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Farm Case Study: Belmont Estate

Los Amates Canton, Santa Tecla municipality, La Libertad Dept. EL SALVADOR

Farm size: 96ha
Altitude: 1200m
CBB pressure in zone: Medium-High
Crop system: Part-shaded, interspersed with plantain (some plots renewed)
Coffee calendar: Defined main flowering, one harvest period per year.
Farm owner: Belmont S.A.
Certifications: Rainforest Alliance, since 2012

Don Abelino Escobar, Farm Manager
Credit: P Lievens, PAN UK

Methods used for Coffee Berry Borer IPM

Timely picking	✓
Sanitary collections	✓
Insecticides	
Biopesticides	
Trapping with methanol attractant	✓
Other physical controls	
Regular grove renewal	✓
Shade regulation	✓
CBB % incidence monitoring	✓
CBB position assessment	
Flowering register to forecast critical control periods	
Other methods	

*Methods in **bold** are considered the most important on this farm*

***IPM effectiveness*:** By combining trapping with cultural controls, Don Abelino has managed to maintain very low levels of CBB in beans, between 1-2% on average, despite no longer using endosulfan. Belmont estate has never received a defects report from the mill (issued when defects, including CBB damage, exceed 1% beans) even when borer levels locally were reaching 10%.

Background: In this zone, borer levels can easily reach 9-10% if CBB management is poor. Many large estates with highly technified groves have relied for years on spraying endosulfan two or three times per season, often without sampling to see if borer levels have exceeded the recommended decision threshold of 5%. For some farmers, it's almost a custom that they spray in May or June, regardless of borer levels. Endosulfan remains the main control method for CBB in El Salvador's coffee production, although the government recently announced plans to ban it.

Don Abelino manages Belmont estate, one of over 2,200 large and medium farms selling to coffee export company COEX. The company, along with around 50 of its suppliers which produce speciality or coffee certified under sustainability standards, faced major challenges in 2011 when Rainforest and Utz standards prohibited use of endosulfan. Starting with COEX own estates, company agronomists sought help from the national coffee research institute PROCAFE on effective methods for CBB control, which they could also roll out quickly to their certified suppliers. PROCAFE's IPM strategy promotes: use of improved cultural controls; CBB monitoring; application of *Beauveria* biopesticide (produced in their own semi-commercial lab); and use of traps with methanol-ethanol attractant. Researchers had collaborated for some years with French research institute CIRAD on trialling and refining trapping methods to suit Salvadoran conditions.

Don Abelino formerly applied endosulfan twice a year in plots which needed control, based on his regular sampling. He recounts that endosulfan could be very effective, however, if it rained shortly after application, he would need to spray again, at further cost. At other times, an application would simply fail to control the pest and levels would rise to 7-8%, requiring yet more spraying. Since COEX agronomists introduced him to trapping as an alternative, he has been delighted with the results, stopped all endosulfan use and succeeded in gaining Rainforest certification for the estate. Furthermore, he no longer risks his workers suffering ill health from pesticide poisoning and is not contaminating the environment with powerful chemicals.

Cultural Controls: Don Abelino usually organises just one round of pre-harvest sanitary berry removal ('*graniteo*') per season, if any early flowerings produce significant numbers of early ripening berries. He pays for *graniteo* collection at daily wage rate, rather than volume, to collect small quantities (20-30kg) of early berries (ripe ones and any green that are bored). He doesn't see the labour cost involved as a concern. In the 2013 season no *graniteo* picking was needed due to heavy attacks of coffee rust in 2012. On those trees that lost their leaves due to this disease, berries didn't develop properly and on others there was no early flowering the following season so berry ripening has been very uniform.

For post-harvest clean-up of groves ('*pepena*' collection), he prefers to buy back berries collected by workers and some local people. Likewise for the last harvesting round, of second grade berries, he feels it's better to buy these back, rather than pay workers to collect them as they will always leave some in the plot. Buying the berries encourages people to collect many more and the farm benefits (a) from getting rid of CBB from the groves and (b) obtaining more coffee to sell.

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Physical Controls: Berries collected in g*raniteo* picking are put in boiling water to kill CBB. Don Abelino says it is too risky just to bury these berries without this treatment.

Trapping: *Trap type:* Don Abelino uses home-made traps made from empty drinks bottles with 2 windows cut in the sides, with dispensers of methanol-ethanol mix supplied by COEX. *Dose*: 2cc attractant in each dispenser. He advises you can use 1 litre, 2 or 3 litre bottles, (the size doesn't matter) but less than 1 litre is too small to suspend the dispenser properly. He uses the same traps the following year. *Density:* He placed around 1,200 traps in 2013, equating to 17-20 traps per ha.

Don Abelino, Farm Manager, with one of his home-made traps, showing the methanol:ethanol dispenser. Credit: P Lievens, PAN UK

Positioning: Across all plots except those recently renovated. Hang at 90-100cm height irrespective of tree height. He increases density near neighbours' uncontrolled plots and where sampling reveals hotspots. Sometimes changes trap position to different trees halfway through dry season. *Timing of trap placement:* February to June. In later part of this period he 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, collected from seasonal workers and from collection bins the estate has placed outside local village stores.

*Maintenance***:** Check every 2-3 weeks**,** cleaning out trap water and refilling dispenser if necessary. 2cc of methanol lasts around 3 weeks. Pour 'soup' of dead CBB from each trap into a bucket and then bury this waste 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 in. Two men can put out 150-200 traps in a day, covering 7-10.5ha.

Comparison with insecticides: Very easy, very cheap and very effective. Approximate costs per ha for trapping: US$10-12 in traps with attractant + US$2 in labour for preparing and placing traps, totalling US$12-14 [+ maintenance labour].

