# FEATURE ARTICLE:

# Coffee Biomes

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**GeoWorld 7, 8, 9, 10 (Macmillan)**

Image: http://www.coffeearea.org/wp-content/uploads/2014/02/worldwide-coffee-varieties-overview.jpg

The coffee plant is a woody perennial evergreen shrub. The white flowering plants produce fruits called 'cherries' which contain two seeds, called coffee beans.

The word 'coffee' comes from Kaffa, a region in central Ethiopia where coffee beans originated. By 1600, the bean had spread from Africa to Italy via Arabia. Today, around 70 countries produce coffee, and countless cafes and restaurants serve the drink.

Over the centuries coffee has faced resistance. It was blamed for fuelling riots, spawning seditious speech and encouraging Satan worship. In Turkey, during the 16th century the Mufti of Constantinople (now Istanbul) forbade the drinking of coffee. Those caught sipping the forbidden drink were supposedly sewn into leather bags and dumped into the Bosporus Strait. Consumers in Cairo (Egypt) and Mecca (Saudi Arabia) also faced prohibitions. However, in London many coffee houses became powerful and wealthy businesses, such as Lloyd's Coffeehouse became Lloyds of London and the Baltic Coffeehouse became the East India Company.

## BIOME: OPTIMAL COFFEE ENVIRONMENT

The ideal environment for growing coffee trees is between the Tropic of Cancer and Tropic of Capricorn called the 'Bean Belt.' The areas includes countries, such as Ethiopia, Indonesia, Brazil and Costa Rica.

### Location of Coffee Bean Belt


Map: http://s3.amazonaws.com/ilovecoffee-img/uploads/beanbelt/beanbelt.png

### Process of Coffee – flower, cherry, bean

The taste of coffee varies across the world, as it is a combination of both natural and human factors.

Natural influences includes:

- ***variety*** (species) of the coffee plant grown
- ***soil*** in which the coffee plant grows
- ***climate*** experienced by the coffee plant- temperature, precipitation and sunshine
- ***altitude*** at which the coffee grows

## ARABICA AND ROBUSTA SPECIES

Out of 6,000 coffee species the two most commonly grown species cultivated today are:

- ***Arabica coffee***, accounts for 75% – 80% of world's production
- ***Robusta coffee,*** accounts for about 20% of world's production

https://upload.wikimedia.org/wikipedia/commons/7/77/Barrels_of_Jamaica_Blue_Mountain_coffee_beans.jpg

## COMPARING ARABICA AND ROBUSTA COFFEE

Finicky ***Arabica*** species grow best at high altitudes with lower temperatures compared to ***Robusta*** species that thrive at lower altitudes with higher temperatures.

***Robusta*** trees are easier to grow, less vulnerable to pests and variable weather conditions, and produce fruit more quickly than ***Arabica.*** Instead ***Arabica*** species require several years to reach maturity.

***Robusta*** beans are generally lower-quality beans but are higher in caffeine and acidity compared to ***Arabica*** beans. ***Robusta beans*** are primarily used in instant coffee.

## ARABICA COFFEE

### Subtropical regions:

- high altitudes 550 – 1000 metres
- low temperatures 16°C – 24°C
- mostly grown in Africa and Papua New Guinea, but grown mainly in Latin America, Mexico, Jamaica, Zimbabwe, and Sao Paulo and Minas Gerais regions in Brazil

### Equatorial regions:

- higher altitudes 1000 – 2000 metres latitudes closer to the equator – lower than 10°N – 10°S

## ROBUSTA COFFEE

- between 10°N and 10°S
- lower altitudes – 900 metres
- tolerant to warmer conditions
- mostly grown in Africa and Indonesia

*Red Catucaí, variety of Coffea Arabica – maturation in different stage, Minas Gerais State, Brazil* Source: https://commons.wikimedia.org/wiki/File:FruitColors.jpg

