Cultural Practices and Sanitation for Coffee Berry Borer: Lessons from Latin America

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Questions about Coffee Production in Hawaii

1- How many farmers produce coffee in Hawaii?

2- How much coffee is produced?

3. Type of farm?

4. Weather conditions?

More Questions

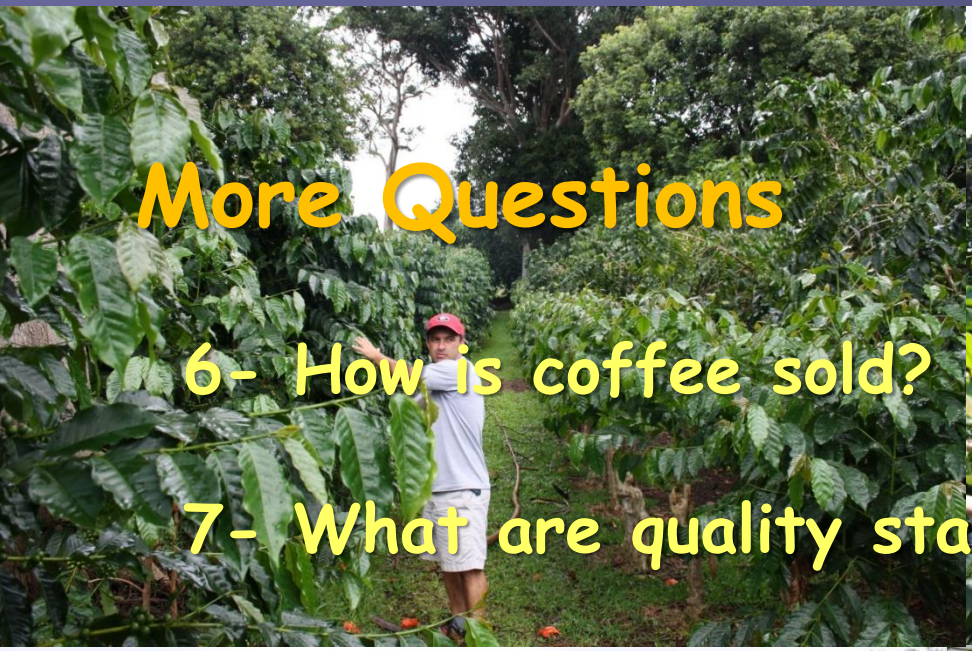
6- How is coffee sold?

7- What are quality standards?

8- Where is the coffee berry borer in Hawaii?

9- What is economic impact of CBB?

10- How is CBB controlled in Hawaii?



Questions about coffee production in my farm

1- How many employees?

2- Type of plantation?

3- Weather conditions?

4- What is the coffee yield?

More Questions

6- How is coffee sold?

7- What are the quality standards?

8- Where is the CBB in my farm?

9- How much does CBB affect my production?

10- How is CBB controlled in my farm?

From 1865 references on CBB

Only (42) IPM 2.2%

Only (22), 1.1%

Coffee farmers

Coffee growers

Participatory Research

Journal of Insect Science

OPEN ACCESS

REVIEW

A Coffee Berry Borer (Coleoptera: Curculionidae: Scolytinae) Bibliography

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Native to Africa, the coffee berry borer, *Hypothenemus hampei* (Ferrari) (Coleoptera: Cu[illegible]nae), has gradu[illegible] in[illegible] coffee-g[illegible] e. Ad[illegible] the coffee berry and oviposit within galleries in the coffee seeds. Larvae and adults consume the seeds, resulting in drastic reductions in yields and quality, negatively affecting the income of approximately 20 million coffee-growing families (~100 million people) in ~80 countries, with losses surpassing more than $500 million annually (Vega et al. 2015).

It has become [illegible] e berry [illegible] nity could greatly benefit from hav[illegible]g access [illegible]a bibliography of the literature related to the insect. Such an information source would allow scientists to find out what research areas have been explored throughout the many coffee berry borer-infested countries after more than 100 years of research on the topic. It could also help to direct lead future research efforts into novel areas, [illegible] thoroughly investigated [illegible]

The first coffee berry borer bibliography was published by Friederichs (1925b) and included [illegible] refere[illegible] additional bibliographies (IICA 1963, 1964, [illegible] 257 references, respectively. The present bibliography includes 1,865 peer and nonpeer reviewed papers (excluding [illegible]). The references are in five predominant lang[illegible] Dutch, and French. Twelve da[illegible] ences (AGRICOLA, AGRIS, BIOSIS Previews, Biological Abstracts, CAB A[illegible] Food Science and Technology Abstracts, Google Scholar, [illegible] Studies Worldwide, and Zoological Reco[illegible]. Hundreds of references not captured by the databases were included after consulting our coffee berry borer literature collections.

Acknowledgments

We dedicate this bibliography to the hundreds of scientists worldwide that have dedicated their professional efforts to learning more about the coffee berry borer with the final objective of alleviating the economic losses by this devastating insect pest.

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Coffee Crops in the World

Coffee crops are grown in Tropical and Sub-Tropical areas

Two commercial species:

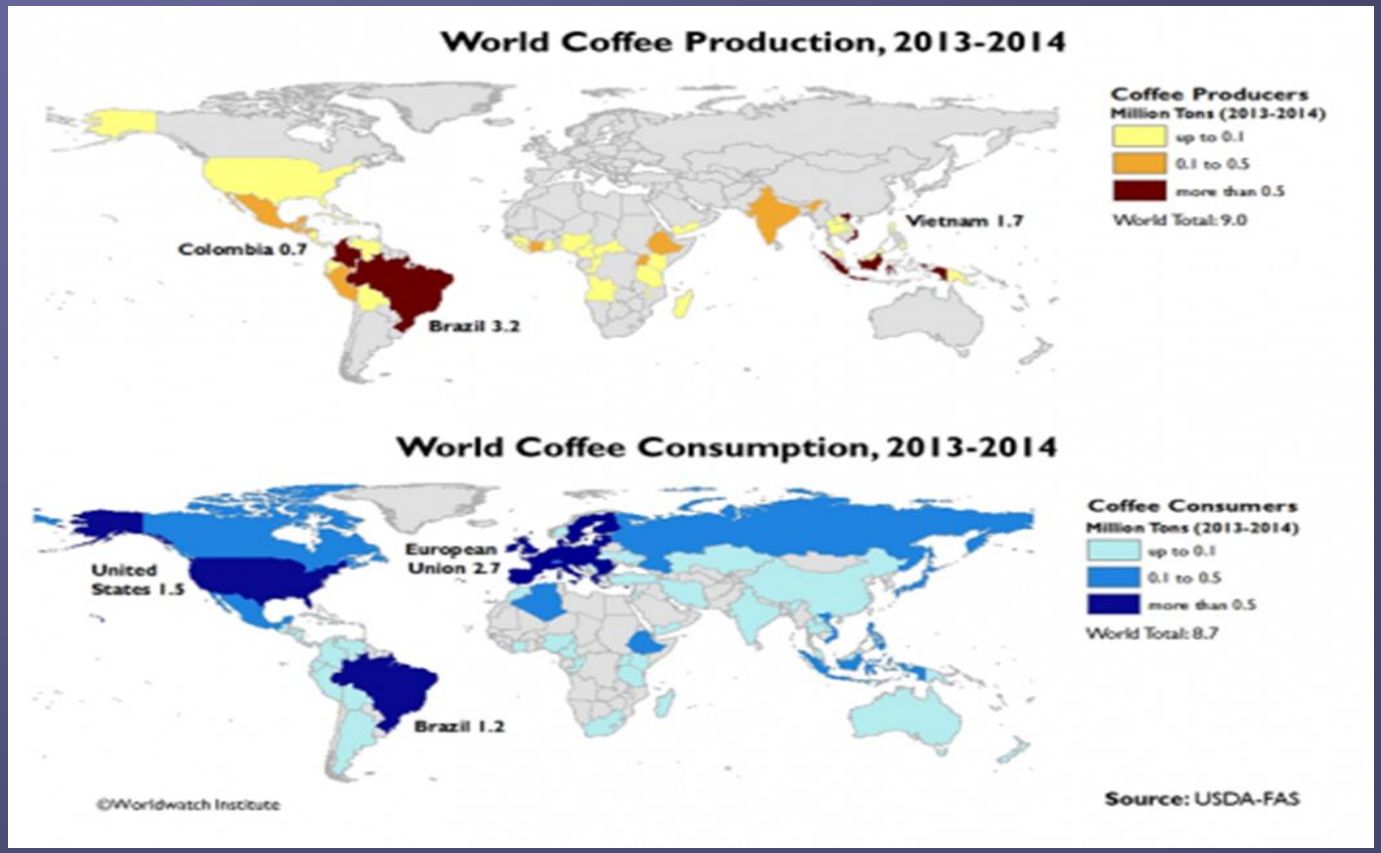
Coffea arabica: planted between 3300 to 6600 ft elevation,

~ 60 % world's production & >95% in Latin America

Coffea canefora (*robusta*): Planted low attitude < 3300 ft

~40% world's production & 80% in Africa


Coffee production is in Central and South America, Africa, India, Asia, and South Pacific Islands.
There are over 80 countries producing Coffee (> 247 million acres)
There are more than 25 million people working and living from Coffee production. This generates over 100 million employees.



Production is estimated at 152.7 million bags (132 lb/bag) (USDA 2015)

The coffee market is about US$ 70 billion a year

More than 400 billion cups of coffee consumed per year

Coffee in Colombia

Background:

Generates 2.5 million jobs

Over 566,230 coffee growers' families.

Coffee crops:

Extension 2,230,000 acres.

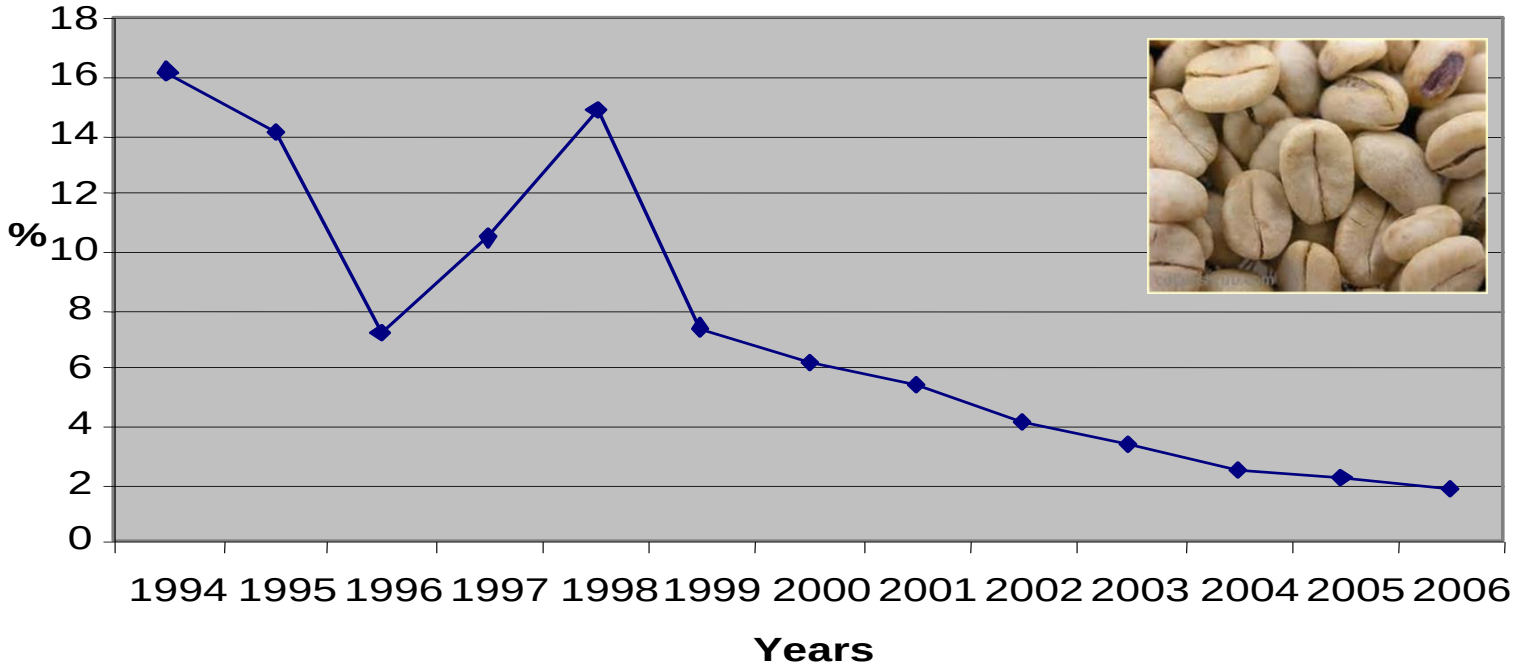
Planted in the middle of high mountains from 3,300 to 6,600 ft elevation.