Endosulfan application needs at least 700cc per 200 litre barrel, at cost of US$9-10 per litre. Labour required is 2 men for 2 days each to spray one barrel or 1.5 barrels for older trees (approx. 2 barrels per ha). For standard 2 applications per year, endosulfan spraying costs US$8.94-13.41 in product and at least US$25.56 in labour, totalling US$70-76 (+ diesel if motorised).

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Don Abelino reports excellent results with trapping, millions of CBB captured and he has not needed to apply any endosulfan since using the traps. Using traps and cultural controls has also reduced CBB incidence on the estate, which used to be quite high (some plots at 15-40%) even when they were applying endosulfan.

He 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. Trapping is much more economical for the farm and less labour-intensive than spraying. They've made considerable savings in control costs.

Monitoring and Decision-making: Don Abelino samples each plot to assess % CBB levels once or twice per season. In plots with higher incidence, he will increase the number of traps.

Biopesticide Use: None.

Insecticide Use: None applied in last two years for CBB control since using traps.

Recommendations

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 his workers used to almost collapse with suffocation wearing all the protective kit. With traps you don't need any special clothing or kit, the workers just walk round placing traps in suitable positions.

"On this farm we respect the environment and protect our flora and fauna", Belmont estate pulping station. Credit: P Lievens, PAN UK

You can start with fewer traps to learn the method and see for yourself that it works. He started with 500 traps in the first dry season and got good results, so he's increased numbers this year. He's found the more traps the better – especially in hotspots and to protect plots next to neighbouring farms where they're not controlling CBB.

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Trapping is a much more certain method than insecticides - you don't need to worry about poisoning risk or whether your spray application has worked or not. With traps, when it rains, you don't risk losing control or needing to repeat an application.

He advises not to put more than 2cc methanol in each dispenser because of issues with alcoholics who may search for full dispensers to drink. He's not had any problem with these small quantities per trap.

Try it out for yourself, whatever your farm size! You'll find it's easier, cheaper and less dangerous than using harmful chemicals.

Support organisation contacts

- COEX (Comercial Exportadora S.A.de C.V.) www.grupocoex.com René Fontan, Head Agronomist, email: renefontan@coex.com.sv
  See also the detailed cost comparison of trapping versus endosulfan use on COEX own estates, presented by René Fontan at the *Growing Coffee without Endosulfan* lesson-learning workshop, via the project webpages at http://www.4c-coffeeassociation.org/uploads/media/5_CoEx.pdf

- PROCAFE www.procafe.com.sv Dr Adan Hernandez, Technical Researcher, CBB IPM programme, email: cir97@hotmail.com

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Farm Case Study: La Azulita (small farm)

El Paraíso District, Anserma Municipality, Caldas Dept. COLOMBIA

Farm size: 5 ha
Altitude: 1270 m
CBB pressure in zone: High
Crop system: Part-shaded, interspersed with plantain (some plots renewed). Fruit trees + poultry.
Coffee calendar: almost continuous flowerings, with two main harvest peaks
Farm owner: Mr Rafael Henao
Certifications: Fairtrade (via Anserma Co-operative membership) since 2008

Don Rafael Henao, Farm Owner
Credit: P Lievens, PAN UK

Methods used for Coffee Berry Borer IPM

Timely picking	✓
Sanitary collections	✓
Insecticides	✓
Biopesticides	✓
Trapping with methanol attractant	
Other physical controls	
Regular grove renewal	
Shade regulation	
CBB % incidence monitoring	✓
CBB position assessment	?
Flowering register to forecast critical control periods	✓
Other methods	

Methods in ***bold*** *are considered the most important on this farm*

IPM effectiveness**:** Good, regular picking is the key. With continual harvesting and sanitary pickings done in a timely way, Rafael is achieving 2-3% CBB levels on his farm, with some insecticide application, based on careful timing and monitoring, and occasional use of *Beauveria*.

Background: Caldas Department suffers some of Colombia's highest levels of CBB. Borer levels can easily exceed 7% and even reach 15% on poorly managed farms in the lower zones, like the district in which Rafael's farm lies.

Rafael is a member of the Anserma Coffeegrowers Co-operative and, like many of the co-op's smallholder members, is certified Fairtrade. Endosulfan use has been prohibited under Fairtrade standards since 2005. However, illegal endosulfan use, including mislabelled and contraband products, has been a serious problem in Caldas and the Anserma co-op had its Fairtrade licence suspended three times between 2007 and 2009 due to incidents of unauthorised use by some farmer members. In response, the co-op launched a poster and radio campaign to urge local farmers to stop using endosulfan, warning them of the health risks and the negative consequences for their coffee marketing. The co-op invested resources into integrated management of CBB without endosulfan, in collaboration with extension staff from the local National Coffeegrowers Federation (FNC), to provide every member with group training and farm visits for specific advice. FNC staff worked closely with smallholders to help them understand the borer lifecycle and how it can be managed and have disseminated flowering register charts and methanol traps for better monitoring and control decisions. The co-op organises twice-yearly collections of empty pesticide containers in each municipality, jointly with the agrochemical industry's *Clean Field* programme, and has succeeded in eliminating members' use of unauthorised or expired products.

Rafael with his methanol trap for CBB monitoring. Credit: P Lievens, PAN UK

Cultural Controls: Rafael does regular pickings every 15 days (which is relatively easy in this zone as the warmer climate means the berries ripen faster), plus sanitary collections when needed. He puts berries from sanitary pickings into water to drown any borers inside and avoid them breeding. No costs were given but he's found that being organised and timely saves him money in the end due to reduced borer damage.

