plots on their farms and make use of at least one decision-making tool for timing effective control actions. Table 1 summarises the methods used by each farmer and their knowledge of CBB levels present.

Sampling CBB incidence levels in plots

Eight of the nine farms visited sample their plots to estimate % CBB levels, at least once or twice a year. Most of the medium and large farms sample more frequently, with one estate sampling each plot every 15 days. Farmers follow the sampling methodology promoted by the National Coffeegrowers Federation (FNC) extension services or something similar. This involves walking across each plot in zig-zag or X pattern, checking 30 trees per hectare and selecting one branch at random from each tree. The person monitoring first counts and notes on paper the total number of green berries on the branch and then counts and picks off those bored, to then calculate the average % infestation level from the 30 trees sampled. Farmers said it takes a trained person around 2-4 hours to sample a plot, according to farm terrain and plot size.

Assessing CBB position within bored berries

55% of farms reported that they also assess the borer position within bored berries collected in the plot incidence assessment. This involves carefully opening each berry with a penknife and recording whether the adult female:

- is just starting to penetrate the berry flesh (position A, according to the National Coffeegrowers Federation recommended assessment system)
- has bored an entrance tunnel in the flesh but has not reached the bean (position B)
- has already bored into the coffee bean; and started to reproduce (positions C; and D)

Dead or absent borers may also be recorded. This assessment of the CBB position is very important to enable farmers to decide what kind of control action to take. The borer can only be killed by insecticide or biopesticide applications before it has bored into the bean, i.e. it is in position A or B. Once a majority of borers are in position C or D, these applications will not be effective as the borer is protected inside the bean and the beans have already been damaged. Some farmers do this position assessment every sampling, others only do it if the plot CBB incidence average exceeds 5%.

Table 1. Summary of monitoring methods and decision making tools reported in use by Colombian farmers interviewed

Farm (size)	Incidence Sampling & % CBB	Position Assessment carried out?	Other decision tools & comments
A (small)	Samples 10 trees per small plot in zig-zag CBB currently below 1%	Yes	Uses flowering calendar Has sometimes used methanol traps but not much need as CBB levels very low
B (small)	Once or twice a year, with external help CBB currently below 1%		Records flowering episodes
C (medium)	Samples 30 trees per ha in x or z, 90 days after 'good' and 'very good' flowering episodes CBB currently below 1%	Will assess 100 berries if >5% CBB level found in a plot	Uses flowering calendar to plan when to sample incidence If more borers in positions A/B than C/D, you need to take timely action.
D (medium)	Only samples once or twice a year, with external encouragement CBB currently below 2%		Picking every 10-12 days keeps CBB levels low and no need for frequent monitoring. Does approximate % estimate from berries collected at each ReRe.
E (medium)	Monitors at least some of the farm every week <i>CBB level not mentioned</i>	Yes	Uses flowering calendar to plan control actions Consults agronomist on spray decisions
F (large)	Regular monitoring of plots Sometimes hired CBB scouts CBB currently 4-5%, some plots below 2%		Uses flowering calendar to plan control actions per plot Incidence monitoring to check if control actions successful Checks CBB numbers emerging from berries collected in ReRes

G (small)	Uses 1 methanol trap to identify peak flight periods and approximate CBB numbers CBB currently 2-3%		Uses flowering calendar to plan control actions per plot
H (large)	Sample 30 trees across each plot every 15 days CBB currently 2-2.5%	Yes	Employ a full-time CBB monitoring & control supervisor Identifies hotspots where two or more trees sampled have over 2% CBB, for extra control action Always evaluate incidence level after hotspot controls to check if they were effective Monitor plots after picking to check that only a very few or no berries left
I (medium)	Regularly monitors 60 trees per ha in plots of 4-6 year old trees. CBB currently 1.5%	Yes	Uses flowering register Identifies as hotspots any trees with over 5 bored berries, for intensive controls on this and neighbouring 6-10 trees branches and ground

Flowering register to forecast critical CBB control periods

Another key decision tool, used by at least 77% of farms, is the flowering calendar. By recording the date of each separate flowering episode in the different plots, the farmer can work out when the berries developing from each flowering will start to become susceptible to CBB attack (from 90 days afterwards) and therefore when control actions may need to be planned. The timing and level of flowering episodes vary widely in different parts of the country and from year to year so knowing the exact timing helps farmers organise much more effective CBB management. To make this recording and planning quick and simple, each year the FNC publishes flowering calendar posters on which farmers can record flowering dates per plot and whether each flowering is scarce, normal, good or very good. The poster shows the critical period for CBB control for each flowering week, based on 120-150 days after flowering, and the likely harvest date.

Other methods and training considerations

Only one farmer regularly uses methanol-baited traps as a way to monitor CBB levels. He maintains one trap on his small farm to check when CBB is flying and to estimate approximate levels (low-medium-high). Other farmers either felt no need to use traps because CBB levels are generally very low on their farms with cultural controls alone, or that trapping was too time-consuming.

The general FNC recommendations are to take additional control measures (beyond timely pickings and sanitary collections) when CBB incidence rises above 5% in a plot. Some farmers have adapted these recommendations and developed their own action thresholds.