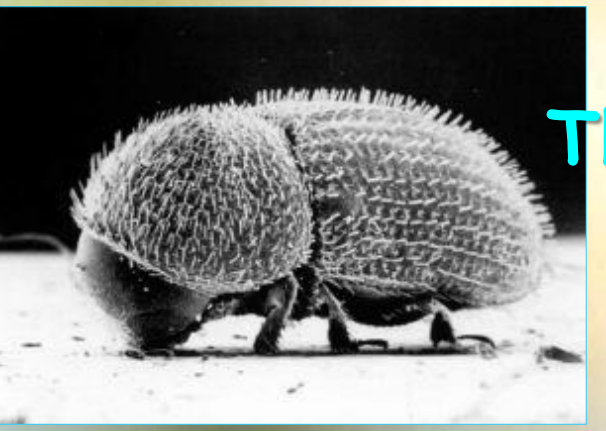
Temperatures about 65 to 75°F.

Production is ± 13 million bags (132 lb/bag) a year.

Coffee has supported Colombia's economy for over 180 years.

Coffee Berry Borer Infestation (%) in Colombia





The Coffee Berry Borer CBB

Hypothenemus hampei (Ferrari).

(Coleoptera: Curculionidae: Scolytidae).

Originally from Central Africa.

Coffee is the primary host.

Affects the berries (fruits).

Has been reported in many coffee producer countries.

The most important pest of coffee.

(Bergamin 1943; Le Pelley 1968; Ticheler 1963; Decazy 1990; Baker 1984, 1999; Bustillo et al. 1998; & Damon 2000; Vega et al. 2015).

Symptoms

The female attacks developing coffee berries (from 8 to 32 weeks).

Crops losses can be severe, ranging from 50 - 100% of berries.

Infestations > 5% can cause crops losses in weight, quality, and price.

When green berries (< 90 days old) are attacked by CBB, can fall prematurely.

(Le Pelley 1968; Moore & Prior 1988; & Baker 1999).

Infestation levels

Colombia and Mexico - 60%

Jamaica 75%

Malaysia 50-90%

Uganda and Côte d'Ivoire 80%

Tanzania 90%

Hawaii 64.5% (recent Ka'u figure)

(Vega et al. 2015)

Estimated losses

> US$ 500 million

Recent estimate for Brazil: $215-358 million/year

Colombia: >(US) $100 million/year;

About 5.5-11% of production cost

(Duque-Orrego et al. 2002; Oliveira et al., 2013; Vega et al. 2015)

Biology and Life Cycle of the CBB

The female lays 30 – 120 eggs.

Average 74 eggs.

Development from egg to adult (25 to 60 days).

Time development (days):

at 81°F

Eggs 4

Larvae 15

Pre-pupae 2

Pupae 7

Total life cycle:

28 to 34 days

(Barrera 1884 & Sponangel 1994).

Blooms of Coffee and Fruit Development

Flowering & harvest (months of the year).

Example:
In Colombia: January & March; August & September
Harvest: October & December; May & June

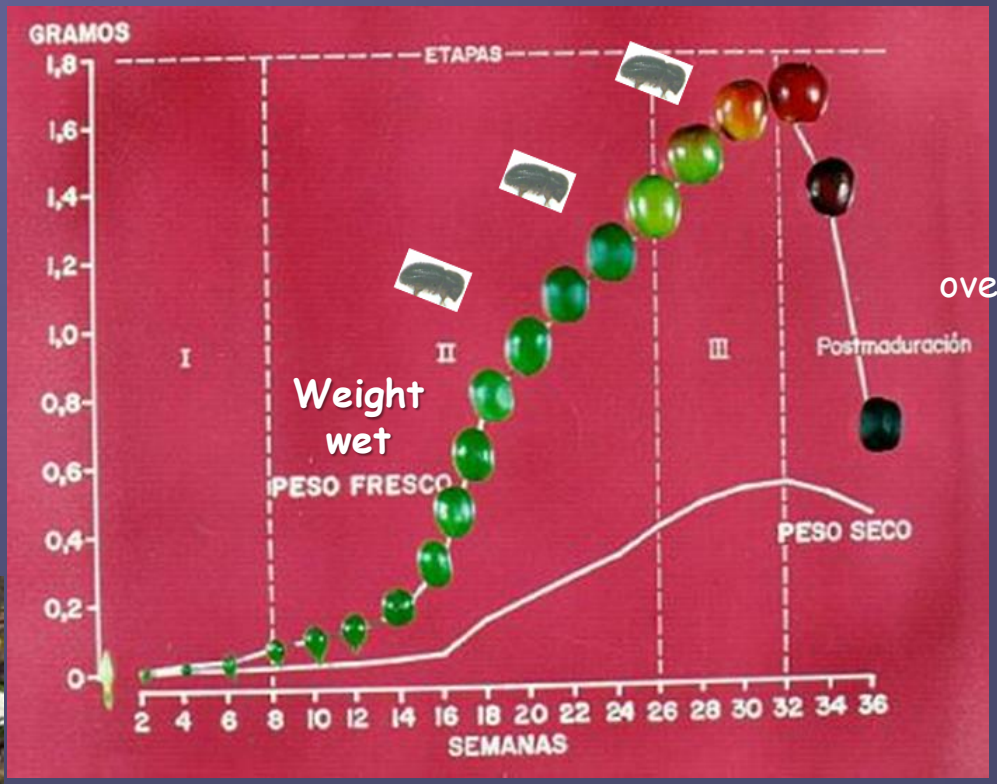
Kona -Hawaii: February & April
Harvest: September & December

From flower to mature fruit: 32 weeks (8 months).

CBB attacks berries over 60 days old.

Coffee Berry Development

Grams



overripe

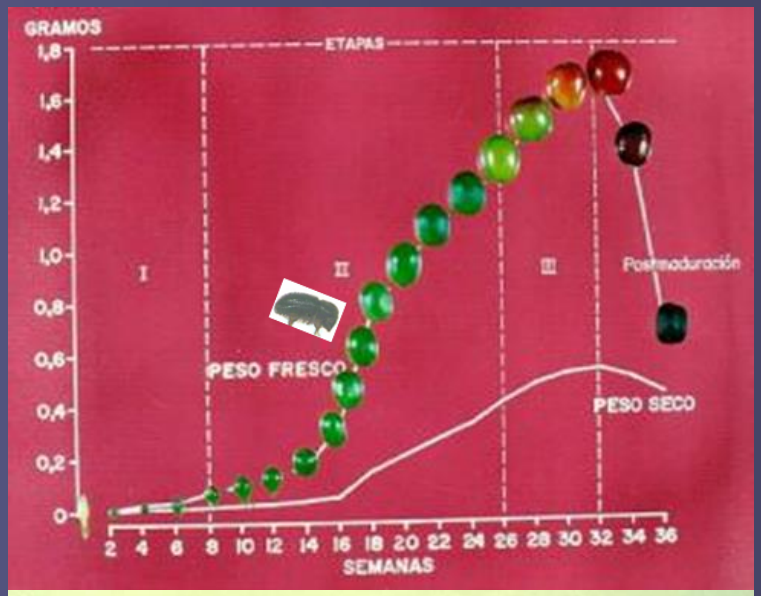
Dry weight

Weeks

How long does the CBB wait for egg laying?

Berry's Age Days-(weeks)	Days	(%) Dry weight
60	91	10.9
90	70	14.6
120	12	20.0
150	5	26.7
210	5	32.2
240	4	33.1

(Ruiz , 1996)



Dry Season

Rapid maturation of berries

High production of berries and increase berries drop

Small berries (low water available)

CBB population

Adults emerge with high humidity

Higher reproduction on dropped berries

Rainy season

Lower production of berries

Lower reproduction of CBB

Prolonged rains reduce CBB population

Lower CBB population on dropped berries

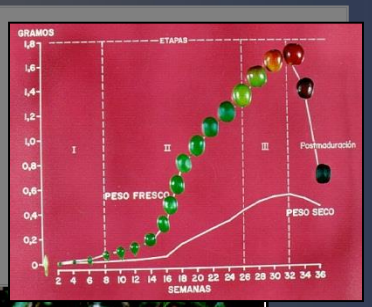
Higher decomposition of dropped berries

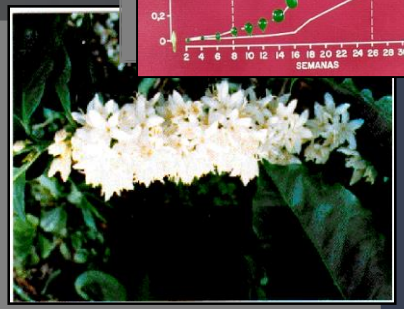
Higher mortality of CBB

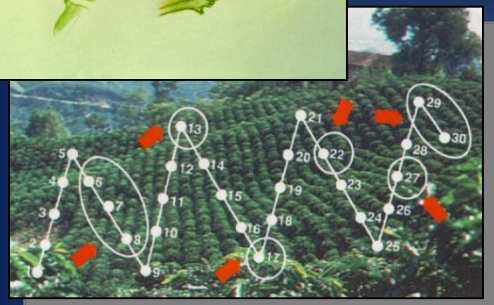
IPM

- Agronomic Management
- Cultural Control
- Biological Control
- Chemical Control

Information needed on the farm

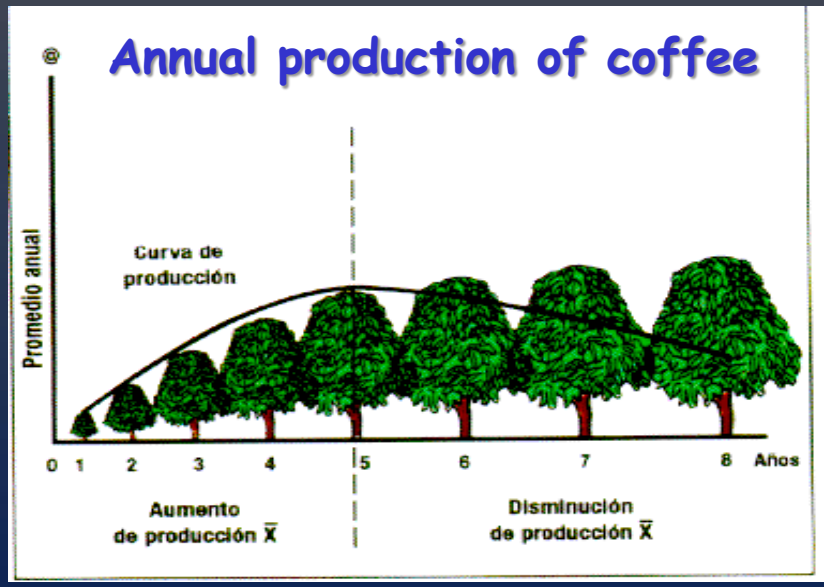


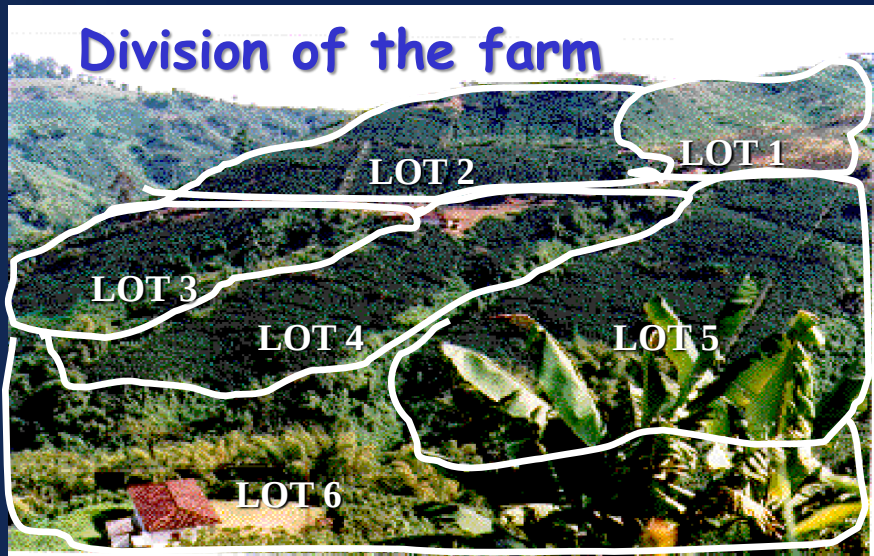




Agronomic Management

- Coffee varieties adapted
- Renew the coffee by cycles
- Agronomic practices





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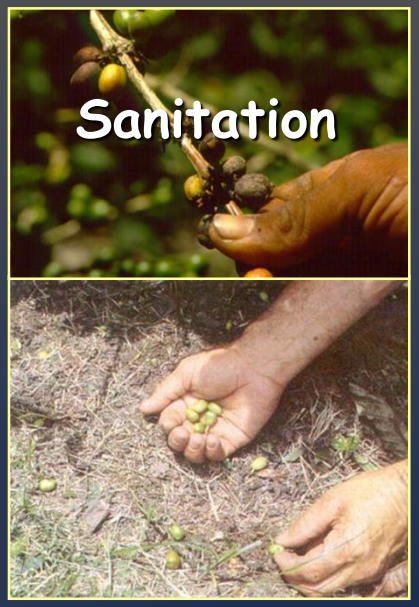