Monitoring and Decision-making: Rafael's first decision tool is the flowering calendar, in which he notes each flowering episode so that he can identify the 'critical control' periods starting 90 days later when he will need to monitor and possibly take control actions. He highlights that from 90 days after each flowering in each plot, a farmer has one month to take action, either manual collection, spraying *Beauveria* fungus or a chemical.

He also uses one methanol trap for his entire farm, which he checks every 15 days by pouring trap water into a cloth to count the numbers of borers caught. When very large numbers are trapped, he uses a 5cc syringe to estimate borer numbers: 0.5cc level full is equivalent to around 500 borers. The approximate numbers caught indicate not only when female borers are flying to infest new berries, but whether his grove population levels are rising and whether he needs to take further action (in conjunction with critical periods indicated by his flowering records). For Rafael, the trap functions as an alarm bell, although he'd like to obtain some more to monitor other plots more closely. He prefers to do the monitoring himself and take care of tasks personally.

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Biopesticide Use: Rafael sometimes makes a *Beauveria* application (no product specified) once a year, where needed, according to data from the methanol trap and flowering calendar, to protect developing berries. *Dose rate*: 1 small bottle per 10 tankfuls. *Cost per ha application*: approx. US$22 + US$14 labour. He's found that if you apply the fungus in good time, it can prevent CBB from boring into beans and works better on the lower branches. He doesn't consider it very costly and advises that if you keep applying it, *Beauveria* becomes established in the groves, easily observable, and this makes it easier for you to keep the pest under good control mainly with cultural controls.

Rafael explaining how he records flowering episodes to predict when he will later need to take control action for CBB. Credit: P Lievens, PAN UK

Insecticide Use: Rafael only sprays insecticide as a last resort if his cultural controls fail to keep CBB levels acceptable. Spraying can usually be avoided if frequent pickings are done in good time. *Dose rate*: 2 litres chlorpyrifos + 2 litres cypermethrin for one application on a problem plot. Cypermethrin costs US$9.86 per litre and chlorpyrifos US$8.77. He considers the costs quite economical and the products effective.

Recommendations

With good, timely cultural practices you should be able to keep CBB levels under control for most of the time, without the need for applying insecticide.

Don't spray chemicals when the borer is already inside the bean as the chemical cannot reach them. Instead, you need to remove those berries and put them in water to drown the pest.

Keeping on top of things, checking and paying attention to detail is important, even for the smallest farm.

Farmer contact: email (via his son) rafita.henao@gmail.com

Support organisation contacts

- Jhon Fredy Arias, Anserma Coffeegrowers Co-op, email: jhonfredy.arias@coopcafianserma.com and Juan Pablo Quintero, Anserma Co-op and Agrocopa floriculture & agronomic advice, email: jpablo80@hotmail.com

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Farm Case Study: La Palmera Estate

La Loma District, Anserma Municipality, Caldas Dept. COLOMBIA

Farm size: 200 ha
Altitude: 1600 m
CBB pressure in zone: High
Crop system: mainly unshaded, highly technified monoculture (groves renewed every six years)
Coffee calendar: almost continuous flowerings, with two main harvest peaks
Farm owner: Dr. Jesús Octavio Rodriguez E.
Certifications: Rainforest Alliance; Fairtrade (via Anserma Co-operative membership)

Information supplied by Don Alfonso Gómez, Farm Manager

Methods used for Coffee Berry Borer IPM

Timely picking	✓
Sanitary collections	✓
Insecticides	✓
Biopesticides	✓
Trapping with methanol attractant	
Other physical controls	✓
Regular grove renewal	✓
Shade regulation	
CBB % incidence monitoring	✓
CBB position assessment	?
Flowering register to forecast critical control periods	✓
Other methods	

*Methods in **bold** are considered the most important on this farm*

***IPM effectiveness*:** Very good cultural controls, along with regular applications of *Beauveria*, achieve 4-5% CBB on average, although some plots have only 1-2%.

Background: Caldas Department suffers some of Colombia's highest levels of CBB. Borer levels can easily exceed 7% and even reach 15% on poorly managed farms in the lower zones.

Years ago Don Alfonso used to run a contract spraying company, using endosulfan products on coffee farms**.** But over time he witnessed the huge damage that widespread endosulfan spraying was doing to the wildlife, with birds killed and snakes and small animals dead on

the ground after every application, and serious risk to humans. He decided to change jobs after several poisoning incidents with some of his work team and became a farm manager, keen to find safer methods of pest control. He has managed La Palmera estate for two years and is aiming to reduce insecticide use and replace it with safer methods, including *Beauveria* biopesticide.

Cultural Controls: Don Alfonso stresses the importance of maximising good cultural controls, with very frequent regular picking and sanitary collections. It can be hard to hire workers to do this work, but you need to try and get these controls done as well as possible, especially removing left-over berries. He pays the farm spray team to do sanitary collections in the winter period when they're not spraying and this helps a lot to reduce CBB reproduction. Good supervision of the work is essential.

Physical Controls: He organises the harvesting and sanitary berry collection tasks so that CBB don't get transferred from one plot to another when transporting berries. It's important to keep sacks of harvested berries closed tight and use greased covers to trap any borers emerging from left-over berries during collection. After each harvesting round, workers collect any remaining berries on branches into 5 litre plastic pots cover with greased plastic. These pots are left for 1-2 days and will trap any CBB emerging and kill them as the contents heat up. This practice also serves as a measure of how much CBB there is in berries left in a particular plot.

