The Coffee Berry Borer: Biology and Ecology

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Introduction

1- Coffee Farmers

2- Coffee Trees

3- Coffee Crops

4- The Coffee Berry Borer (CBB)

5- Biology and Ecology of the CBB

6- Application of the CBB Biology studies



1- Coffee farmers

"A search of CABI PestCD from 1973 to the middle of 1998 reveals over 400,000 abstracts on pests but only about 1% of these mention the word 'farmer', 'farmers' or their respective possessive forms. In this same database there were 221 references to CBB but only one mentioned farmers and this was not an article about IPM." (Baker 1999).

Some Questions:



What distinguishes and characterizes coffee growers ?

What are farmers' perception of control techniques?

What does the CBB mean to coffee growers?



How are coffee growers' lives affected by CBB?

What do farmers do to control CBB and when?

What resources do farmers have to control CBB?

What do farmers know about IPM of CBB?

(Baker 1999).



2- Coffee Trees

Family: Rubiaceae

Genus: *Coffea*

Originated from Africa

Small trees: 2 to 3.5 m (6 to 12 feet) height.

Perennial, (It will produce for about 50 or 60 years).

Key points for CBB:

1- Good administration of the crop.

2- Flowering time.

3- Fruit development.

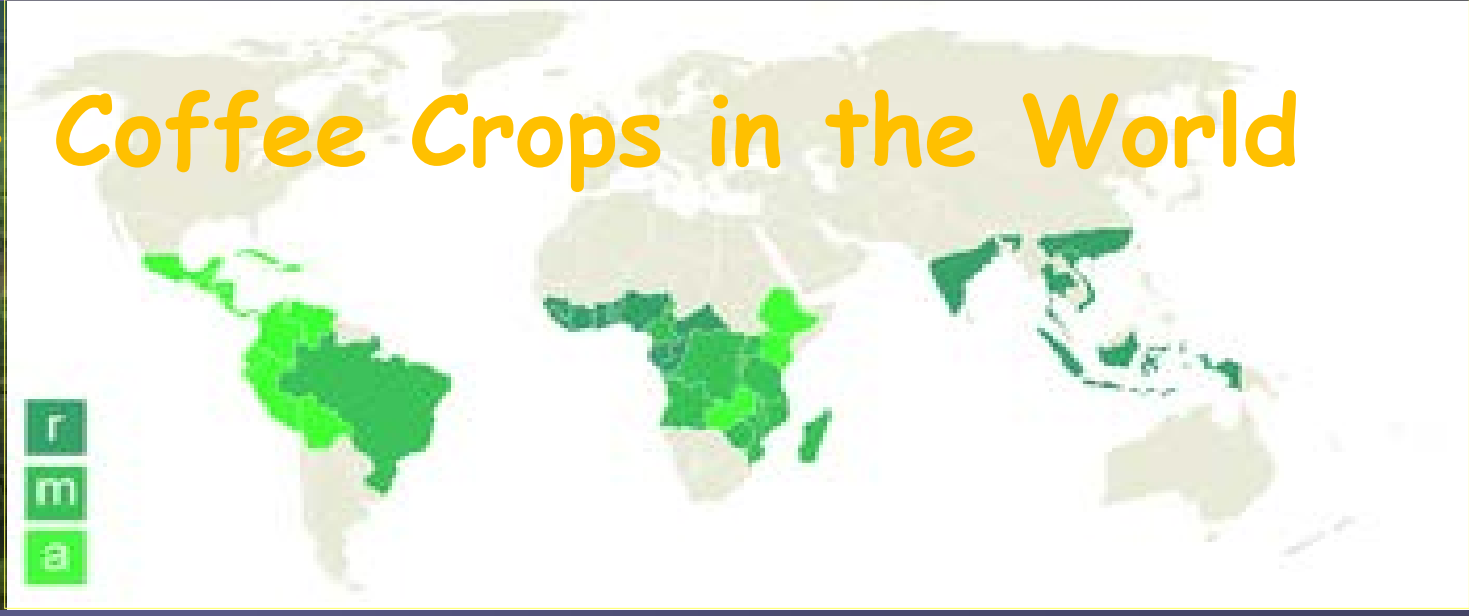
4- Harvest time.