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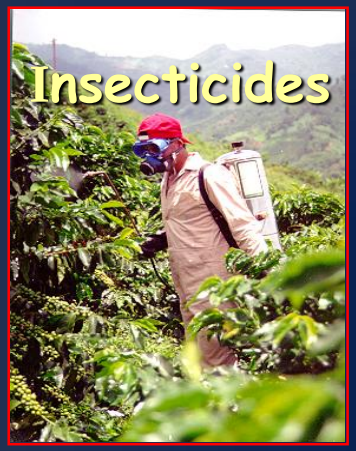

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= Integrated Management of Farm

Cultural Control & Sanitation

Goals:

- Cut the reproduction (life cycle) of CBB
- Manual remove of all berries: green, ripe, over-ripe, raisins (tree & ground)
- Prevent fruits dropping to the ground

Cultural Control

Harvesting

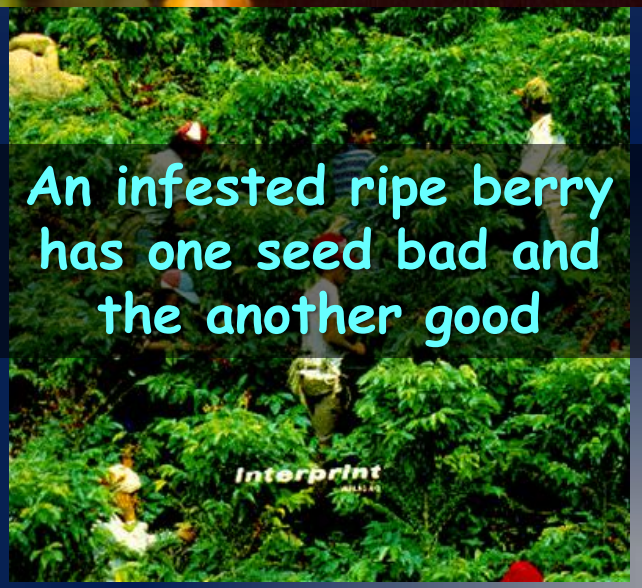
Periodic harvesting (frequency 15 – 20 days)

Appropriate (mature berries, over-ripe, raisin)

Efficient (< 10 berries/tree)

Rigorous (supervision)

Prevent fruits from dropping to the ground



Harvesting

Colombian Situation Before CBB (1988)

Manually Collected ripe and over ripe berries only at harvest time

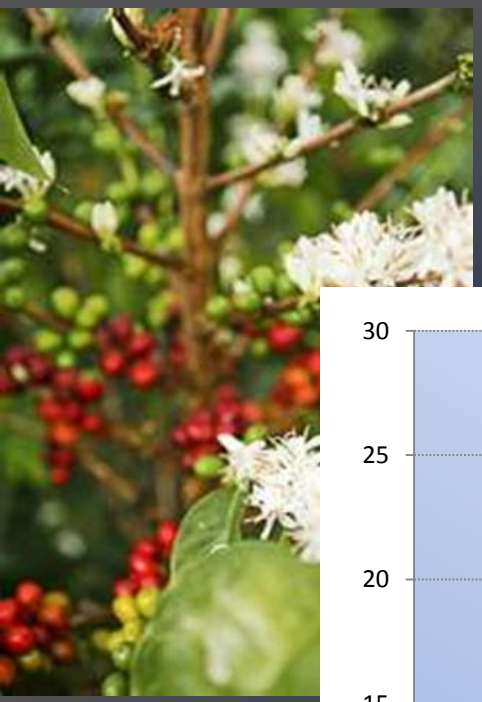
Work: owner-farmers or contracted pickers

Nobody cared about dry-berries

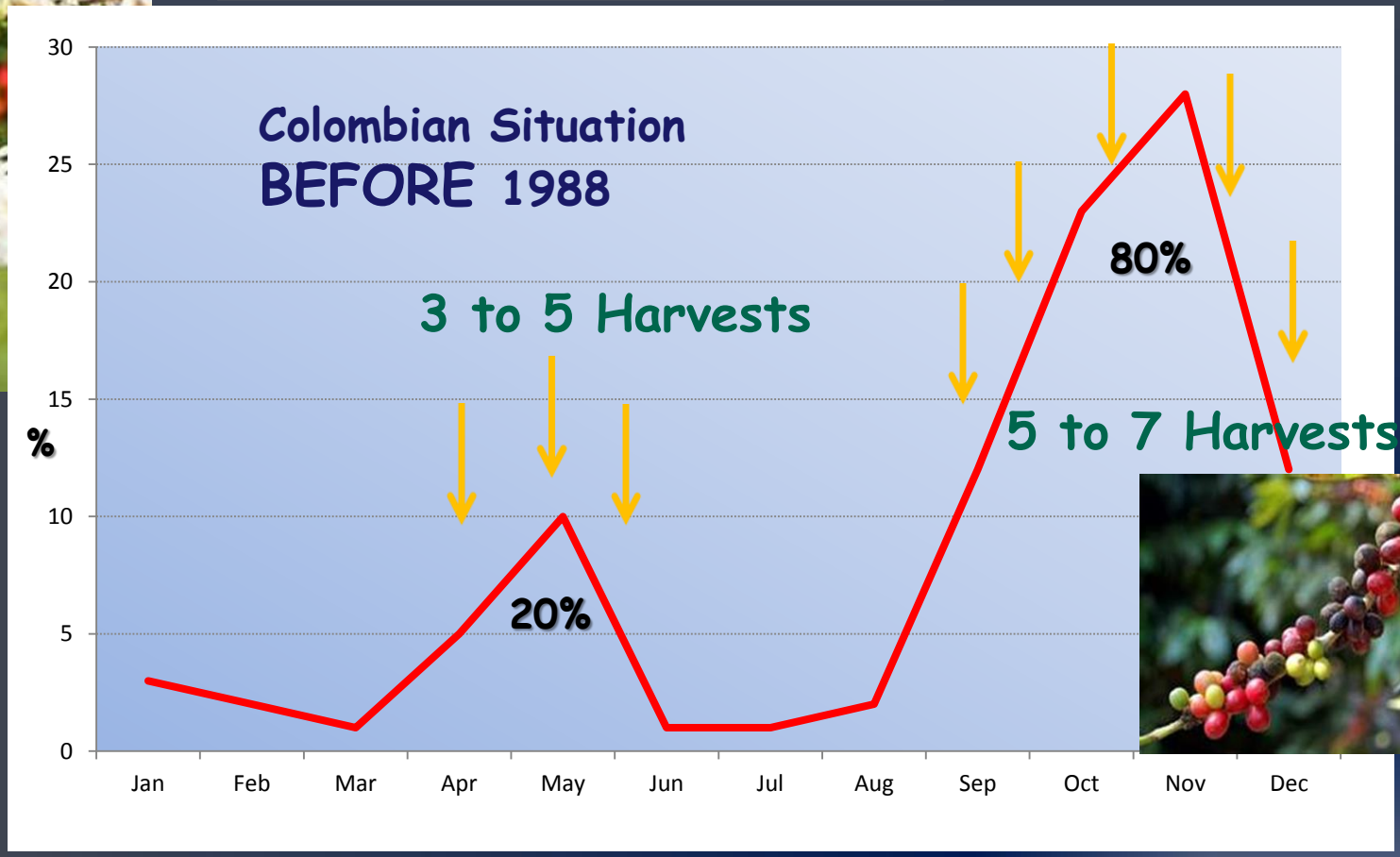
About 5 to 10% of berries were not picked!