Monitoring and Decision-making: The team does regular incidence sampling in each plot, even though control actions are almost always needed on this farm, due to high pest pressure. He uses the flowering register to plan exact control periods in advance. You can almost use the register alone to plan controls but he prefers to back it up with plot sampling for actual % level. This also helps to identify CBB hot spots, often on the lower parts of the farm, the borders, or where coffee collected gets weighed. The estate focuses chemical or biopesticide applications in hotspots, not necessarily a general application.

Don Alfonso Gómez next to the farm work plan, showing different activities scheduled and recorded, including CBB control actions.
Credit: S Williamson, PAN UK

Incidence sampling is important to see whether you've managed to reduce levels after control actions.

Don Alfonso has sometimes hired young men trained as CBB scouts, who charge US$3.85 to assess CBB % and position per hectare, but their services are much in demand and scouts are not always available.

Biopesticide Use: In recent years, the estate has started using *Beauveria* biopesticides, as an alternative to conventional chemical control. *Product:* Brocaril ® (Laverlam) *Dose rate*:

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50g product per 200 litres water, with 300-400 litres per ha according to tree size/age. *Cost per ha*: approx. US$10-13 in product + US$22 in labour. This is similar to or a little more expensive than insecticides, as the cheapest generic chlorpyrifos product costs around US$10 per ha, using 3 litres. *Frequency*: 3 applications of Brocaril® per year around 90-120 days after flowering, in plots requiring treatment according to monitoring results.

Don Alfonso has found Brocaril® very effective because it can 'wipe out' all the borers it reaches. He feels it's better than many insecticides if applied just as the insect starts to enter the berry. Beyond direct kill by contact, the fungus will spread in the environment and infect more CBB. It also exerts very good control on CBB present in any fallen berries. But farmers need to understand that *Beauveria* works differently from chemical products, it takes more time (up to 10 days) but then has a longer-lasting impact as it spreads. You can't use it as an emergency, last-minute control and just like an insecticide, if you wait too long during the critical control period, the borer will be out of reach and you'll end up wasting your money.

Insecticide Use: After stopping endosulfan use some years ago, Don Alfonso first managed CBB with good cultural controls and chlorpyrifos. At La Palmera he began reducing insecticide applications and introducing Beauveria use and the estate currently uses low amounts of chlorpyrifos on worst affected areas only. Chlorpyrifos can be effective but you have to spray at exactly the right time.

Views and plans

Don Alfonso estimates that La Palmera could end up managing CBB without any insecticides, just with Brocaril® spraying on top of very good cultural controls. This is his plan, with support from the farm's owner and son who has returned from abroad to take an active role in making the estate more sustainable and gain speciality coffee clients. They recently hired a staff member trained in the US on use of botanical extracts in organic farming to test different local plants for CBB control. Field trials conducted this season in different plots have shown very high CBB mortality (over 80%) using a mixture of plant extracts, with hemp fibre as sticking agent. If further trials are successful, the estate may produce the extracts for sale. They already sell several tons a year of worm composted organic fertiliser produced in large vats.

Don Alfonso with La Palmera's branded 'worm juice' produced from on-farm vermiculture.
Credit: S Williamson, PAN UK

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Recommendations

Please stop using endosulfan - it's killing people and all the fauna! It's perfectly possible to control CBB on a large farm without endosulfan, using very good picking and sanitary controls and applying biological products.
Make a start by applying *Beauveria* products in a very well-timed manner, instead of endosulfan, for immediate control and to build up background levels of the fungus in your groves. *Beauveria* can control CBB in fallen berries but effective cultural controls are essential too.

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Farm Case Study: Las Brisas (medium size)

El Hogar District, Pereira Municipality, Risaralda Dept. COLOMBIA

Farm size: 25 ha
Altitude: 1450m
CBB pressure in zone: Medium-High
Crop system: Part-shaded, with plantain borders and intercrop rows. Plots renewed after 5th year harvest.
Coffee calendar: almost continuous flowerings, with two main harvest peaks
Farm owner: Don Juan Guillermo Londoño
Certifications: Fairtrade and 4C (via Risaralda Co-operative membership); Rainforest Alliance; Utz Certified; since 2010

Don Guillermo Londoño, Farm Owner. Credit: S Williamson, PAN UK

Methods used for Coffee Berry Borer IPM

Timely picking	✓
Sanitary collections	✓
Insecticides	
Biopesticides	✓
Trapping with methanol attractant	
Other physical controls	✓
Regular grove renewal	✓
Shade regulation	
CBB % incidence monitoring	✓
CBB position assessment	✓
Flowering register to forecast critical control periods	✓
Other methods	

*Methods in **bold** are considered the most important on this farm*

***IPM effectiveness*:** Don Guillermo's 'cultural-ecological' system is based on careful and frequent monitoring to identify CBB hotspots and then carry out intensive sanitary controls and application of Beauveria to the ground around each hotspot. This system achieves 1.5% CBB levels even in last season's high attack rate, following an unusually hot summer.

Background: In this part of Risaralda the warmer climate encourages rapid borer multiplication and levels may easily reach 6-8% even with decent cultural controls. Don Guillermo took an active decision not to rely on insecticides when he bought the farm some years back, even though CBB levels were up to 18% on some of the plots and the extension service agents were advising him strongly to spray. Instead, he developed his own CBB management system, based on intensive sanitary picking at hotspot trees and neighbouring trees, complemented with *Beauveria* applications to the ground beneath the foliage, to control any borers surviving in fallen berries. He and his farm manager have trained two young women to work regularly on hotspot berry collection and help monitor groves to check whether control actions have succeeded in reducing CBB levels.