5- Coffee processing (post-harvest).

6- Coffee rejuvenation (pruning).



3- Coffee Crops in the World



Coffee crops are grown in Tropical and Sub-Tropical areas.

Coffee production is in Central and South America, Africa, India, Asia, and South Pacific Islands.

There are over 50 countries producing Coffee.

Production of Coffee was 117 million bags (70 kg) (ICO, 2007).
The coffee market is about US$ 65 billion a year.

There are more than 25 million people working and living from Coffee production.
This generates over 100 million employees.

Coffee in Colombia

Background:

Area planted is 1,141,748 sq km (440,839 sq Mi).

Over 550,000 coffee growers' families.

Coffee production generates 2.5 million jobs.

Coffee crops:

Extension 870,000 has. (2,175,000 acres).

Planted in the middle of high mountains from 1000 to 2000 altitude (3,300 to 6,600 ft).

Temperatures about 18 to 24°C (65 to 75°F).

Coffee production is ± 10 million bags (70 kg) a year.



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



Coffee in Hawaii

Area planted: over 7888 acres (3200 ha).

Number of coffee farmers: over 800.

The Coffee Belt of Kona ranging from 700ft (210m) to 2000ft (610m) elevation.

Production: 8.6 million pounds (2007).

Harvest time: late summer to early spring.

Coffee varieties: Mokka, Kona Typica, Red Catuai, Yellow Catuai.



100% KONA COFFEE FARMERS ASSOCIATION

(Bittenbender & Smith 2008; WWW// Wikipedia 2012).



Both Coffee farmers from Hawaii and Colombia are part of the 100 million of people producing and living of off coffee plantations in the world.



By implementing an IPM program, we can regulate the population of CBB without affecting the environment and without risking human health.

So, our goal is to keep producing one of the best coffees in the world, despite the presence of the CBB.





4- The Coffee Berry Borer CBB

Hypothenemus hampei (Ferrari).

(Coleoptera: Curculionidae: Scolytidae).

The CBB is originally from Central Africa.

Coffee is the primary host.

It affects the berries of coffee (fruits).

It has been reported in many coffee producer countries.

CBB is the most important pest of coffee.

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



Damage of CBB

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

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

Infestations greater than 5% on a field can cause crops losses in weight, quality, and price.

When green berries (less 90 days of development) are attacked by CBB, it can cause premature fall of berries.

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





5- Biology and Ecology of the CBB



Female body is about 1.4 to 1.6 mm long.

The longevity is varied:

Males live for 20 – 87 days

Females live for an average of 157 days

Number of generations per year:

Uganda 8

Ivory Coast 9

Colombia 3

(Barrera 1994; Hargreaves 1926; Montoya & Cardenas 1994; Baker 1999; & Damon 2000).

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 27°C

Eggs 4

Larvae 15

Pre-pupae 2

Pupae 7

Total life cycle:

28 to 34 days

(Barrera 1884 & Sponangel 1994).



6- Biology and Behaviors of the CBB

Host plants:

First and principal host plant is Coffee.

CBB females are attracted to coffee plants (green & red berries).

The CBB feeds and reproduces in coffee berries (endosperm).

Reproduction:

Ratio female: male is 10 to 1

Females & males from the same mother mate inside the berry.

Female leaves the berry in which it is born, then looks for new berries to start the reproductive cycle again.

Males can not fly (nonfunctional wings).

(Barrera 1984; Sponangel 1994; Bustillo et al. 1998; Baker 1999; & Damon 2000).



Biology and Behaviors of the CBB

Aggregation

The CBB populations tend to accumulate in aggregations of foci (hot spots).

CBB distributes to neighboring coffee trees.

Females are attracted to:

- odor, color, and fruit shape.
- waste produced by the first female founder.
- Alcoholic substances from the waste.

(Baker et al. 1984; Damon 2000; & Bustillo et al. 1998).



Alternative Hosts

The CBB is not specific to coffee. Other plants may give appropriate conditions for feeding and reproduction.