One large farm considers over 2% CBB in more than 2 out of 30 trees sampled per plot as a hotspot, for extra control action and then further monitoring. One medium farmer has devised his management system based on intensive controls around CBB hotspots. He identifies these as any trees with more than 5 bored berries, for extra control actions on this tree and the neighbouring 6 or 8 trees. These farmers explained that the time and cost dedicated to careful and regular monitoring is more than recompensed by the gains in reducing CBB levels through well-timed management and achieving clean coffee. One large farm now employs a full-time staff member to monitor pest levels across its 5 estates and organise the farm's CBB control programme.

The National Coffee Growers' Federation has clearly played a hugely important role over the years in promoting excellent monitoring methods and aids for farmer decision making. Local FNC extension services produce leaflets explaining sampling methodology and run training sessions for farmers and farm managers. Farmer co-operatives are also actively involved in advisory services, while some medium and large farms may hire trained CBB scouts to monitor their plots. Some farmers also obtain advice from FNC or independent agronomists, especially in regard to insecticide application. Several farmers interviewed explained that the monitoring methods are easily learnt with a little practice and support and can be used by any farmer, irrespective of their educational level.

Appendix A describes in more detail the monitoring methods and decision tools used by each farmer, along with comments about time involved, usefulness and other points to consider. Relevant comments from FNC extension staff and other technical support organisations interviewed are included in Appendix B.

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

Very few of the farmers interviewed in Central America undertake a full quantitative assessment of percentage CBB incidence per plot. Table 2 summarises the monitoring and observation methods reported by each farmer and their knowledge of CBB levels present, along with any tips or comments made. Only the two large farms visited carry out regular sampling for % estimation, including the farm which still uses endosulfan (described in the *Synopsis on Chemical Control*). One of the smallest farms also does some form of % assessment in different plots.

However, most farmers said they do regularly check for disease and pest or other problems affecting coffee tree health and they have a reasonable or a good idea of where the CBB infestation hotspots are in their different plots. Several will also check damage levels in the berries collected in the sanitary pickings of early berries and in their harvested beans after pulping. Unlike Colombian farmers, who could all specify their current infestation level to within a percentage point, over half of the Central American farmers could not give an exact percentage of borer infestation, only an approximate level and whether this was higher or lower than previous years.

Table 2. Summary of monitoring methods reported in use by Central American farmers interviewed

Farm	Monitoring or other decision making
Farm A (medium)	-Checks plots regularly for any disease or pest problems or trees in poor health. Prefers to do these observations himself, rather than leave it to a worker. -Qualitative rough assessment of CBB hotspots by noting where bored berries are prematurely ripening. -Knows CBB level around 2-2.5% in his farm.
Farm B (medium)	-Has approximate idea of parts of plots where CBB tends to be bad. -Does not know exact CBB % but considers it low, around 2%.
Farm C (small)	-Does diagnosis of pests and diseases in different plots to find the most affected areas. --Starts assessing borer attack in early berries as they turn yellow. -Has taught her children how to recognise bored berries. -Recently visited different plots and knows CBB levels about 1-2%, which is low.
Farm D (small-medium)	-Rough assessment of hotspots from observations in plots. -Knows CBB currently around 3% on his farm.
Farm E (medium)	-Checks how much borer damage there is in each batch of harvested beans and sends a worker to check in the plots. -Knows hotspot locations, usually along borders with neighbour farms. -During manual weeding at start of rainy season, workers will check for any remaining fallen berries. -Considers a large number of coffee seedlings sprouting in groves as a sign of low CBB levels, as bored berries usually fail to germinate. -Doesn't know exact CBB level but considers it low.
Farm F (small)	-Observes plots regularly and checks very carefully first harvest round berries to see if any are bored. -Doesn't know exact CBB % but usually fairly low.
Farm G (small-medium)	-Doesn't do systematic sampling but regularly observes groves to see how much CBB and where attack is heaviest. Receives advice from organic development NGO staff. -Doesn't know exact % but aware incidence has risen this year, hence he is taking more action.
Farm H (small)	No monitoring just general idea from plot observation of whether CBB is problematic this season. Receives advice from organic development NGO staff.
Farm J (large)	-Samples each plot to assess % CBB levels in each. In plots with higher incidence, he will increase the number of traps. -Knows current CBB level between 1-2% average.
Farm K (small-medium)	-Regularly visits plots to check for problems in general. CBB attack can be observed where berries are ripening early. Checking damage levels in early pickings will also show where problem areas are. -Doesn't know exact % but considers it lowish this season.
Farm L (medium)	-Regularly visits plots to check for problems in general and knows where CBB hotspots are. -Checks level of CBB in berries picked in <i>graniteo</i> collection of early berries. -Doesn't know exact % CBB but estimates under 5% and knows this season has low incidence in <i>graniteo</i> berries.
Farm M (small-medium)	-Important to monitor each plot and keep checking to see when the first berries are ripening and borer begins to enter these, so you know when to collect them. -Does rough assessment to identify hotspots and put up more traps in those areas, usually shady parts. -Now takes careful note of when erratic flowering takes place, as the climate is changing and you can no longer predict flowering or calendar schedule <i>graniteo</i> collections. -Doesn't know exact % CBB but considers it very well controlled now he's been using traps for 2 years.