Las Brisas has obtained Rainforest and Utz certifications through Don Guillermo's initiative and he is a member of *Entre Verdes* speciality coffee producers' association in Pereira, with client companies interested in top quality and environment-friendly practices. Don Guillermo avoids use of herbicides, maintaining a moisture-conserving mulch of plantain leaves with non-competitive broad-leaved weeds and leguminous plants between his coffee trees, which help *Beauveria* work well in this shady micro-climate. He is proud that he has not used any insecticide for over 10 years on his coffee and now produces insecticide-free plantain. His CBB programme is certainly labour-intensive in monitoring time and thorough sanitation but he benefits from better berry-bean yield ratios and selling quality coffee at a higher price. He motivates his workers with good day rates, rather than piece rates, for time-consuming tasks and prizes for the picking team which collects the least green berries during harvest and the most dried berries after harvest rounds, to deliver excellent grove management.

Farm Manager, Don Juan Pablo Salguero, demonstrates how they mark CBB 'hotspot' trees with yellow ribbons, for more intensive cultural controls and biopesticide application to the ground under the tree. Credit: S Williamson, PAN UK

Cultural Controls: Regular harvest pickings of mature berries every 21 days, increased to every 15 days in plots with higher CBB levels. Hotspot sanitary controls every 3-4 weeks after major and minor harvest periods. These consist of rigorous collections from identified hotspots (trees with more than 5 bored berries from sampling) and their 6-8 neighbouring trees, removing all berries from the ground and any overripe or dry berries on the branches.

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When cutting back groves to renovate trees, they first collect all the green and developing berries, to prevent CBB migrating to infest nearby plots when the trees are cut down.

Physical controls: Berries collected from hotspots and from second harvest passes are collected in greased lidded containers (to capture any borers emerging) and put into hermetically sealed barrels for 24 hours. As berry fermentation starts, carbon dioxide gases released kill any CBB inside or emerging. Many of these berries can then be processed and sold as 2nd grade beans. Don Guillermo employs good controls (mesh filters, greased plastic covers, smooth-lined delivery funnels) at pulping and processing stations to prevent CBB re-infesting from pulp or collection containers.

Monitoring and Decision-making: Las Brisas 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. Staff then dissect bored berries to assess borer position. Hotspot trees are flagged with a yellow plastic strip and a white strip at the row end so the hotspot control team can easily find the relevant trees.

The farm manager involves all workers in reporting any flowering incidents and uses the flowering calendar to forecast critical control periods. Don Guillermo has been using his original record-keeping book provided by the local Coffeegrowers Federation extension service to document his CBB management plot by plot and now maintains detailed computerised records of all CBB control tasks, timings and inputs so he can assess costs.

Biopesticide Use: *Product used*: Brocaril® (Laverlam). Farm used Conidia® too but found Brocaril is better, even though more expensive than national *Beauveria* products. Applies only on the ground on plots with tall trees (4-5 years old) when monitoring shows high CBB levels in fallen berries. Don Guillermo has found this product works very well to prevent re-infestation from CBB breeding in fallen berries. He doesn't consider costs too high as spraying is limited to the ground under certain trees on a maximum 40% of his groves (in the remaining 60% of younger trees they use only cultural controls). However, farmers need to be aware that biological products need to get established and they work more slowly than chemicals.

Mixed banana and plantain cropping with coffee groves at Las Brisas farm, with plots mulched and with non-competitive vegetation left to provide favourable microclimate for Beauveria fungus action.
Credit: S Williamson, PAN UK

Don Guillermo's experience is that encouraging several farmers in neighbouring farms to all apply fungus at the same time can help a lot to increase natural levels and reduce CBB pressure on everyone's farms. He draws attention to the recent increase in *Beauveria* use by many more farmers in this area since 2011, even on large estates, thanks to

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availability of new products of better quality, with more aggressive *Beauveria* strains. Agricultural supply stores and the National Coffeegrowers Federation extension service now prioritise biological and cultural controls, with insecticides only recommended as a last resort. Companies selling biological products in Risaralda Dept. have contracted agronomists to run demonstration trials and train farmers in biopesticide use. With effective promotion and seeing *Beauveria* in action on others' farms, farmers are getting more used to the concept of fungal biopesticides. Risaralda Coffee Co-op actively promotes their use, selling *Beauveria* products in its 16 supply stores and no longer sells any products prohibited by any of the certification standards, even if approved at national level. Fear of worker poisonings from insecticides (a considerable problem in Risaralda Dept.) has also been a factor for change in attitudes, plus awareness-raising of pesticide risks by the departmental Health Secretariat.

Insecticide Use: None

Recommendation

Make sure you're only leaving green berries on the trees- that's the most important thing.

It's very bad practice to risk pesticide poisoning- Don Guillermo wishes all coffee farmers would commit to stop using hazardous chemicals.

You need a dedicated and well-trained farm manager, foremen and pickers for effective CBB management. It's best to train a few permanent staff to do the intensive controls.

When using *Beauveria* and other biological products, you've got to be patient because you won't see immediate results. If you keep applying it until the fungus gets established, you then start seeing the effects.

Support organisation contacts

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Farm Case Study: López Brothers (medium-sized farm)

Los Cerrones 2 district, Jinotega municipality, Jinotega Dept. NICARAGUA

Farm size: 20ha under coffee
Altitude: 900-950m
CBB pressure in zone: Medium
Crop system: Mainly part-shaded Catui variety, with a few plots unshaded (plots renewed on a fairly regular basis). Plus land under maize, beans, pasture.
Coffee calendar: defined main flowering, with one harvest period per year
Farm owner: Mr Bernardo Antonio López J.
Certifications: Fairtrade since 2005 (via local co-op affiliated to SOPPEXCCA marketing & services cooperative)

Methods used for Coffee Berry Borer IPM

Timely picking	✓
Sanitary collections	✓
Insecticides	
Biopesticides	
Trapping with methanol attractant	✓
Other physical controls	✓
Regular grove renewal	
Shade regulation	✓
CBB % incidence monitoring	
CBB position assessment	
Flowering register to forecast critical control periods	
Hotspot identification	✓

*Methods in **bold** are considered the most important on this farm*

***IPM effectiveness*:** Bernardo is achieving very good results now with careful cultural controls, especially pre-harvest, and use of methanol traps. CBB levels are well under 5% on his farm and he's not been penalised for poor coffee quality since he started more intensive cultural controls in 2008 and then introduced trapping from 2011.