Colombia

Latin America

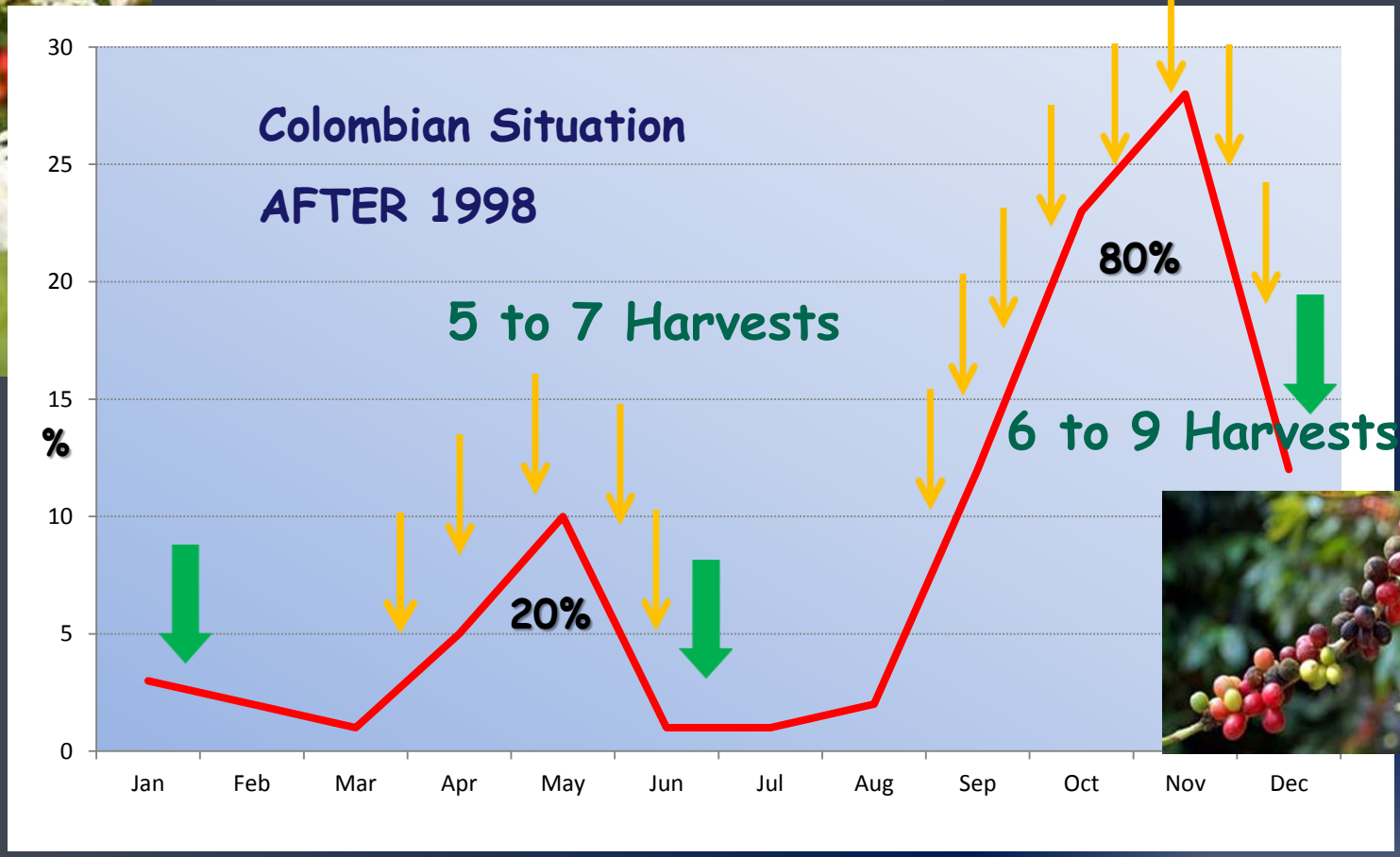


Harvesting



"Recollection of the over-ripe + raisin" was not done

Harvesting



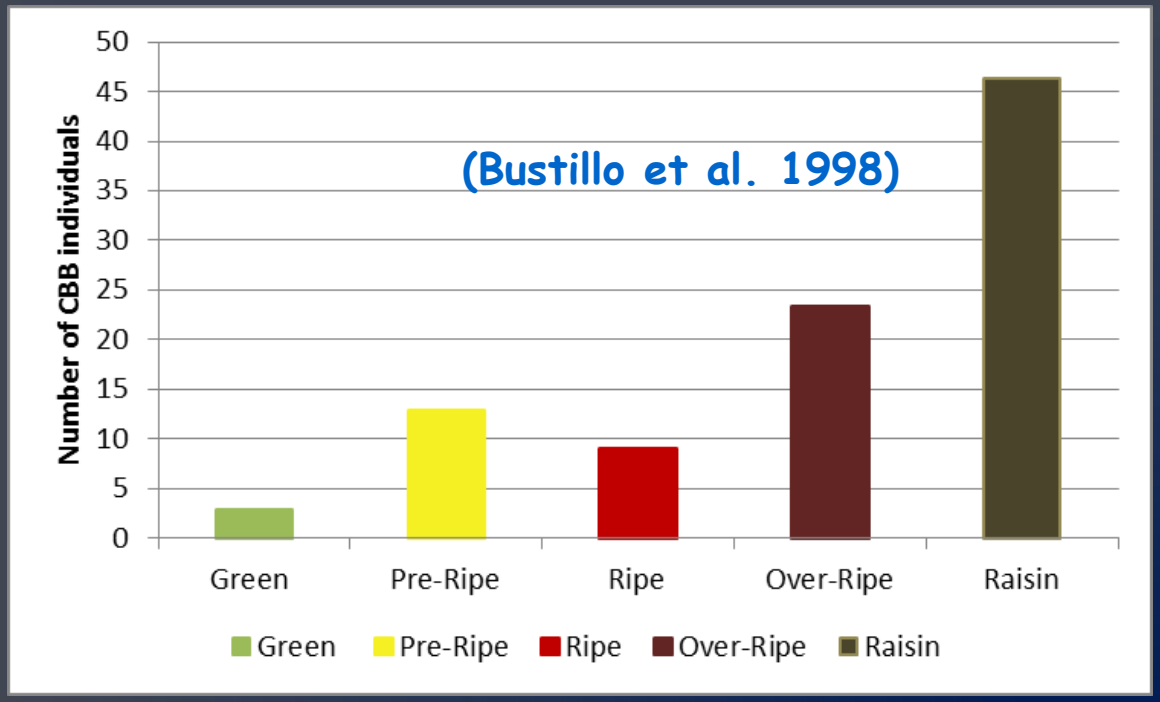
ADDITIONAL recollection

Frequently Re-Re: Repase

"Sanitation" = Recollection of the over-ripe + raisin after harvest season.

It is mandatory

Number of CBB on fruit developmental stages



"La Virginia" Farm
Specialty coffee producer

50 permanent staff (+ 400 contractual pickers)

275 acres cultivar Caturra:

(including 25 zoqueo).

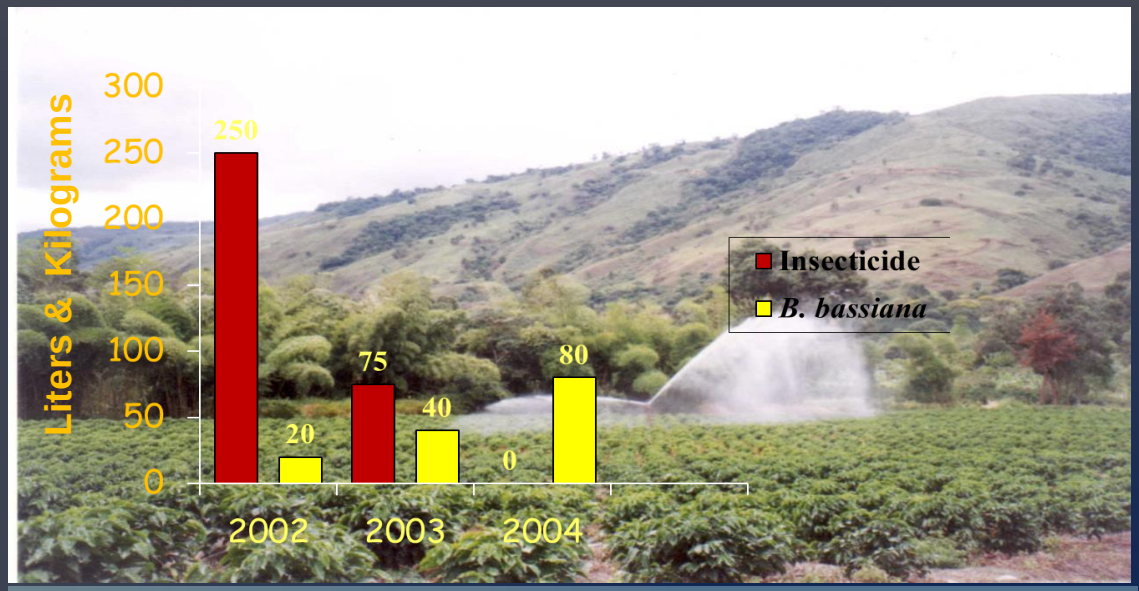
Density: 2664 trees per acre

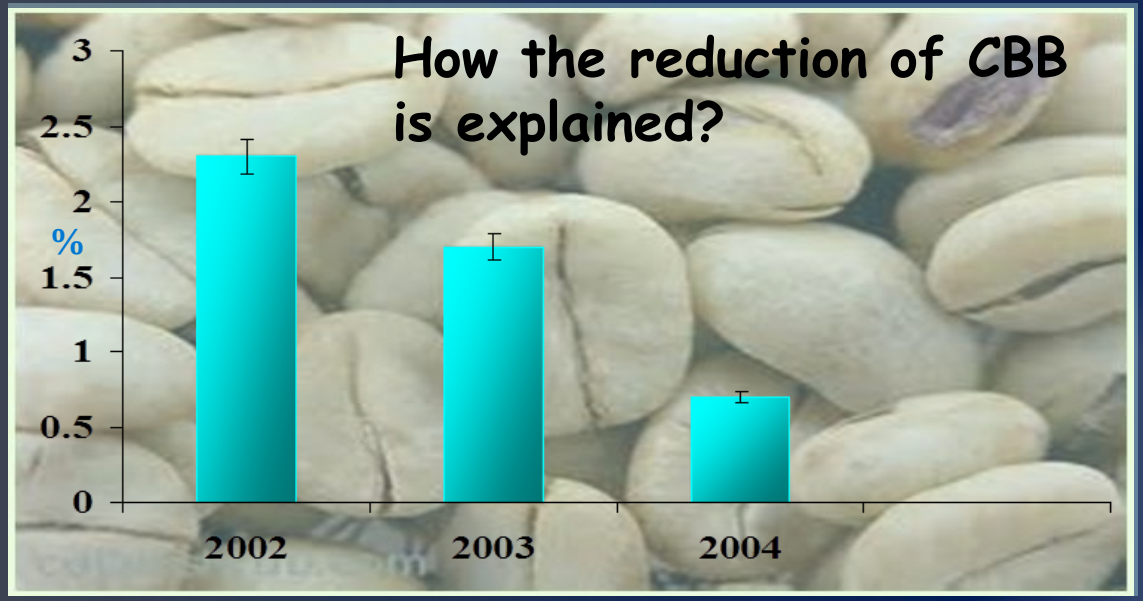
Production cycles: 5 years

Coffee is exposed to sun in order to increase production

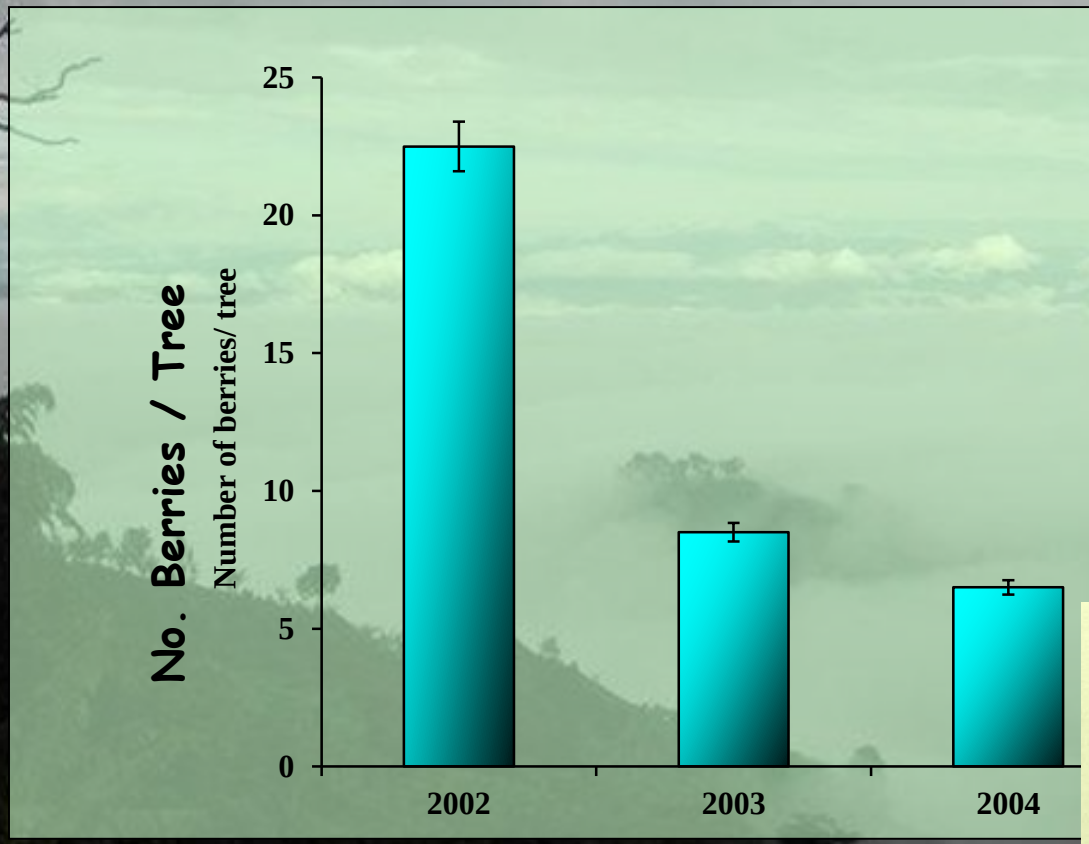
Elevation: 5200 ft ; Temperature: 66°F ; Precipitation: 87 in