The relatively low level of attention to quantitative monitoring reported by farmers in this region is possibly because coffee flowering is much more seasonally defined than in Colombia, hence periods when the borer is attacking and control actions required are more predictable and limited. It may also relate to the absence of a national and comprehensive extension service for coffee in either Nicaragua or El Salvador, which have not enjoyed the benefits in advice and training that Colombian farmers obtain from their National Coffee Growers' Federation.

As one farmer pointed out, climate change in the Central America region is making the local patterns of coffee grove flowering, ripening and pest and disease attack far less predictable than in the past. It will probably become more important for farmers to note down early and main flowering episodes in the coming years, so that they know exactly when berries are at the susceptible stage for CBB boring on their plots and to plan and time control actions, rather than relying on approximate rules of thumb such as 'the second half of July'.

Summary from on-line survey responses (global)

The survey included one combined question asking if people were using some form of decision-making tools or monitoring and any post-harvest controls. 20 of 50 respondents answered 'yes' but it was not possible to assess what % were using decision tools and very little useful information was generated. Nevertheless, there seem to be a few examples from each continent of some farmers or programmes undertaking some form of monitoring.

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

Question: For CBB incidence sampling, does the sampling methodology (number of sampling points per ha or plot and number of branches assessed) need to be specific to the region's coffee phenology or not? Would using the Colombian FNC methodology for incidence and position sampling (30 trees per ha in zigzag, then checking broca position in 100 of the bored berries collected) work as well in regions with defined dry season like Central America?

Answer: The precise methodology for sampling is not that important- the main thing is to get farmers out into their plots on a regular basis to check for approximate infestation levels, even using a very 'rough and ready' guesstimate.

Question: Is the Colombian FNC recommendation to check borer position when sampling shows >2% incidence applicable to other regions? El Salvador seems to promote a 5% damage economic threshold.

Answer: Yes, the FNC recommendation is relevant in other regions. The actual % incidence figure used for decision-making will depend on:

- Who the farmer is selling to (i.e. their requirements on maximum % CBB damage, if any)
- Weather conditions and how quickly CBB is reproducing in the zone in a particular season

Question: Most technical staff and farmers who carry out incidence sampling reported that you need to do sampling from 90 days after flowering (DAF) and the critical period to control CBB is 90-120 DAF. But one advisory poster shows the critical period for CBB control based on 120-150 days after flowering. Which is the correct critical period?

Answer: 120-150 DAF sounds too late. The most important point is that control actions [e.g. spraying chemical or biological products] should be before the bean endosperm is sufficiently solid to allow the female to start boring in. So the 120 to 150 day rule may apply for certain higher altitude ranges, but this could speed up a bit at lower altitudes or during a warm spell. The farmer who said that from 90 DAF in each plot you have one month to take action is about right for lower altitude zones. For borer to develop well, berries need to be 120 DAF or older.

Question: Does it make sense to make more than one Beauveria or insecticide application per season in zones with defined major flowering, like Central America?

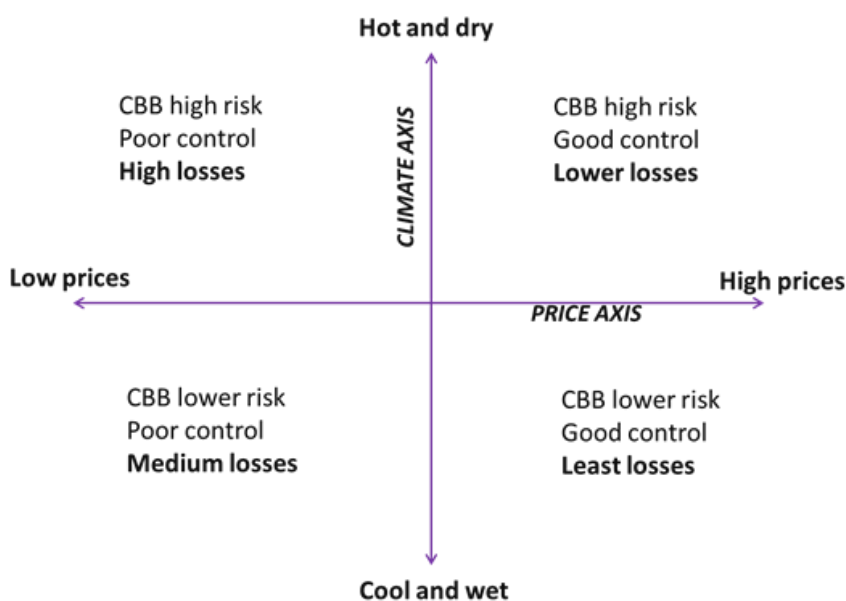
Answer: You'll always get some CBB emerging from bored berries on the tree in the months before harvest. You can't do very much about that in terms of applying a product if it's close to harvest- you should have been controlling it earlier on. Vigilance is absolutely key for this pest.