Name	Family	Reference	Feeding	Reproduction
Coffea canephora	Rubiaceae	Le Pelley, 1968	+	+
C. arabica		1	+	+
Oxyanthus spp.		Decazy, 1990	+	+
Rubus spp.	Rosaceae	3	+	
Eriobotrya japanica		Urbina, 1987	+	
Zea mays	Poaceae	Urbina, 1987	+	+
Ricinus spp.	Euphorbiaceae	Urbina, 1987	+	
Hibiscus spp.	Malvaceae	3	+	
Gossypium hirsutum		Urbina, 1987	+	
Senna occidentalis	Fabaceae	1	+	
Crotalaria juncea		1,3	+	
Cajanus cajan		Campos, 1991	+	+
Leucaena leucocephala		1,3	+	+
Mimosa pudica		1	+	

1= Morallo-Rejesus & Baldos, 1980; 3= Waterhouse & Norris 1989. (Taken from Damon 2000).



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 with 60 days age and over .



When are the Coffee Berries Attacked by CBB?

CBB prefer to infest berries with 100 days age and over.

Why those berries?

Because coffee berries start to accumulate dry weight. This condition gives the best opportunity for CBB reproduction.

Coffee berries with more that 20% of dry weight are susceptible to CBB. For best development of CBB, berries need to be more than 120 days old.

Coffee berries 60 to 100 days old are affected as well, but the CBB reproduction is low. Coffee berries may fall prematurely.

(Bustillo et al. 1998; Baker 1999; & Damon 2000).