Applications of Insecticides and *Beauveria bassiana*. at "La Virginia" Farm





Effectiveness of Cultural Control



Berries

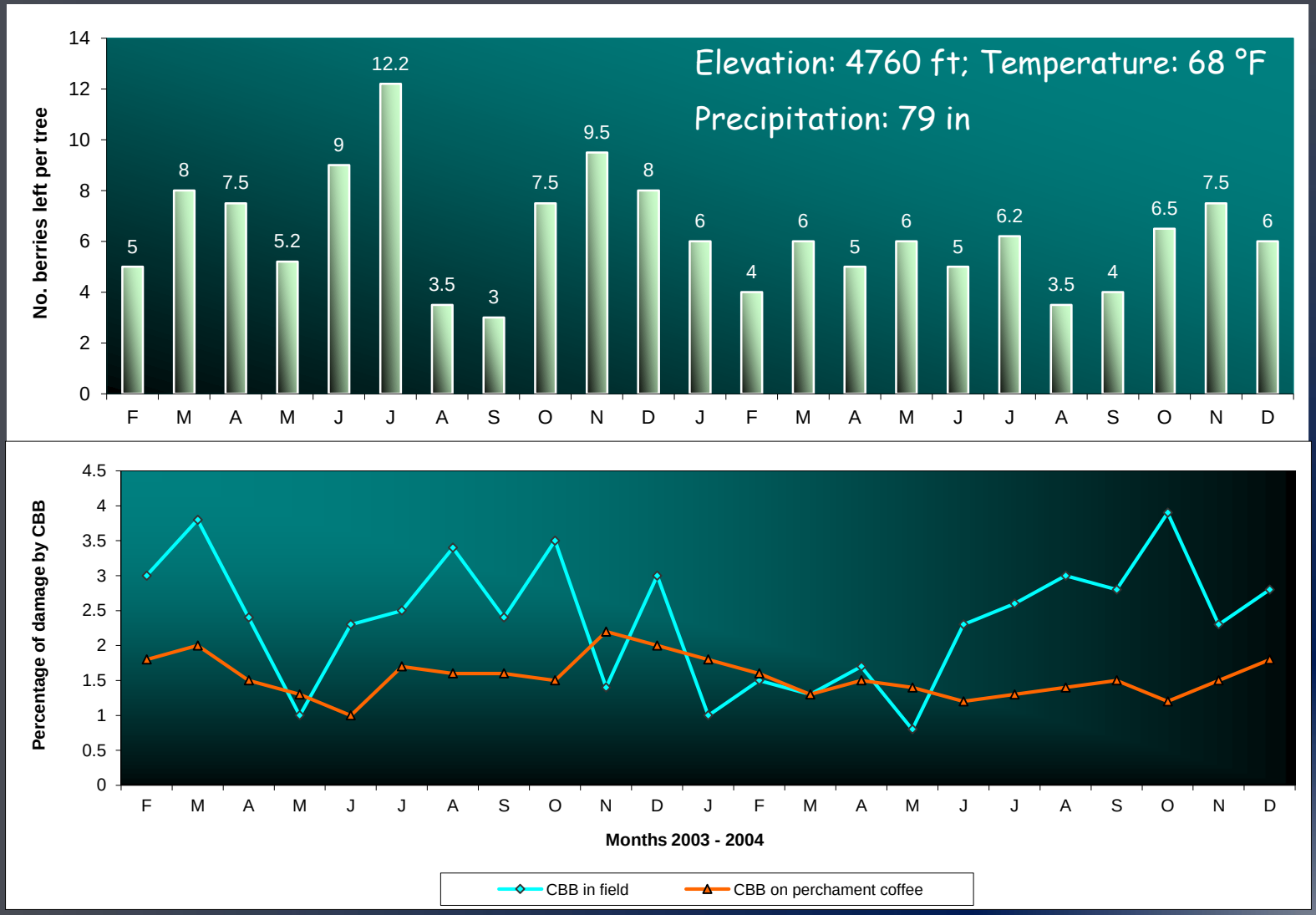
> 10 = Bad

5 to 10 = OK

< 5 = good

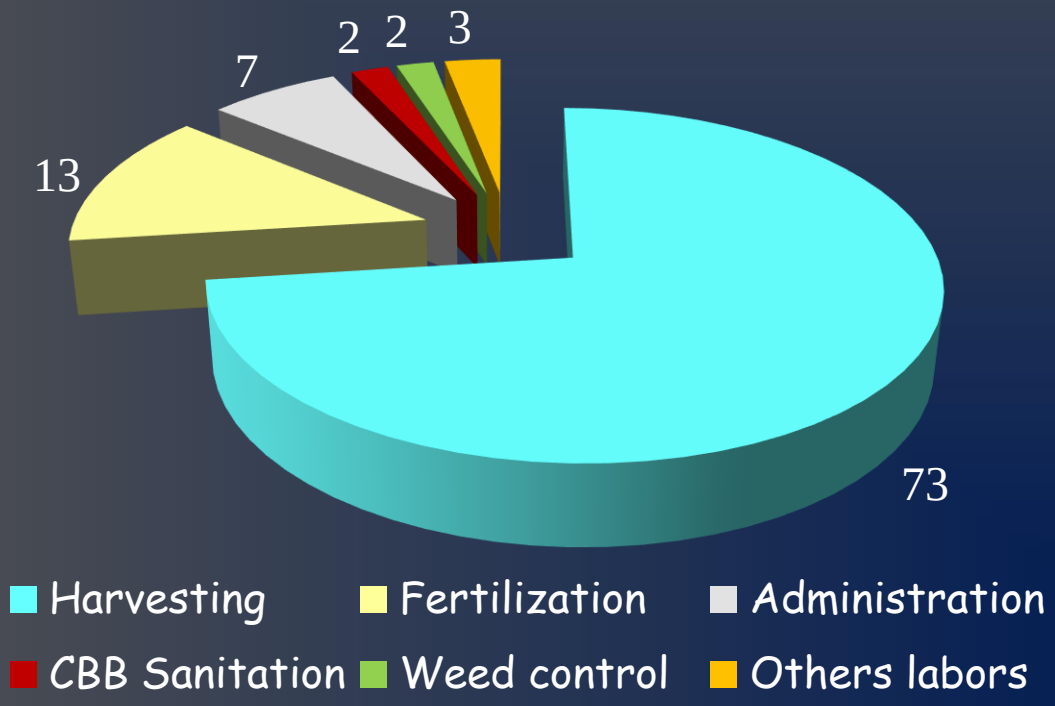
(Bustillo et al. 1998; Aristizábal et al. 2012).

Monitoring Cultural Control for CBB Management in "La Esperanza" Farm



"La Esperanza" small coffee farm, Quimbaya, Colombia (Aristizábal et al. 2011).

Cost of Coffee Production & CBB (%) "La Esperanza" farm



Production:

11,160 lbs 2003

10,362 lbs 2004

Frequent harvest (every 15-20 days)

Parchment coffee

1.5% CBB damage

(Aristizábal et al. 2011)