You must apply a product (biological or chemical) BEFORE the bean consistency reaches 20%, which is when CBB is able to bore it. It's easy for farmers to do a quick check on this, cutting open a few berries to see/feel. It's definitely from 90 DAF you need to start sampling- cut open a few berries and if the bean is still soft and watery, you can wait a couple of weeks. If the bean is already 'creamy' and hardening, you need to take action. In higher or cooler climates/seasons, it might be nearer 120 DAF when beans start to reach this stage and therefore become highly susceptible to borer. But this varies a lot each year and some years it could be earlier, so you can't be complacent.

He also gave comments on some of the information reported by farmers and technical staff interviewed:

- Regarding estimates of one farm interviewed that incidence sampling takes 2-4 hours per plot, I think that's much too long. It's something that could be improved with participatory research. [NB this estimate was made by the full-time CBB control supervisor for a large estate for a 5ha plot and included dissecting 100 berries for CBB position assessment, as well as recording in detail CBB% in each of the 30 trees sampled, as part of their hotspot identification strategy. Small farms could do quicker incidence sampling in a plot of 1 ha or smaller].

- In Colombia CBB pressure is closely related to weather events and whether the ocean currents affecting the climate are in El Niño (hotter and drier) or La Niña (cooler with much more rain) phase. The steady rise in minimum temperature in recent years may be one reason why CBB seems to be getting harder to control there
- CBB is not going to go away –serious attacks will be cyclical and hard to predict. The chart below tries to clarify the relationship between CBB and dependence on weather and prices. [It assumes that when coffee prices are low, farmers' CBB control tends to be poorer, because labour and other inputs cost relatively more in terms of what they receive for their coffee].



- The Nicaraguan farmer who talked about climate change making local patterns of coffee phenology e.g. flowering times, much less predictable is right. The same applies to coffee rust disease – it's now looking like intermittent wet and dry spells may have aggravated the rust problem. It also means coffee farming is getting more and more difficult for farmers – this pushes up costs but they are not being rewarded by higher sale prices.
- Colombia has some of the worst CBB problems anywhere in the world because of its continuous flowering pattern and year-round availability of berries. Indonesia too has economically important CBB issues and Jamaica, for example. ICIPE scientists have found that increasing average temperatures in East Africa are generating more CBB problems, even in places like Ethiopia, where it was previously under effective natural control. Brazil, however, doesn't have too much problem due to the very concentrated flowering period there.
- CBB problems are linked to climate change, we may be getting far more serious CBB attacks at lower altitude now. With other coffee production problems of rising input costs (more fungicide applications, more expensive fertiliser, etc.) and falling yields, it

may be time for some coffee farmers to diversify into other crops which will be more sustainable.

- Another issue to be considered in the CBB management cost/benefit equation is when countries subsidise their coffee production. For example, Colombia is subsidising the price by US\$0.30 per pound of coffee. What would be the cost-effectiveness of CBB control costs if farmers didn't receive that subsidy? [In Mexico regional Depts. of Agriculture are subsidising CBB traps, according to several survey respondents].

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):

- Calendar spraying is totally inappropriate for this pest. Monitoring CBB and incidence sampling is very important for effective control in zones where altitude or weather increase pest attack. Farmers should check if plots have 2% or higher incidence and if 50% of borers are in positions A or B [i.e. still reachable by biological or chemical applications], an application can be made. If fewer than 50% are reachable, a farmer will probably lose money by spraying.
- Cenicafe's research on weather factors influencing CBB levels has helped the National Coffee Growers Federation classify the country into zones with higher or lower vulnerability to CBB attack. Cenicafe has been assessing differences in borer reproduction rate and incidence in 4 regions in El Niño, La Niña and Neutral years since 2007. El Niño years are generally much worse in terms of CBB attack, especially at lower altitudes [where the pest can reproduce much faster in these hotter years]. Lowest CBB levels are found in cooler, wetter La Niña years, with an average of 152 bored berries per tree at low altitude (1218m), compared with 959 per tree in El Niño years.

They have developed broad advisory messages on what farmers are likely to face in these 3 weather phases:

Temperature < 19°C: Nil CBB situation. Minimal CBB impact. Farms above 1600m in central coffee zone tend to be in this situation.

Temperature 19-20°C: Low CBB situation. Some CBB controls may be needed in El Niño years.

Temperature 20-21°C: Moderate CBB situation. Cultural controls alone should keep CBB from causing economic damage in Neutral years but need extra controls in El Niño years. Generally relevant for farms at 1200-1400m.

Temperature >21°C: Critical CBB situation. All IPM tactics will need to be combined whatever the year, with greatest CBB impact in El Niño years. Generally relevant for farms below 1200m.