Background: CBB pressure can be high in this zone, especially on farms at lower altitude, and in localities where several neighbouring farms are under poor management, with dense, very tall, unpruned groves, sometimes virtually abandoned due to low coffee prices in the

last three years. The López Brothers farm suffers both these disadvantages, with borer migrating into their plots from neighbouring farms where little effort is made to control the pest. Although CBB had been present in the area for at least a decade, Bernardo had no major problems until five years ago, when his first 80 sacks of parchment beans processed were totally full of borer and he lost a lot of money. Several other farmers locally had entire batches rejected for export by the trader mill. This experience acted as a wake-up call and Bernardo started to put real effort into CBB management across the whole farm.

He had used endosulfan once many years before but that was no longer an option since his co-op gained Fairtrade certification, which prohibits its use. Besides that requirement for co-op members, Bernardo had always been reluctant to spray a lot of insecticide, particularly as some larger neighbouring farms had had workers poisoned on more than one occasion handling endosulfan and they had to be rushed to hospital for stomach pumping. To avoid such problems, he looked for safer and less polluting methods, starting with sanitary removal rounds of early ripening berries ('*graniteo*'), which he had not bothered with before. He then heard about methanol trapping, from a nearby large estate which had started using commercial traps, and went to see them in action, before taking part in the first trap promotion project with SOPPEXCCA technical staff in 2011.

Cultural Controls: Bernardo now does 3 pre-harvest *graniteo* collection rounds in Aug, Sep and Oct, removing all ripe and ripening berries, plus any green ones that are bored. *Labour requirements:* 1st round takes 50 person/days for his farm (equivalent to 2.5 days per ha). 2nd round has more berries ripening so needs 4 days per ha. 3rd round is heavier still and needs 10-15 workers over several days but those berries will have very little infestation and most should be good marketing quality.

Seedlings of disease-resistant varieties in López Brothers coffee nursery. Credit: S Williamson, PAN UK

For post-harvest sanitation, he allows locals to collect *pepena* berries for free from branches and ground. Some farmers don't like to give away the *pepena*, they pay somebody half rate to collect it, but he finds it better to allow local people to get the benefit directly, even in plots where a lot falls to the ground. Very occasionally a few workers may deliberately drop berries during harvesting or even hide some to collect for themselves later under *pepena*, so he has given them a warning and had to dismiss a couple. His workers do a further collection of any remaining berries they notice during tree pruning time a few weeks later so altogether he achieves a good clean-up before the next season with almost no additional labour cost.

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Bernardo does not consider *graniteo* expensive or very time-consuming and points out that it's cheaper than the cost of spraying endosulfan over 20ha. *Graniteo* needs careful work as the berries are scattered and take time to find and workers can only collect a few kilos in a day. He's found it very important to collect these early berries in good time to reduce borer breeding and prevent it from moving onto healthy developing berries.

The microclimate of Los Cerrones zone is often very cloudy and misty so shade regulation is important for borer control. He likes to prune back shade trees to limit shade to 50-60%, as well as conduct a good annual pruning of coffee trees.

Physical Controls: Bernardo puts graniteo berries in boiling water to kill pest. Some of the damaged berries will have clean half beans so he dries these and keeps them to sell later when traders are buying poor quality coffee at harvest end, so he gains a little income from these. Remaining berries collected during coffee pruning are spread to dry on racks in the sun. The dry season heat will kill most of the borer in these berries and the beans can be sold.

Don Bernardo López, Farm Owner, showing one of his traps for CBB. Credit: S Williamson, PAN UK

Trapping: *Trap type:* Bernardo makes home-made trap containers by cutting 4 entry 'windows' into empty 1.5 or 3 litre soft drink bottles. He's found it very easy to obtain sufficient empty bottles for his farm (about 360 needed for 14ha of trees of fruiting age) by paying a local youth to bring him bottles at US$ 4 cents equivalent each. He buys the methanol:ethanol attractant and syringes used as dispensers from SOPPEXCCA field agents. Each syringe is dosed with 5-6cc methanol and suspended inside the bottle with string. Washing detergent added to trap water to make it more difficult for borers to escape. *Density:* The co-op recommends 22.7 traps per ha but Bernardo prefers to place them closer at 25.6 per ha and increasing up to 35.5 per ha in the most infested parts. *Positioning:.* 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. *Timing:* in the dry season. Traps will catch only a very few CBB in the rainy season as these will prefer the ripening berries.

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Maintenance: Check traps every 15-20 days to empty and see if methanol needs refilling. Bernardo likes to do this himself to make sure it's done well**.** Labour requirements: For 360 traps on 14ha, estimated 2 person/days to make traps and 6 days to place them out. For checking and refilling, another 5 person days. Total labour equivalent to 0.93 days per ha. Labour cost at US$5 per day, equivalent to US$4.65 per ha. *Cost of traps and attractant:* Pays US$0.04 per empty bottle. Methanol and syringes obtained on credit from SOPPEXCCA [at US$0.21 per trap worth], equivalent to US$5.33 per ha. Total cost for first year's use at Bernardo's increased density = US$10.02 per ha for traps + labour. *Comparison with insecticides***:** one endosulfan application estimated at US$10.65 per ha incl. labour, but excluding diesel for motorsprayer or sprayer maintenance. Some farms spray endosulfan 2 or even 3 times per season. Trapping is zero health risk for workers compared with high risk of poisoning using endosulfan.