Large coffee farms

La Marina	(A)	247 acres
Guadalupe	(B)	99 acres
Los Alpes	(C)	49 acres

Elevation 3800 – 4200 ft

Temperature 74.3 °F

Relative humidity 80%

Precipitation 72 in

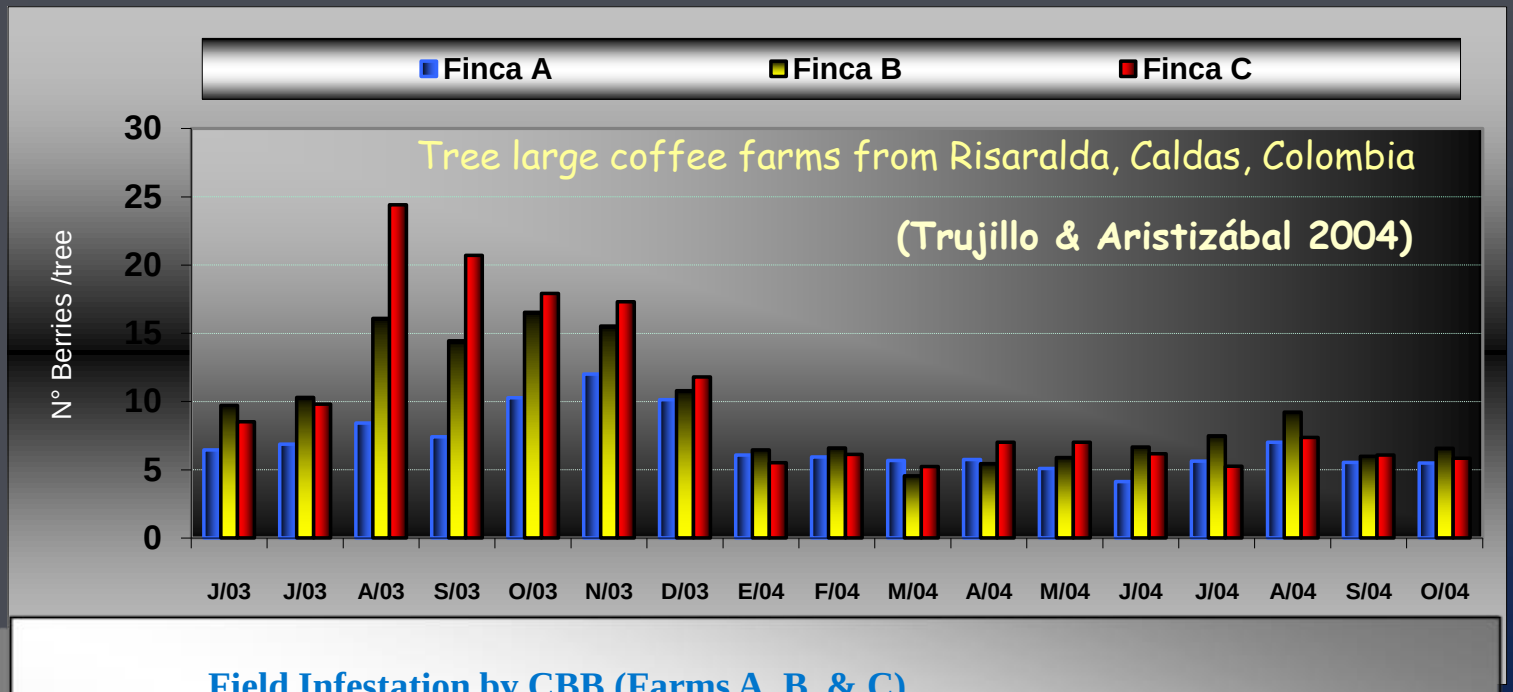
Monoculture

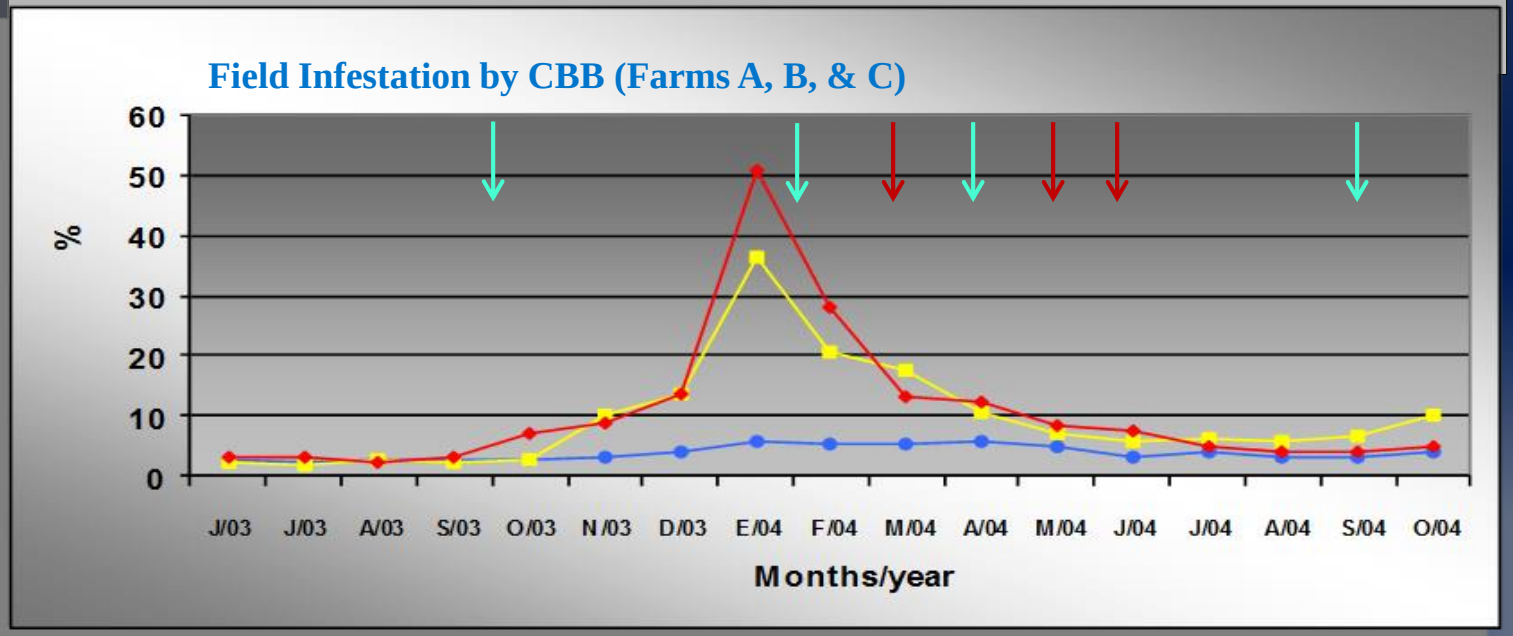
4,000 trees/acre

Full - Sun

9 3:41PM

Efficiency of Manual Coffee Harvest

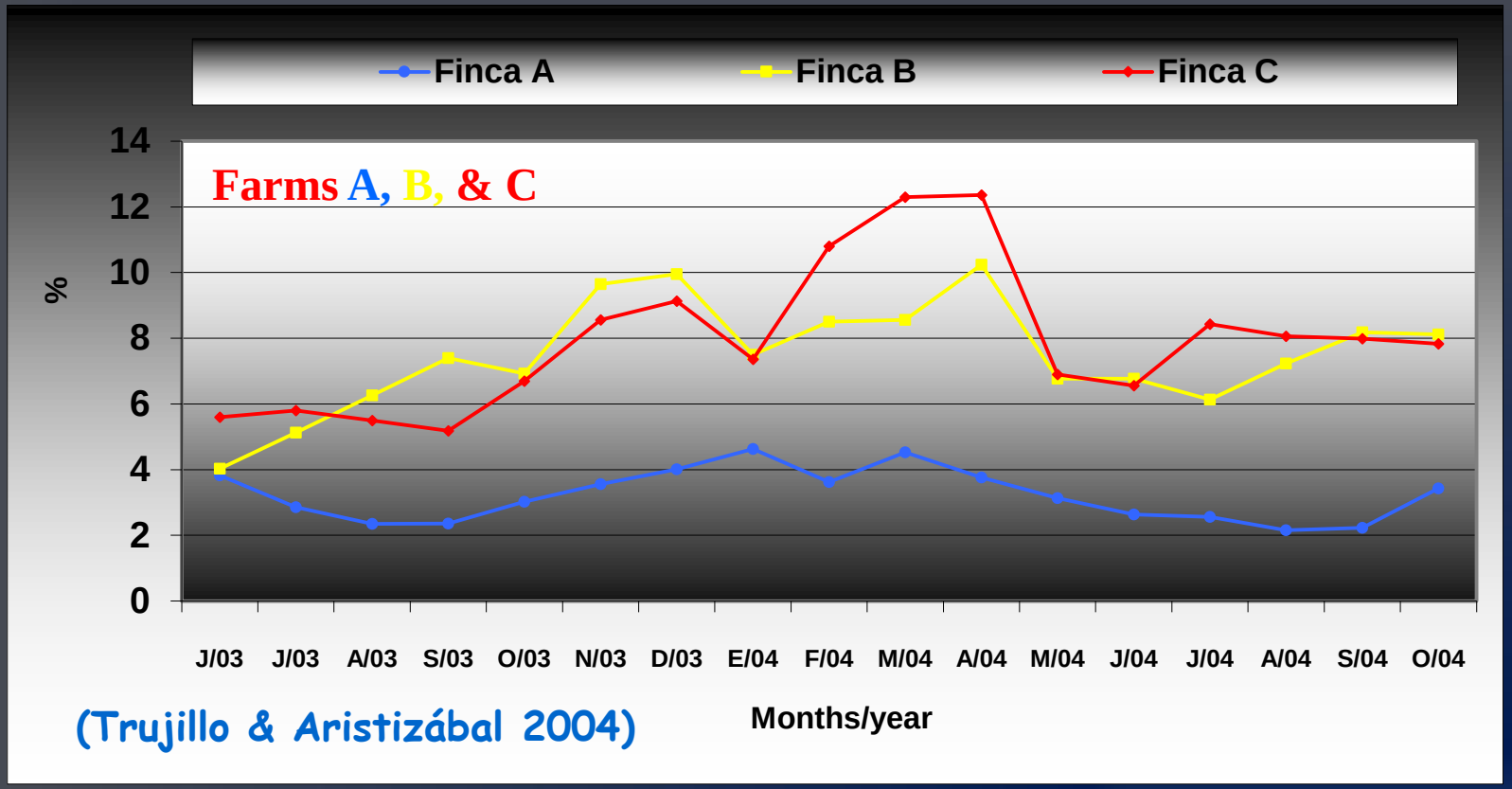




Insecticide

Beauveria bassiana

Infestation of Parchment Coffee



(Trujillo & Aristizábal 2004)

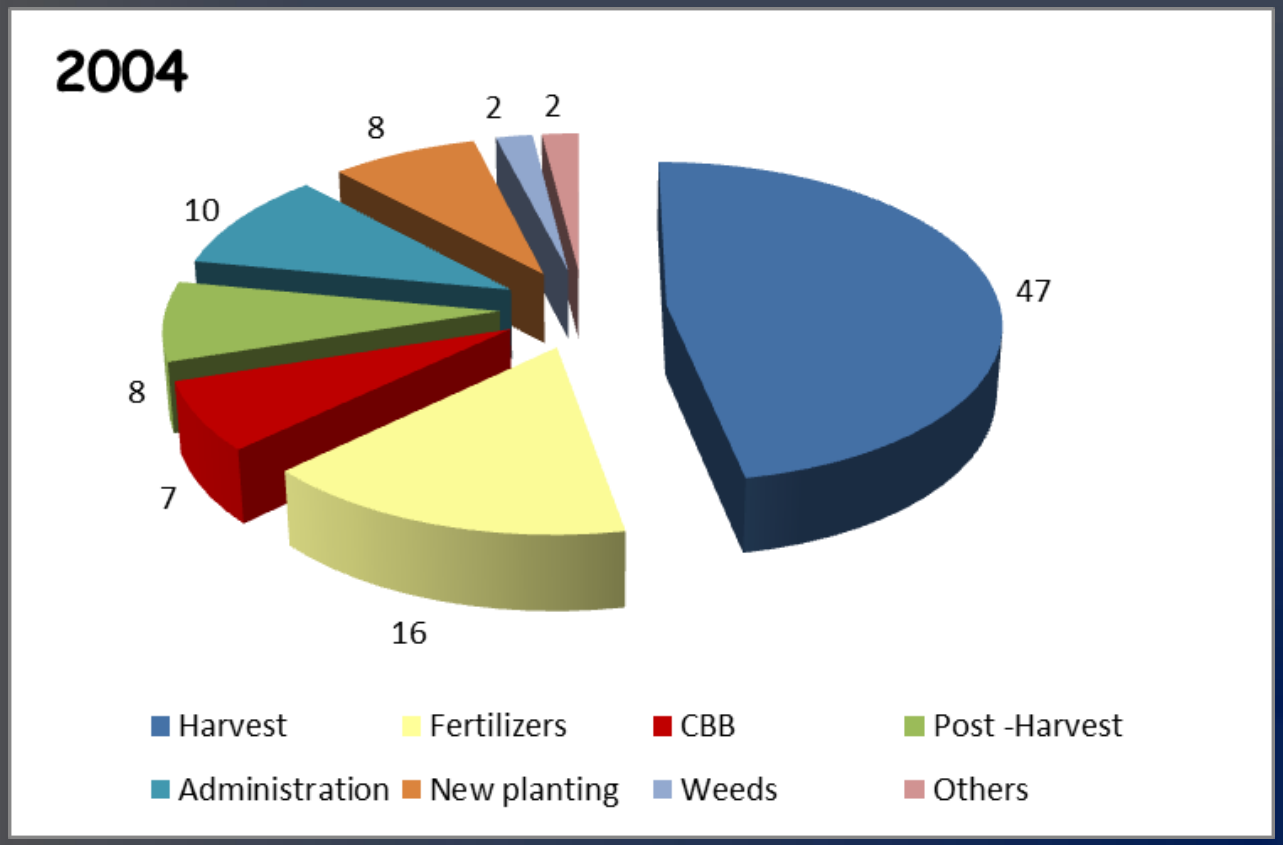
513 coffee growers in Caldas, Colombia:

51% reported CBB damage (>2.5%)

23% reported (> 5% damage) despite 62% applied insecticides

(Aristizábal et al. 2006)

Cost of coffee production & CBB (%)



Cost CBB:

Monitoring

Applications

B. bassiana

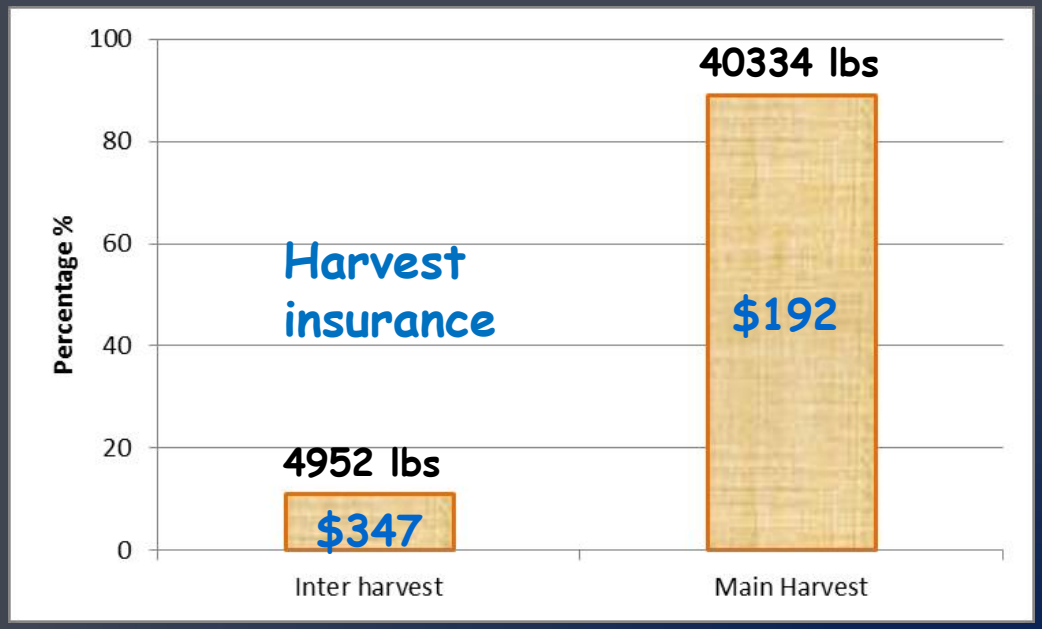
Insecticides

Sanitation

Post-Harvest

7-8% of total cost production

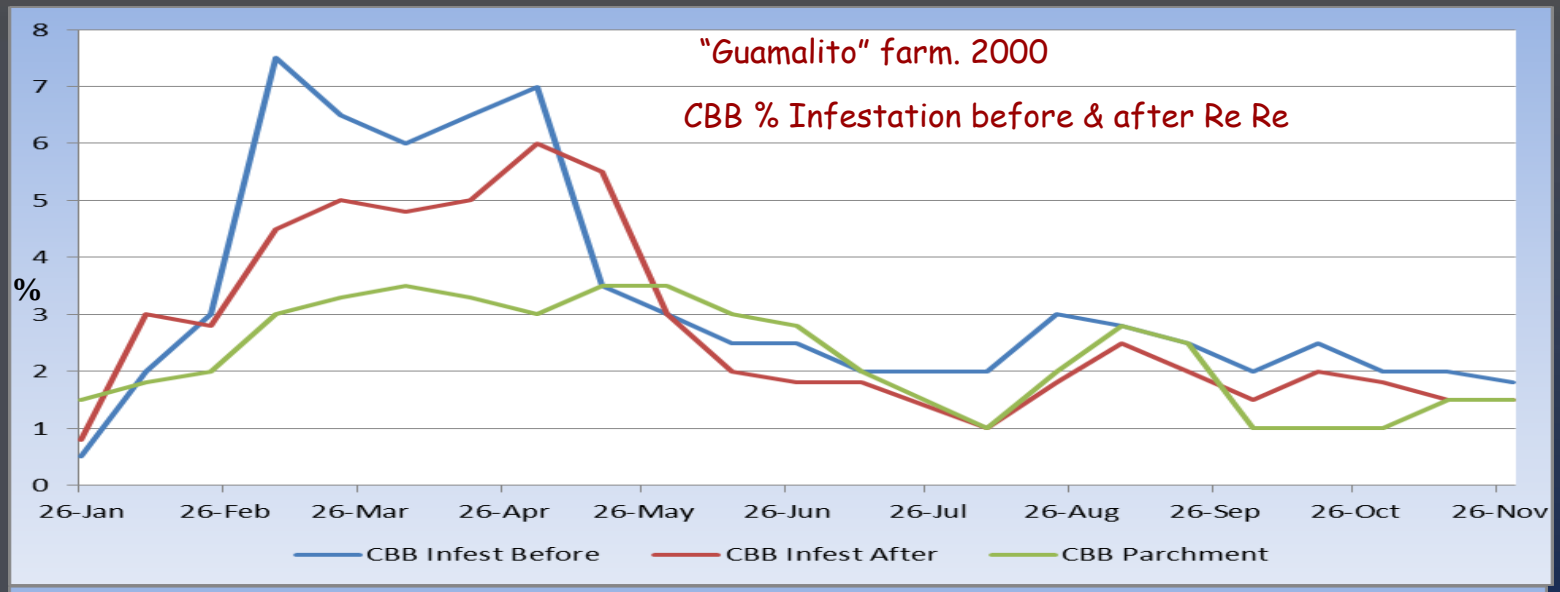
Cost of Cultural Control

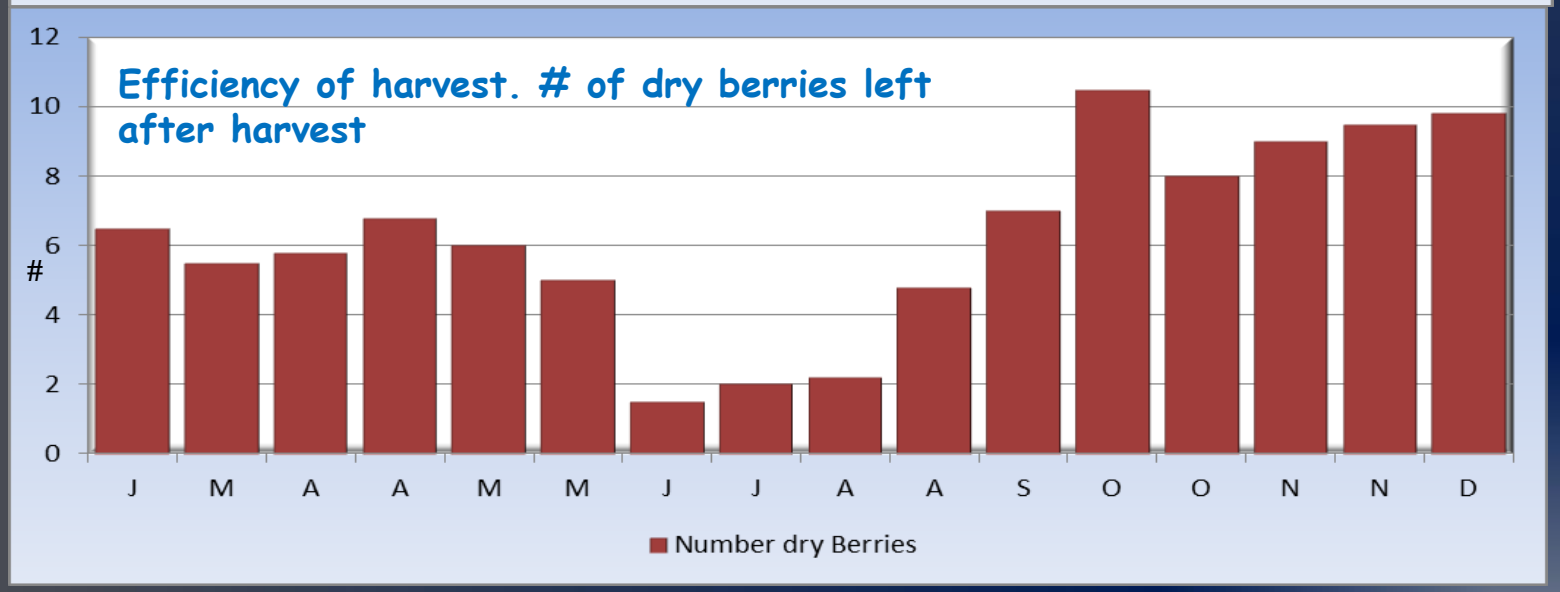


Coffee sold:	$ 1,183 k	$ 9,659 k
Cost coffee:	$ 780 k	$ 3,529 k
Profit or loss:	$ 402 k	$ 6,129 k

"Guadualito" farm, Balboa, Colombia, 2000.

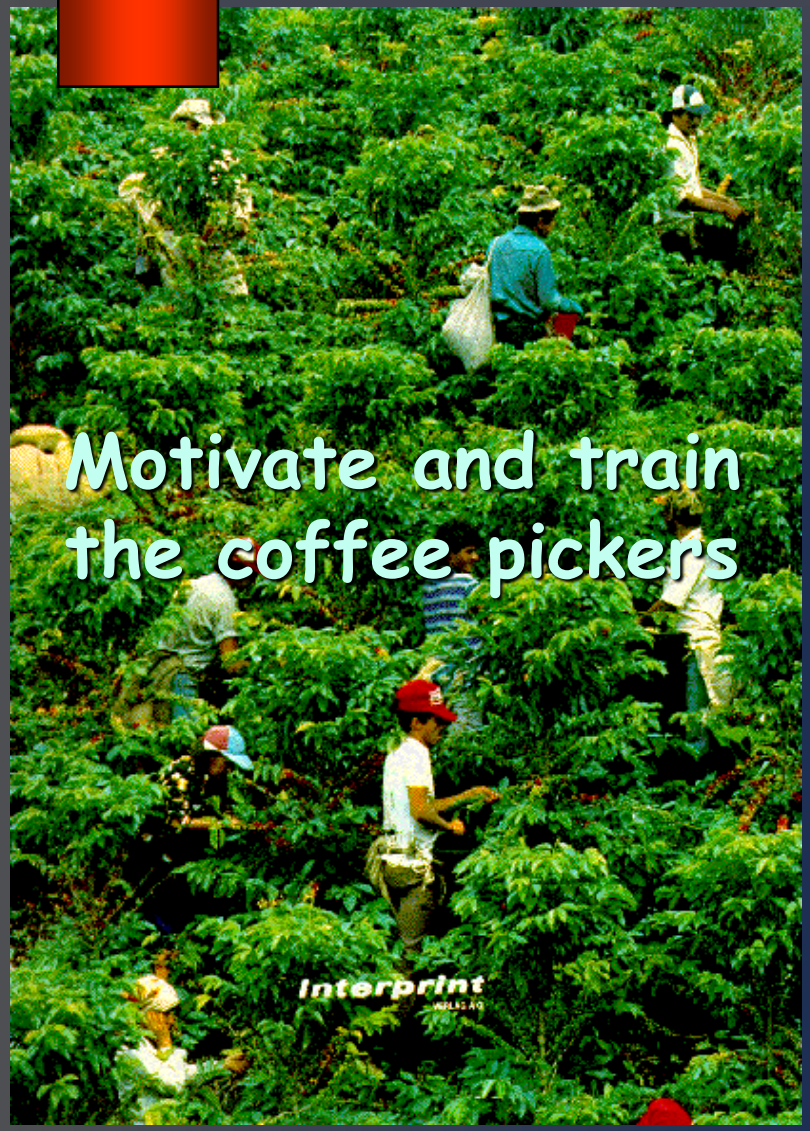
(1.00 US $ = $2.000 Colombian pesos).

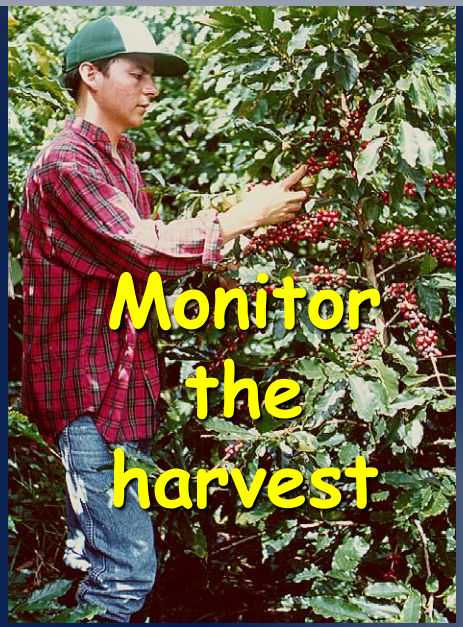




(Aristizábal et al. 2002).

Supervison of Coffee Harvest





Advantages of Cultural Control

- Controls > 80% of CBB
- Environmentally clean
- No health risk
- No equipment required
- Coffee collected may be sold ($)

Disadvantages of Cultural Control

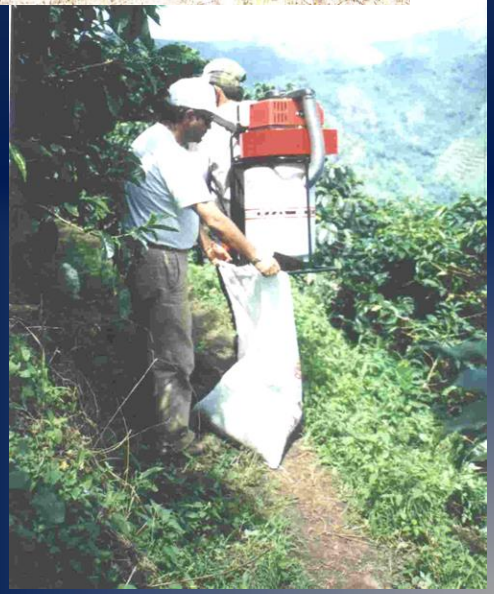
- Costly (depend of location)
- Tedious (difficult on large trees
- Requires trained personal
- Collection of fallen berries difficult

What is cost/benefit of frequent and efficient harvesting under Hawaiian conditions?

?

New Harvesting Alternatives

Vacuum berries from ground



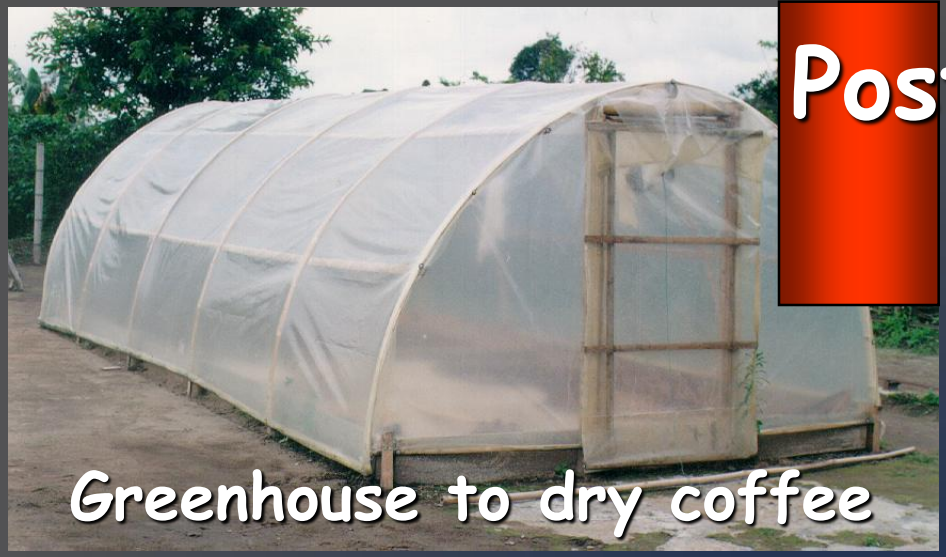
RECMAX-43 This is a back equipment for collect berries from the ground. It has two stroke engine, and it is practical, light, and efficient.
www.cosechemos.com

Aroandes device for coffee harvest

Does Mechanical coffee Harvesting control CBB?

?