Useful Brocarta advisory leaflets (in Spanish):

No. 43 Critical Periods for CBB Attack

No. 45 CBB and weather phases in El Niño, La Niña and Neutral years

Suggestions for follow-up:

- ✓ Some type of CBB alert service, based on actual, local monitoring data in real time, by SMS messages from local extension, coffee trader or research organisations could be useful in many countries. The aim would be to help farmers know whether CBB is likely to be particularly problematic in a given season and when control actions need to be planned. Some limited sampling by trained staff of CBB numbers in berries on the ground after harvest would help indicate whether the breeding potential is high and whether it is worthwhile for farmers to put extra effort into post-harvest clean-up and/or focus on early control actions the following season.
- ✓ More data on the costs and effectiveness of different IPM methods under different price scenarios (for inputs and for coffee sold) would be very useful. Rather than creating a long list of extra things for farmers to do, more detailed case studies would be helpful to get an idea of farmers' full pest and disease costs and how these relate to total production costs and expected coffee prices.
- ✓ Setting up a modest network of 'monitor' or benchmark farms across the coffee growing countries, as recommended at the project lesson-learning workshop, would be very useful. It could involve some of the estates and farmer organisations who collaborated in this project and others within the 4C Platform. The data collection and sharing could be supported by technical organisations or coffee companies working with these farms and include also other key problematic pests or diseases, e.g. coffee rust. It could also link with climate change data gathering, especially if 4C Platform is involved in taking forward the Coffee & Climate Change initiative (C&C).

Appendix A. Details of monitoring and decision-making reported by farmers interviewed in Colombia

A.1. La Divisa (El Aguila municipality) (very small farm, high altitude & low CBB pressure. CafeNorte Coop member, Utz certified). Mr Nevarado Restrepo, Owner.

Incidence monitoring methods used: samples 10 trees in each of his very small plots.

Borer position assessment: Will open bored berries from sampling to check position

Frequency and time involved: Takes about 2 hours to monitor incidence and position per plot.

Decision tools:

- Use of flowering calendar to plan when you need to do control actions. Around 3 months after each flowering episode he will monitor incidence levels in the plot.

-Incidence monitoring identifies hotspots where you need to do more controls.

- His wife has occasionally used methanol traps, promoted by Neumann Group community project, to monitor borer and catch some too. With very low CBB levels in this zone, they see little need to use traps.

Views and tips:

- Counting how many berries are bored and how many are not will help you decide what control is needed. Maybe doing a sanitary removal- you've got to keep a careful eye out.
- If they're mature fruits, then general picking, to help with the control.

A.2 La Manzanares (small farm, high altitude & low CBB pressure, CafeNorte Coop member, Rainforest). Mr Luis Aníbal Suárez, Owner.

Incidence monitoring methods used: Occasional monitoring when he receives support

Borer position assessment: Not mentioned

Frequency and time involved: Around 1 hour to check incidence levels on his farm of 3.5ha

Decision tools:

-Uses flowering register to record episodes.

-Not used traps as CBB incidence very low in this zone

Views and tips:

- His wife maintains the farm records for workers' wages, volumes of picked and sold coffee, other farm task inputs and costs, flowering records. This record-keeping is a requirement of Rainforest certification. At first he considered it very time consuming but his wife is very organised. It's part of the farm's commitment to Rainforest values.
- Local FNC extension staff and his wife did a full incidence sampling 2 weeks earlier across the farm and didn't find a single bored berry! This proved how clean his groves are, compared with 10-12 years ago.

A.3 La Divisa (Buenavista municipality) (medium farm, medium altitude & CBB pressure. Certified Rainforest, Utz, 4C, member of Grupo Cordillerano producer group.). Mr Diofanor Ruiz, Owner.

Incidence monitoring methods used: Sample around 30 trees per ha, in zig-zag, x or z format. Choose a random branch per tree in the middle/upper part of the productive area, then count all the berries on the branch to see which are bored and remove and keep any bored ones.

Borer position assessment: If sampling reveals 5% or higher infestation levels in a plot, he will then assess position. 100 bored berries taken back to dissect inside using a sharp penknife, noting down numbers in positions A,B, C, D.

Frequency and time involved:

Decision tools:

-checking what position the borer is in berries from high incidence plots (5%+) helps you decide what to do: maybe a ReRe, or applying Beauveria, or, as a last resort, an insecticide but focussed application, i.e. in specific hotspots only.

- Add up how many of the 100 berries have borer in A/B and how many in C/D. If you find more in A/B that means you could make a Beauveria application in good time to work well. But if most borers are in C/D position, it's too late to do either biological or chemical control.

- Using the flowering register is important for timely action. When you get a 'good' or 'very good' flowering episode, this means that the critical time for CBB control will start 90 days later. You need to be out in the plots sampling at 90 days to work out what you might need to do in borer IPM.

Views and tips:

- You should sample inside the plot and not at the edges because these can skew your estimate higher than actual as you tend to get more CBB on roadsides, pathways, near a weighing station or where the picking sacks are left.
- It takes a few hours only for CBB to bore into the cherry flesh and some days to bore into the bean. You need to keep a very careful eye on the behaviour of this pest- it can get into the beans in a very few days.
- It's not too difficult for farmers without high school education to do these assessments. FNC have promoted sampling in a way to be accessible for those farmers. It's a matter of putting it into practice and accompanying farmers to do it well, till they're familiar with the procedure. It doesn't really depend so much on the farmer's level of education but on his level of commitment to his coffee enterprise.