Bernardo is very pleased with the good results from the traps, which 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). Trapping is a method that doesn't harm anybody, neither the person consuming the coffee nor the worker in the field, and his work team much prefer working with traps as less arduous than insecticide spraying. He's not had any problems with anybody drinking the methanol but he did have 0.5 litres go missing from his storage shed so he now keeps access to the bulk supplies strictly limited. He views the commercial traps (US$1.60-2.00 each) as rather expensive and because they're novel and bright red, kids will often steal the ones visible from the roadside. With home-made versions, nobody steals those made from old bottles.

Monitoring and Decision-making: Bernardo does not carry out full incidence sampling but regularly visits his plots to check for problems in general and knows where the CBB hotspots are. He does check approximate levels of CBB in berries picked in *graniteo* collections. He's not sure of his exact % level this season but estimates it well under 5% and has observed low incidence in *graniteo* berries picked so far.

Biopesticide Use: None. Bernardo is aware that some farmers find Beauveria useful but he doesn't think it makes sense to apply it in his groves because he has made several fungicide applications for various diseases.

Insecticide Use: None

Recommendations

You mustn't let those early ripening bored berries fall to the ground or you get real problems later. Two careful rounds should mean you start the harvest season with little infestation. You must also make the effort with boiling water treatment for all the *graniteo* berries collected, otherwise you may end up re-infesting plots.

Labour costs for *graniteo* collection can seem a lot but if you look at the figures, that small amount of coffee removed will mean fewer berries affected in the next month or at harvest.

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You need to realise that in the end you don't lose out by paying this labour cost as you're avoiding too much damage later on.

You can quickly learn how to do trapping, you simply need to take care, for example, it's important to make sure the bottles are hanging perfectly straight and not leaning against branches, to avoid any borers crawling out.
If all farmers undertook better manual practices, CBB levels would be lower in general and everybody would benefit. Abandoned or poorly managed plots just breed lots more borer. If you leave this pest uncontrolled, the population in your groves will take off like a rocket!

Bernardo recommends for farms in this zone good shade and weed control, a thorough clean-up after harvest, using the methanol traps and careful *graniteo* collection is very important. He recommends all farmers to stop using harmful products like endosulfan because they are risking the health of their workers or for smallholders, themselves and their families.

Support organisation contacts

- SOPPEXCCA co-operative: Erik Antonio Morales, technical and training department, email: erk2676@gmail.com; co-op extension agent for Jinotega municipality, Marlon López, email: marlonantoniolopezrivera@yahoo.es

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Farm Case Study: La Consentida (Smallholder Farm)

San Lucas District, San Juan del Rio Coco Municipality, Madriz Dept. NICARAGUA

Farm size: 2.8 ha
Altitude: 1050m
CBB pressure in zone: Medium
Crop system: Shaded, traditional varieties (mainly Caturra-Bourbon + a few Catimor). 1,000-2,000 trees replanted annually, if resources permit. Fruit trees + poultry + beehives.
Coffee calendar: defined main flowering, with one harvest period per year
Farm owner: Doña Maritza Colindres
Certifications: Fairtrade and Organic since 1999 (via her local co-op membership affiliated to regional marketing and services federation PRODECOOP)

Doña Maritza Colindres, Farm Owner, in her coffee nursery. Credit: S Williamson, PAN UK

Methods used for Coffee Berry Borer IPM

Timely picking	
Sanitary collections	✓
Insecticides	
Biopesticides	✓
Trapping with methanol attractant	✓
Other physical controls	✓
Regular grove renewal	
Shade regulation	
CBB % incidence monitoring	✓
CBB position assessment	
Flowering register to forecast critical control periods	
Hotspot identification	✓

*Methods in **bold** are considered the most important on this farm*

***IPM effectiveness*:** Careful and well-timed cultural controls, along with application of Beauveria semi-commercial product once a year, work really well on Doña Maritza's farm to keep CBB levels around 2%.

Background: In this medium altitude zone, farms that don't pay attention to proper cultural controls can easily reach 10% CBB levels or higher in seasons with weather favourable to the pest reproduction. CBB breeding rate and resulting damage can be high in traditional, 'non-technified' groves, with dense foliage and heavy shading, or where small farmers may not carry out annual pruning and cannot afford to renew groves regularly, especially when coffee prices are low.

Doña Maritza is a local community leader and active in promoting organic farming and the Fairtrade movement. The benefits from the price premiums for organic and the guaranteed price from Fairtrade have been very important for smallholder families, like hers, when conventional coffee prices are low. Despite her years of experience, she attends all the training provided by PRODECOOP and is currently taking part in fortnightly Farmer Field Schools run by *Café Nica* project to improve organic production, mainly in relation to shade regulation and biodiversity conservation.

Doña Maritza demonstrates picking of early ripening, bored berries from branches for pre-harvest cultural control. Credit: P Lievens, PAN UK

Doña Maritza feels strongly that all coffee sector organisations should do more to help poorer farmers control CBB – too many farmers do few or ineffective controls and often see bored coffee as 'normal'. Many local traders hinder efforts to control the pest because they pay the same price for bored as for clean beans, with no recognition of quality. Commercial agrisupply stores only recommend chemicals for borer control, they'll never advise farmers about cultural controls, traps or biopesticides. In her experience, farmer organisations make a real difference, along with the rules of certified standards that non-chemical pest methods should be preferred. She predicts that use of endosulfan will rise among unaffiliated farmers as soon as coffee income increases.