Post-harvest Control


Greenhouse to dry coffee

Prevent CBB escape


Tank or hopper

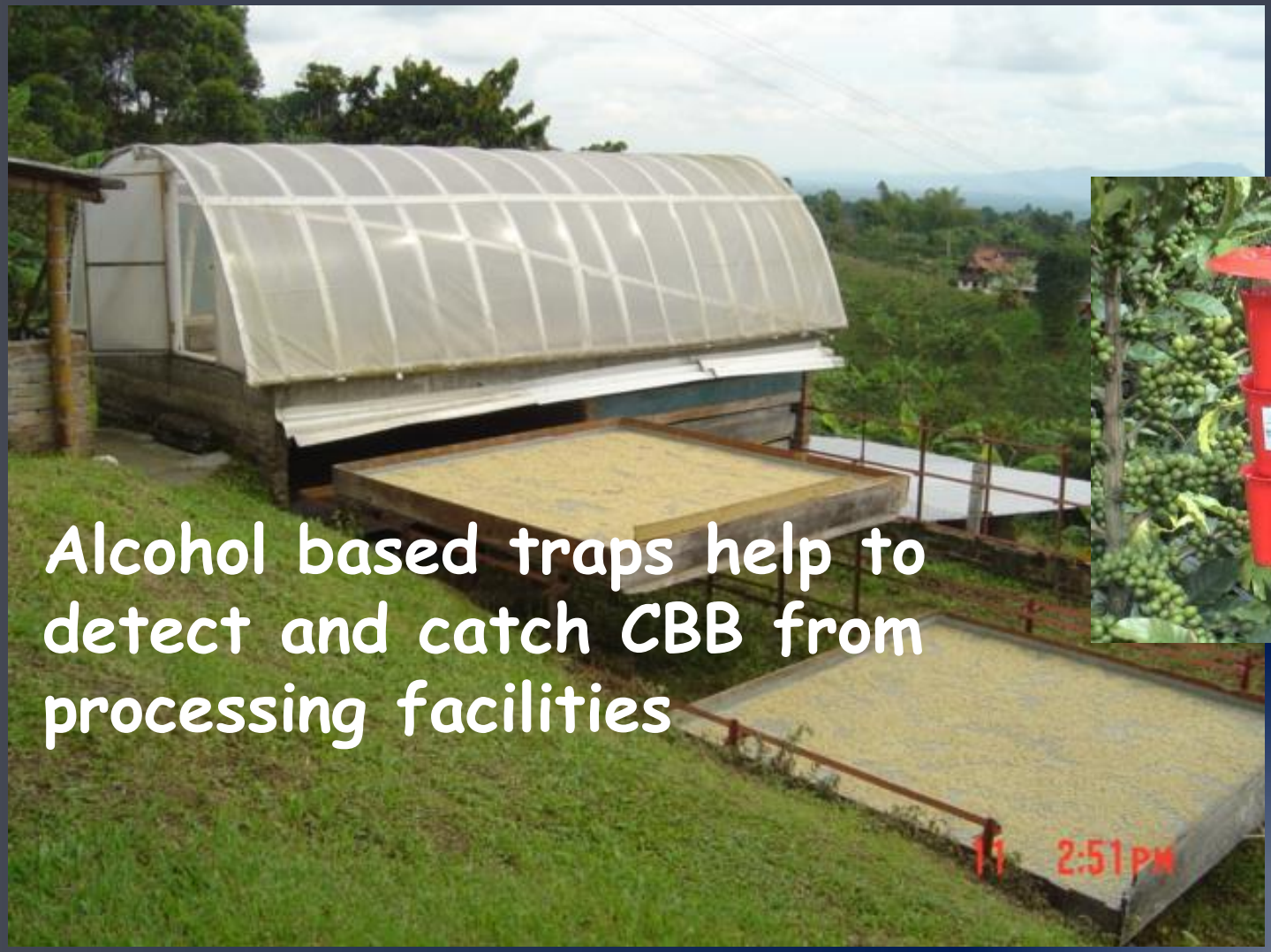

Bags


Raisin coffee


Drains


Pit for pulp

Using Traps During Post-Harvest



Post-harvest Control

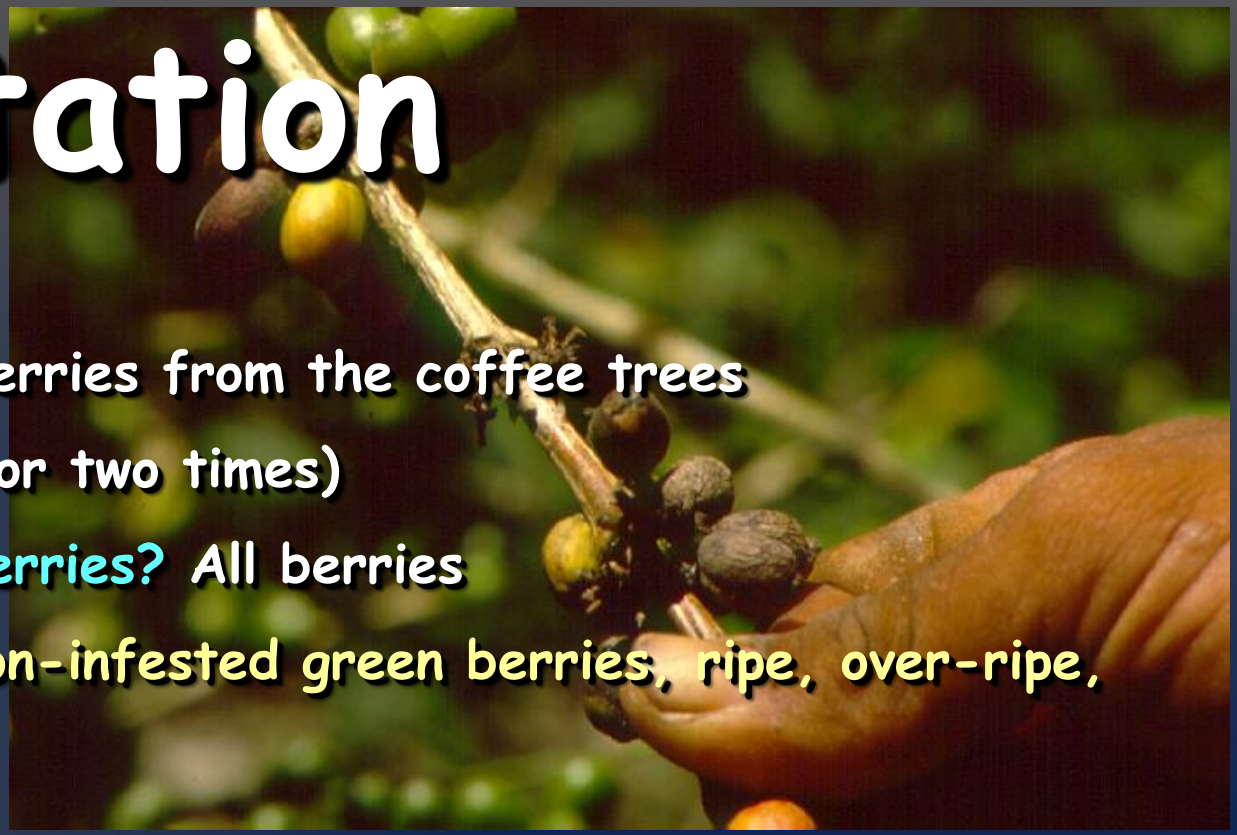
CBB captured in the hopper

Plastic lip smeared with grease in the tank and the pit to trap insects.

(Aristizábal et al., 2002; Salazar et al., 2003).


Post-Harvest control
BECOLSUB
Prevent CBB escape
Helps control CBB during processing
Reduce infested beans
Rapid dry of coffee
ingesec
ingesec
5 9:31 AM

Sanitation



Remove of all berries from the coffee trees

Frequency (one or two times)

What kind of berries? All berries

(infested and non-infested green berries, ripe, over-ripe, and raisins)

When?

At end of harvest season and before pruning

Prevent fruits dropping to the ground

Collect berries from ground

***Berries must be destroyed or disposed

Sanitation

Dispose of CBB-infested berries:

Hot water "boiling" 30 minutes

Dry by machine at 131°F, 60 minutes

Bury the berries under ground (6 inches of compact soil)

Keep CBB-infested berries completely enclosed in containers

***Berries must be destroyed or disposed

Do these coffee plantations need Sanitation practice ?

NO!

Why?

Do these coffee plantations need Sanitation practice ?

Yes!

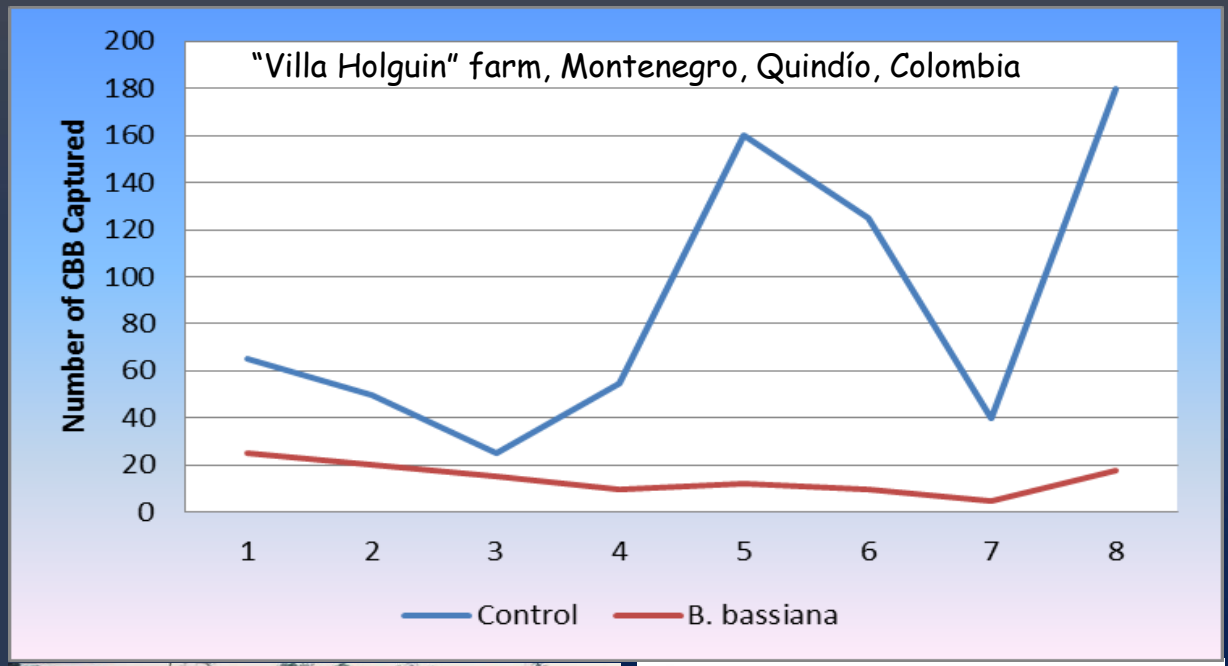
Pruning

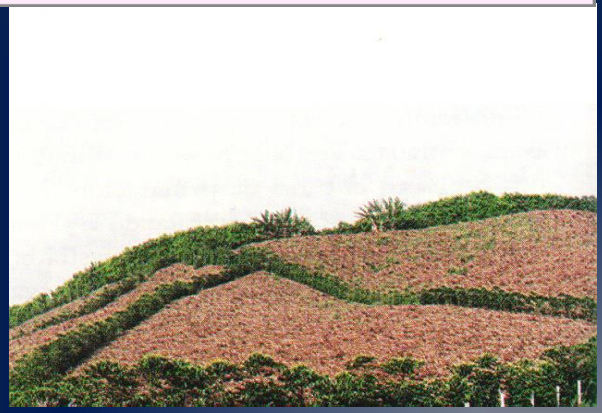
Rejuvenate coffee lot after 6 years of harvest.

B. bassiana applied.

Trap trees left in lot.

Recollection of coffee on trap trees.





(Aristizábal et al., 2002).

Rejuvenation or pruning in Hawaii

What kind is conducted?

Kona Style system.
The Beaumont-Fukunaga system.
Mechanical hedged & Topped system.

How does pruning affect the CBB?

If pruning stimulates movement of CBB, how do we prevent re-infestation in the coffee farm?

(Bittenbender & Smith 2008).



By late afternoon, and after 11 hours of work: men, women and children leave the field. Tired, their faces burnt, sweat-drenched bodies and a lump on their shoulders is the trophy won after the long day.



So, when you drink a cup of coffee just think about those people ...

Thank you for your Attention

Peter S. Baker
Alex E. Bustillo
Steven P. Arthurs
Jeffery W. Bentley
Olga Lara
Carlos A. Leon
Juan C. Zape
Jaime Orozco
Juan C. Lopez
Bernardo Chavez
Esther C. Montoya
Lucely Orozco
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Francisco J. Posada
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Sandra P. Velarde
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Colombian Coffee Farmers

The Kohala Center

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