Penetration into the Coffee Berries



Green berries = 5 hours, 36 minutes



Green – ripe berries = 5 hours, 54 minutes



Red or yellow berries = 4 hours, 50 minutes



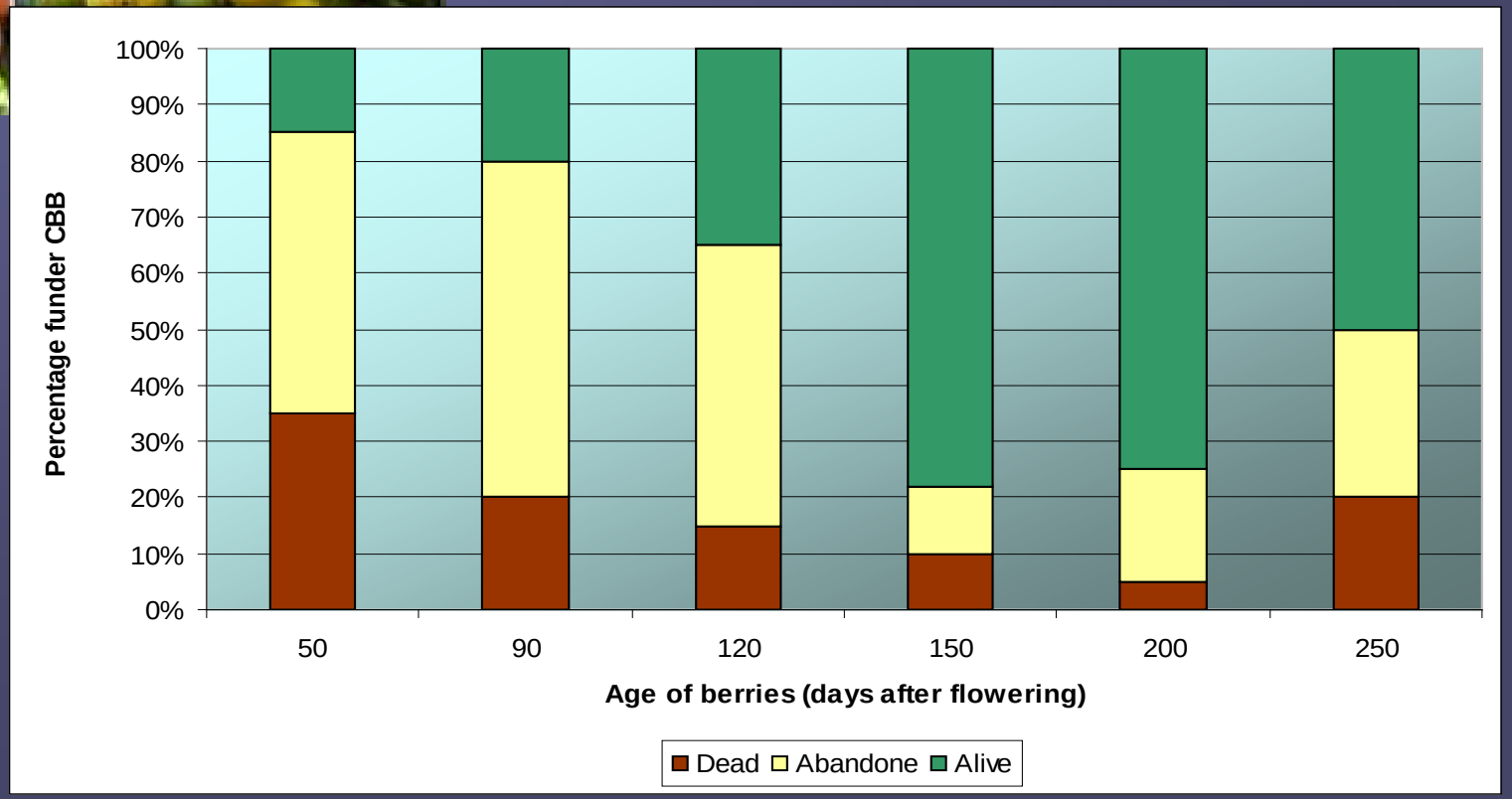
Raisin berries = 11 hours, 21 minutes

(Miguel & Pauline 1975; cited by Bustillo et al. 1998).



CBB Life History Parameters

Berries with 50 to 250 days after flowering were infested with CBB.



(Taking from: Baker , P. S. The Coffee Berry in Colombia; Final report of the DFID-Cenicafé- CABI Bioscience IPM for coffee project. Chinchiná (Colombia), 1999).