A.4: Villa Marin (medium farm, medium altitude & medium CBB pressure. Member of Grupo Cordillerano producer group, Rainforest, Utz, 4C). Fernando Corrales, Owner.

Incidence monitoring methods used: Occasional sampling, every 6 or 12 months in plots under production, usually with external agronomist.

Borer position assessment: No mention

Frequency and time involved: gets a rough idea of % infestation from berries collected in his very frequent ReRes (every 10-12 days)

Decision tools:

-With only 1-2% CBB levels in collected berries, he doesn't feel the need to do regular full sampling, especially as many of his plots are recently replanted.

-Agronomist assessed his plots as 'perfect' due to very regular picking.

Views and tips:

- Learning how to sample is not difficult, you just need to practice with good support from agronomist on where best to sample.

A.5 **El Balcón** (medium farm, medium altitude & medium CBB pressure. Member of Grupo Cordillerano producer group, Rainforest, Utz, 4C). Jorge Olivares, Owner.

Incidence monitoring methods used: Depending on plot type, he samples trees in Z, X or zig-zag form.

Borer position assessment: Yes, according to what infestation level he finds in incidence sampling. Records whether CBB in position A (just entering flesh); position B (boring into the green part) or Positions C/D when the bean is damaged and no longer marketable.

Frequency and time involved: He and his farm manager monitor at least part of his 21ha farm once a week, checking what's happening and assessing borer position, if necessary.

Decision tools:

-Using the flowering register is one of the most important things, so you know when you need to go and sample.

Consults with agronomist to decide, according to what position you record CBB in a particular infested plot, to do either:

- picking
- spraying with insecticide, according to FNC agronomist recommendation

Views and tips:

- He's had support from the FNC at municipal level on training, especially for certified farmers, on how to assess CBB, how to do sampling in the plots, before applying insecticide or taking any control decision.
- Agronomist support helps you decide whether you need to apply an insecticide in certain hotspots or just a picking pass.
- You need to keep a careful eye on this tricky pest, you have to learn to live with it but control it in a sustainable way.
- We take care to monitor often, especially along the pathways because with all the pickers' traffic, that's where you tend to get lots of CBB, so we'll spray on those type of hotspots, not the whole plot.

- Effective control is integrated- manual methods, technical understanding and then chemical methods, if you need to make an application.

A.6 La Palmera (large estate, medium altitude, high CBB pressure. Member Anserma Coop, Rainforest & Fairtrade certified). Mr Alfonso Gómez, Farm Manager.

Incidence monitoring methods used:

Berries collected during ReRes are put into plastic pots and covered with plastic smeared with grease, to trap any borers that emerge. The numbers stuck on the lid the following day also helps him judge how much borer there is in a particular plot.

Borer position assessment: Does not mention

Frequency and time involved: Does regular incidence sampling in each plot, even though control actions are almost always needed on this farm

Decision tools:

-Uses flowering register to plan control periods in advance. You can almost use the register alone to plan control but he prefers to back it up with plot sampling for actual % level.

-Assessing infestation levels identifies hot spots. These are often lower parts of the farm, the borders, or where coffee collected gets weighed, , so he does chemical or biopesticide applications in the worst areas, not necessarily a general application.

-Has sometimes hired young guys trained by FNC as CBB scouts, they charge US\$3.85 to assess CBB % and position per ha. Not been able to hire any recently as their services are too much in demand.

-Used methanol traps a few times but considers it too time-consuming to check and refill traps.

Views and tips:

- Incidence sampling is important to see whether you've managed to reduce levels after control actions.
- Flowering register and knowing the pest behaviour is essential so you understand in advance when you need to apply control measures for berries from each flowering, around 90 days later.
- Important to understand that if you wait too long after the critical period for a particular plot, you're just wasting your money if you spray.

A.7 La Azulita (small farm, lower altitude, high CBB pressure. Fairtrade certified, member of Anserma Co-op). Mr Rafael Henao, Owner.

Incidence monitoring methods used: Uses one methanol trap for his 5ha farm, pouring trap water into a cloth to observe numbers of borers. Uses a 5cc syringe to guesstimate borer numbers when very large numbers trapped: 0.5cc level full equivalent to around 500 borers.

Borer position assessment: Not mentioned

Frequency and time involved: He checks methanol trap every 15 days.

Decision tools:

Uses flowering calendar to identify periods 90 days later when he needs to start control actions

From the date of 90 days after each flowering in each plot you have 1 month to take action, either manual collection, spraying *Beauveria* fungus or a chemical

Approximate numbers of borers caught in trap indicates whether population levels are rising and whether he needs to take further action (in conjunction with critical period indicated by flowering records). The trap functions as an alarm bell.