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Cultural Controls: These comprise one or more rounds of pre-harvest selective removal of bored early ripening berries (*graniteo*) and a sanitary removal of remaining berries on branches and from the ground post-harvest (*pepena*). Doña Maritza carries out 2 rounds of *graniteo,* in late July and early October, removing the ripe berries from the very limited early flowerings. These early berries are almost always bored in this zone.

Graniteo pickings need around 3-4 person/days per hectare for good collection, carefully selecting the berries. This is not a major expense if using family labour alone. For hiring 1-2 workers, it costs US$35 per ha plus their lunch. *Graniteo* collections are very important to keep the pest from spreading. Doña Maritza understands that each borer can produce up to 60 new ones, so many harvest beans will be damaged if you let borers reproduce in the berries from early flowerings.

She always permits her picking workers to stay to take the *pepena* berries, along with some local landless people, so this does not incur labour costs for her farm. If it's been very rainy and lots of berries have fallen during the harvest, people might collect up to 9kg per day which they can sell unprocessed to local traders and this income helps poorer families to buy rice and sugar. Doña Maritza just makes sure one of her family or a permanent worker is around to do a little supervision during this clean-up.

Physical Controls: Doña Maritza puts all ripe bored berries from *graniteo* collection into boiling water for 10-15 minutes to kill any live borers and prevent them breeding. These beans are normally too damaged for sale but she sometimes separates out any clean kernel halves for home consumption if the infestation level is not too high.

Trapping: She makes some use of commercial methanol-baited traps, obtaining 6 traps at US$2.00 each in 2011 and placing these every 10m in the hotspots only. She hangs these about 1m high and checks traps roughly once a week. Traps are placed in September when CBB emerge from the ripening berries and in March, after harvest, when borers start flying again. Doña Maritza reports that the traps are good as they attract and trap lots of borers. Not much work is needed to hang out and maintain them - you just need to be careful and methodical. However, she feels the commercial traps are expensive.

Monitoring and Decision-making: Doña Maritza carries out a regular diagnosis of pests and diseases in different plots to find the most affected areas. She does not carry out detailed plot sampling for CBB but will start to assess the level of borer attack in early berries as they turn yellow. In July she had recently visited different plots and assessed CBB levels about 1-2%, which is low for this zone. She has also taught her children how to recognise bored berries so they understand about the pest and when it needs to be controlled.

Biopesticide Use: She has been using *Beauveria* semi-commercial products for many years, produced and promoted by a few farmer co-operatives in the coffee-growing regions. *Product used*: *Beauveria* rice+ spores pack from a small biopesticide lab affiliated to PRODECOOP supply and services regional co-operative. *Dose rate*: Pack for 0.5 manzana dose (0.35ha) contains around 300g rice with spores. She uses equivalent of 2.84 'dose' packs per ha. *Cost per ha application*: US$11.34 per ha in product + labour. [This compares with US$ 9.37-15.62 per 1 ha dose of endosulfan with prices obtained from 3 different

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agrisupply stores, July 2013]. *Frequency*: Once per year, in late July – early August when CBB is starting to attack growing berries when the bean is filling out.

Doña Maritza's experience is that spraying *Beauveria* can control CBB attacking the bulk of green berries left after *graniteo* collections. If sprayed at exactly the right time, she's found it can completely prevent bean damage at harvest. If she can afford it, she will treat all the groves, otherwise just the worst affected areas. She stresses the importance of understanding how *Beauveria* works and how to look after the fungus. You should apply within 12 hours of the product being taken out of the fridge, otherwise the spores may die, and it's best to spray when cool and cloudy. Unlike endosulfan, which gives a visible result within 3 days, *Beauveria* takes much longer. You may not appreciate the full effects until the following season after the fungus has been reproducing in the grove but you should see reduced bean damage at harvest the same year. One advantage of this method is that as long as you don't apply other products that might compete with *Beauveria*, the fungus will develop and persist among the trees, so it helps you to cope with the pest long term. After several years' application, her background levels of fungus increased a lot, helping to control CBB naturally. Another advantage important for organic farmers like her is that, unlike endosulfan, it will not harm soil life or the beneficial microorganisms that help the plant thrive.

Coffee zone scenery near La Consentida farm, San Juan Rio Coco. Credit: S Williamson, PAN UK

The main disadvantages are the logistics of obtaining and quickly spraying a product which does not keep for long. *Beauveria* spores are not readily available- no conventional agrisupply store in her nearest town stocks it- so it takes her 2 hours' bus journey to buy packs from PRODECOOP direct. Also, many smallholders cannot afford to buy *Beauveria* this year due to the tough economic situation (very low coffee price in 2012 and heavy yield losses due to coffee rust). Doña Maritza does not know if she can afford to apply it this season.

Insecticide Use: None

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Recommendations

Cultural controls are the best method to prevent the pest reproducing. You need to begin yourself and hope neighbours will follow your good practices. Doing good *graniteo* collections protects your plots and those of neighbours - it's a responsibility. If all coffee farmers carried out good cultural practices that would really help control borer, not totally, but minimising the damage.
In difficult economic years, many small farms cannot afford chemicals or biological products so you must rely more on really good manual collections.

Farmers have to understand that they will never eradicate this pest - you have to learn to live with it to some extent.

Regarding *Beauveria*, farmers must know how to use it, look after it and must apply it correctly, otherwise they're wasting their money. You must apply the spores when CBB is outside the berry or just entering the flesh because the fungus cannot kill borers once they are inside the bean. Farmer training and awareness is essential for good *Beauveria* use.

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