Harvest and CBB



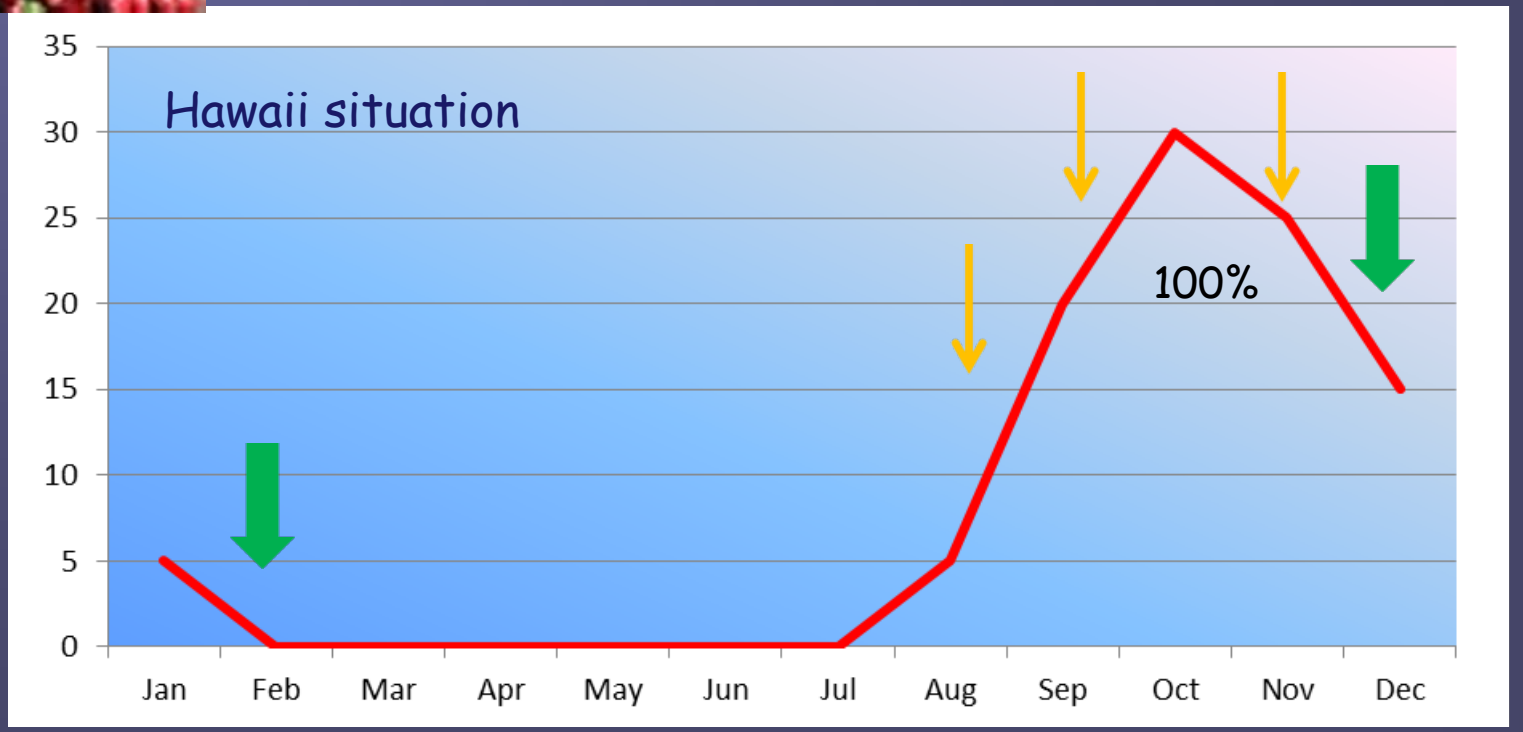
Normal recollection

Re-Re: Repase

"Recollection of the overripe + dry berries"



Harvest and CBB



Normal recollection

Re-Re: Repase

Recollection of the overripe + dry berries"



Reinfestation During Harvest

Picking red-ripe, yellow-ripe, and overripe berries, moves coffee from the tree through the coffee lot, and from the coffee lot through the coffee farm.

So, harvesting not only means moving coffee berries from one place to another but also moving CBB through the coffee farms and coffee region.

According to Baker (1999), "For every berry infested at least three months before harvest, another berry will be infested by harvest time if no control measures are taken."

Emergence and Dispersion of the CBB



When does CBB emerge?

After rainy season comes, adult females start the emergence from coffee berries previously infested.

High humidity (90 -100%) and temperatures about 20 to 25°C (78 to 88°F).

From where do CBB emerge?

Coffee berries in the trees and ground. Especially from overripe and raisin berries which have between 10 – 150 CBB.

Where is the CBB going?

New berries, new trees, and new coffee plantations.

(Bustillo et al. 1988; & Baker et al. 1994).



Locations Preferred by the CBB

Coffee tree

Older branches in the bottom and in the middle.
All berries from green until raisin fruits.

Coffee plantation

Borders of the coffee lot, places shaded by trees, close to roads, close to springs, humid areas, and inside weighing station.

Coffee farm

Borders of the farms, gateways , internal roads, inside weighing and processing stations, location of coffee pulp, older coffee plantations, lower areas of the hills, and around renewed coffee lots.

Coffee Plantations' age and the CBB

The infestation by CBB increases with the age of the coffee plantation.

Hypothetical situation in Colombia.

Coffee age	% infestation by CBB
1 year harvest	0 - 1 %
2 year harvest	1- 3 %
3 year harvest	2- 4 %
4 year harvest	3 - 5 %
5 year harvest	> 5%



Zoqueo in Colombia

This is a rejuvenation practice recommended in Colombia in order to keep younger and productive coffee plantations.

This rejuvenation is conducted after 5 or 6 years of harvest in a coffee lot.

Zoca = coffee tree cut about 0.3 m (1 feet) from the ground.

In general coffee farms divide the area into 5 coffee lots, all with different age. (Ranging from 1 to 5 years of harvest). Every year the oldest coffee lot is rejuvenated by zoca (20% of the area).

After zoqueo, a huge population of the CBB emerge from fallen Coffee lots. Between 1.5 and 2 million adults female of CBB emerge a few days after zoqueo.

(Bustillo et al. 1998; Baker 1999; Aristizábal et al. 2000).