Views and tips:

- Carrying out actions at the right time is key for achieving very good CBB control and avoiding damage to your coffee. Control action on berries from scarce flowerings is just as important as from good flowerings because borers multiplying from the scarce flowering can jeopardise the main harvest if not controlled.
- Local FNC extension staff have worked closely with smallholders to help them improve their CBB management, promoting and disseminating methanol traps.
- If you can control rising levels with a ReRe picking, that's the best option.
- He prefers to do the monitoring himself. It's important for every farmer to pay attention to what is going on in the plots and not blame others but take care of tasks personally. Being organised and timely helps you keep costs low and win the battle against this pest.
- It's easy to record flowering episodes with the chart provided by the local committee. He also records rainfall with a simple gauge. He keeps records of CBB levels from his trap too. He'd like to get another one to monitor more closely in a susceptible plot on the lower part of the farm.

A.8 La Lila, Agrovarsovia Farms (large estate, medium altitude, medium-high CBB pressure. Certified Utz, Rainforest & Fairtrade). Mrs Marlen Sanchez, Mr Arlides Aricama, Internal Auditor and CBB Control Supervisor respectively.

Incidence monitoring methods used: Sample 30 trees across each plot, counting full size green berries only on one branch per trees to assess % incidence. Select 10 high, 10 medium and 10 low branches randomly across the 30 trees to get a better estimate of incidence.

Borer position assessment: Assessment always involves picking and dissect each bored berry from sampled branches to record borer presence and position: position 1 (equivalent to FNC position A/B); position 2 (FNC position C/D); alive; dead; or absent.

Frequency and time involved: They sample each plot every 15 days in order to make the best decisions. It takes the CBB supervisor around 3 hours to sample a 5ha plot and assess borer position in the berries.

Decision tools:

-They audit picking efficiency and check 10 trees at random across a plot, counting berries left on the tree and fallen, and if pickers have left considerable numbers of berries, the plot is picked again.

-Weekly meetings with farm manager, field supervisors and CBB control supervisor are essential to plan tasks for the next week and as an early warning if anything is going wrong.

-They employ a full-time CBB supervisor in charge of monitoring and control programme on each of the 5 farms, working closely with each farm manager. He was trained by local FNC and now has several years' practical experience developed with Agrovarsovia's careful auditing system and can compare the situation on the different farms.

-Using record sheets in the system devised by the internal auditor in the last two years is extremely useful for careful assessment and farm organisation. They use record sheets for coffee picking and separate ones for CBB control, disease and weed management, fertilisation.

- sampling % incidence every fortnight means they know exactly where hotspots are developing in a plot and can target those with sanitary collection or biopesticide application. Re-assessing 2 weeks later allows them to see whether control action has been sufficient or other actions are needed.

-They consider over 2% in more than 2 out of 30 trees sampled per plot as a hotspot, for extra control action and then further monitoring. For their system they prefer to take action well before the 5% threshold recommended nationally.

Views and tips:

- Monthly evaluation with the farm manager of each of the 5 farms is important for checking whether CBB control and other tasks are going well.
- For their system of control aimed now at replacing chlorpyrifos with biopesticides, they need to monitor plots more frequently than just at 90 and 120 days after flowering. They need to know well in advance of the critical time for control where CBB levels are rising above 2-2.5%, as it takes several days to carry out applications on a farm this size.
- They recognise that this level of intensive monitoring of picking performance and CBB levels requires considerable time and labour cost but farm owner and auditor are convinced that this is a worthwhile investment as they now have very low % of bored beans, very high quality score and achieving 3-4% price increases. You must consider the cost:benefit and the extra revenue from high quality beans.
- Sampling should never be straight in a line but in zigzags and you never sample trees just on the path edge or at the edge of the road or just those in the middle of the plot. You need to get a selection of tree sites.
- Some farmers mainly sample from the middle branches as that's easiest but you need to include high and low branches to get a more accurate estimate across the plot.
- You need to take time and care when dissecting berries for position assessment, you should not rush this job.
- Well trained farm managers, field supervisors, good communication with the CBB supervisor and with the quality control people at the trading mills is essential. They will take immediate action if the mill finds even 3 or 4 bored beans in a batch.

A.9 Las Brisas (medium farm, medium altitude, medium-high CBB pressure. Member of Risaralda co-op, certified Fairtrade, Utz, Rainforest, 4C). Mr Guillermo Londoño, Owner, and Mr Juan Pablo Salguero, Farm Manager.

Incidence monitoring methods used: Monitors 60 trees per ha in plots of 4-5 year old trees (where CBB attack is most likely) and in 6 year old plots before renewal.

Borer position assessment: Observe bored berries for positions A, B, C, D.

Frequency and time involved: Not mentioned

Decision tools:

-Farm has developed its own system based on intensive controls in hotspots. Trained monitoring staff identify any trees with more than 5 bored berries as a 'hotspot' tree, for extra control actions on this tree and neighbouring 6-8 trees. Hotspot trees are flagged with a yellow plastic strip and a white strip at the row end so that hotspot control staff can easily find the relevant trees.

-Has used local FNC committee record-keeping book to document CBB management plot by plot.

-Uses flowering register and involves all workers in reporting any flowering incidents.

-Farm maintains detailed records of all CBB control tasks, timings and inputs so he can assess costs.