Rejuvenation or pruning in Hawaii



What kind of rejuvenation or pruning is conducted in Hawaii?

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

How these prunings may or may not stimulate reinfestation of the CBB in the coffee farm?

If the pruning stimulates movement of the CBB, how we can control and prevent reinfestation in the coffee farm?

(Bittenbender & Smith 2008).

The CBB and Weather Conditions

The Relative Humidity, temperature, precipitation, and dry season affects the CBB:

Lower humidity causes high mortality .
High humidity (90 – 100%) and temperatures about 25 °C increases the emergence of CBB.

Low temperatures (below 15 °C) inactivate the CBB.

High temperatures (over 30 °C) affects the biology of CBB.

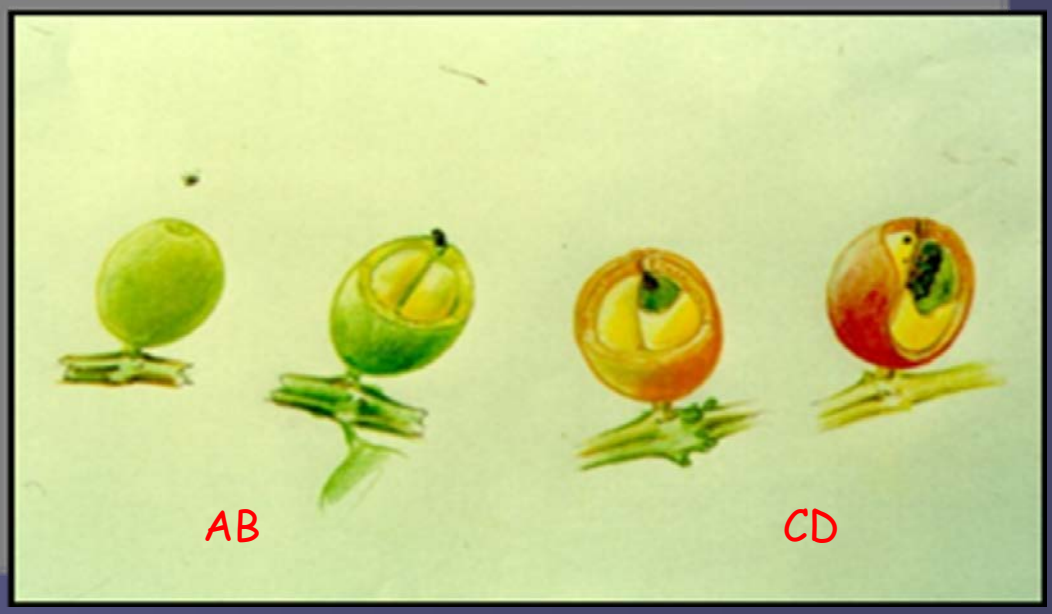
High and prolonged periods of rain reduces the population of CBB.

Berries infested and fallen to the soil suffers quick decomposition and affect the CBB.

Prolonged dry season increase the population and when rains come, high population of adults emerge.

(Baker 1999; Bustillo et al. 1998; Sponalgel 1994; Damon, 2000).

When is the CBB vulnerable ?



A population of the CBB have two components:

Adults (female and male).

Immature stages (eggs, larvae, and pupae).

Where they live?

Inside of coffee berries.

80% of population is inside of the berries.



20% *** Just adult females are outside looking for a new berry for their feeding and reproduction.

Answer:

Just when the adult females are flying or boring a coffee berry they are vulnerable.

(Bustillo et al. 1998).

Natural enemies of CBB





Entomopathogenic fungi:
Beauveria bassiana





Ecto parasitoids:
Cephalonomia stephanoderis,
Prorops nasusta



Entomopathogenic nematodes:
Steinernema sp.



Endo parasitoid:
Phymastichus coffea

Orozco & Aristizábal 1996; Posada 1998; Bustillo et al. 1998; Baker 1999; Jaramillo et al. 2005, Lara et al. 2004; & Aristizábal et al. 2004, 2011, 2012).

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Colombian Coffee Farmers

Thank you for your attention

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Photos from Cenicafé, Internet, and Aristizábal