Views and tips:

- His intensive hotspot monitoring and control system has enabled him to eliminate insecticide use and replace with good picking and cultural controls and application of *Beauveria* on the ground at hotspots.
- It's easy to train workers to record flowering. His workers are very conscientious and will note down as soon as they observe any significant flowering. The FNC chart is easy to follow, even for smallholders without secondary level grades, you just note down the flowering and you can see when you'll need to control the pest later.

Appendix B. Experience and advice from technical support organisations

Colombia:

FNC Buena Vista, Quindío Dept: CBB starts to attack berries 90-120 days after flowering (DAF). That's why we tell farmers they've really got to be 'on the ball' from 90 DAF and 120-150 DAF will be application time when borer is most active. If you spray after 150DAF you're totally wasting your money.

Important for farmers to understand that if the borer starts to bore into the berry flesh but finds the bean consistency is not yet right to bore into the bean, she'll wait in the tunnel. This is a critical stage for evaluation. Local FNC extension leaflet on CBB monitoring recommends farmers to assess borer position if plot incidence exceeds 2%. If live borers are found in the berry flesh in more than 50 of 100 bored berries dissected, extra control measures are needed.

FNC Anserma, Caldas Dept: FNC local committees produce very simple almanacs with colours so farmers can easily see when they need to take action. Rapid timing is essential for good control, if your 90 days after flowering falls on a Thursday and you don't get your product till the weekend and then spray it on Monday, that's 5 days gone and you may be too late.

The methanol trap methodology has been around for some time but you can't really use them in large farms because they're too large and the workers tend to steal them. Traps work well for small or medium farms where the owner does the checking himself.

CaféNorte co-operative, Cauca Dept: Just because a farm is small doesn't mean that it's easier to control CBB -, it's all about good management, including monitoring, and understanding that it's carrying out a set of practices. No single method alone will give you effective control of this pest.

Fundación Natura (Colombian member of Rainforest Alliance Sustainable Agriculture Network): IPM is a set of different practices which need monitoring, checking regularly what level of pest is in the crop and identifying areas with higher pest incidence. The farmer needs to be constantly monitoring to make sure CBB levels aren't increasing to the point that cultural control methods alone no longer work.

In addition, each farmer should know what his 'menu' of practices is and how he can implement them according to his particular circumstances. Fundación Natura's way of working is to focus on why we do things in a certain way, as much as the methods themselves. If we manage to get the coffee farmer to understand the reasoning, the logic behind the methods, it's much easier for him to implement and use them.

When a farmer decides to start sustainable practices for a certified standard such as Rainforest, part of those practices is monitoring the condition of the grove. Many certified farmers do sample but it's important they do it because they're convinced about it and it will help them make well-founded decisions. In Colombia the average age of coffee farmers is quite old and for some of them doing CBB samples or calculating percentages is not easy. However, many will get their kids or grandkids to help them. It's very much a requirement of Rainforest that farmers monitor their fields and understand why they need to do this – not just doing it because that's what the standard requires but because they really understand how monitoring helps with proper pest management.

Central America:

Technical support organisations and co-operatives do encourage farmers to monitor for CBB levels. **Exportadora Atlántica** trading company in Nicaragua recommend general monitoring for all pests and diseases. Certified farmers need to keep CBB levels below 5%, preferably less than 3%. It is very important to check on berries from any sporadic flowerings after 90 days. In their view, it's not too difficult for even small farmers to do monitoring. Good incidence sampling needs time (approx. half a day to monitor 7ha) and care but some farmers will do it because they've learnt how useful it is for their management.

Nicaraguan **SOPPEXCCA farmers' co-operative** considers CBB levels of over 5% as high. Co-op technical field agents recommend monitoring for CBB incidence, sampling 10 assessment sites per *manzana* (14 per ha) and 5 neighbouring trees per site, selecting high, low and intermediate branches. They recommend selecting different trees in zig-zag across the plot once a month. From feedback received, the co-op estimates that around 40% of its members do some form of incidence sampling to estimate % berries bored, some farmers will check fortnightly. It takes around 2 hours to carry out the sampling and calculation per *manzana* (just under 3 hours per ha) but this depends on the experience of the person sampling. Providing handlenses to farmers and workers involved in monitoring could help them spot CBB boring and recognise disease symptoms more easily as part of general observation of coffee pest and disease problems recommended by the co-op.

PROCAFE in El Salvador encourages farmers to sample to determine CBB incidence before applying PROCAFE's *Beauveria bassiana* biopesticide product. Using this threshold from field monitoring will avoid costs and make Beauveria application more effective.

They recommend assessing proportion of bored berries in future harvest in plots of up to 3.5 ha and using this data to decide whether or not control action is needed. El Salvador uses a level of 5% bored berries as the action threshold, above which economic loss will occur if control measures are not taken. Sampling forms can be obtained from PROCAFE centres. Their recommended sampling method:

- Divide farm into plots of 3.5ha each
- Identify 20 sampling sites in each plot, well spaced
- Identify 5 trees in a row at each sampling site
- Check 20 berries selected at random from each tree and note down number of bored berries (100 berries at each sampling site, totalling 2,000 berries per plot).