## Altitude linked to coffee taste

A rise of 1°C is equivalent to moving 150 metres in altitude


Source: http://www.scribblerscoffee.com/blog_flavor_mountain.jpg

## LOCATION OF WORLD'S TOP TEN COFFEES

1. Kenya AA Coffee: grown at more than 2000masl on Kenya's high plateaus
2. Jamaica Blue Mountain Coffee: grown in Jamaica's Blue Mountain District on estates between 900 – 1,600masl
3. Java Arabica Coffee: wet processed (washed) Arabica coffee grown in Java- particularly around 1,400m on east side in Ijen volcano
4. Tanzania Peaberry Coffee: grown on Mt. Meru and Mt. Kilimanjaro, Tanzania
5. Ethiopian Harrar Coffee: grown in southern Ethiopia from 1370 – 1900masl
6. Sulawesi Toraja Coffee: grown in SE highlands of Sulawesi
7. Hawaii Kona Coffee: Arabica coffee grown at 600masl on fertile slopes of Mauna Loa and Hualalai Volcanoes on the Big Island of Hawaii
8. Sumatra Lintong Coffee: grown in Lintong region in north central Sumatra
9. Ethiopian Yirgacheffe Coffee: wet processed and grown between 1700 – 2000masl
10. Mocha Java Coffee: Arabian (Yemen) Mocha coffee and Indonesian Java Arabica coffee

*Sun coffee in Costa Rica . Source: S Bliss*

*Shade coffee in Kumili, Spring Valley, Robusta coffee. Source: J Bliss*

## SUN COFFEE VERSUS SHADE COFFEE

Coffee was traditionally gown in the shade under the canopy of tropical rainforests, with other food species referred to as polyculture. However, the commercialisation of the crop in the 1970s and 1980s, saw large tracts of forests cleared, and coffee cultivated in rows in the sun. The sun-grown coffee method, with the aid of pesticides and fertilisers produces higher yields, but eliminates diversity of plants that support insects, birds and other species in the food web.

The establishment of unshaded coffee monoculture in places such as Brazil and Vietnam reduced biodiversity, accelerated soil erosion and increased water pollution.

### Comparing sun and shade grown coffee


Diagrams:https://s-media-cache-ak0.pinimg.com/originals/5d/55/7e/5d557e9040666241d390423cd3313794.jpg

## PROCESS – FROM SHRUB TO MUG

### 1. GROW
- Arabica and Robusta from white flower to cherry
- Issues: pests and diseases, use of fertilisers and pesticides

### 2. HARVEST
- Berries change from green to red before they are harvested.
- Hand labour or machines are used

### 3. PROCESS
- Dry (in sun) or Wet (machine and use of water)

### 4. MILL
- Hull, clean, sort, grade

*Stages of ripening in coffee cherries*
Source: http://www.kaffee-alchemie.at/wp-content/uploads/2011/06/Aida-Batlle-photo-of-various-ripeness-of-bourbon-2.jpg

*Mechanical coffee harvesters in Brazil* Source: http://heidichang.com/wp-content/uploads/2013/03/HarvestingCoffee700.jpg

## DRYING THE BEANS

*Drying coffee beans in the sun* Source: http://www.fratellocoffee.com/wp-content/uploads/2013/02/photo-1-2.jpg

### 5. ROAST
- Hot air or drum roasting

### 6. PACKAGE AND TRANSPORT
- Containers/bags move from producer to retailer to consumer

### 7. GRIND
- For specific fineness

### 8. BREW
- Plunger, Espresso etc

### 9. DRINK

Source: https://stylesatlife.com/wp-content/uploads/2016/08/Veinna-coffee.jpg

*Flowers of the Arabica coffee plant*

## GROWING THE BEANS
- The plant produces white jasmine-scented flowers
- Coffee berries form and ripen to cherry red
- There are two coffee beans in one cherry

## HARVESTING THE BEANS

*Margaret Mukamugema harvests coffee bean crop by hand, Kagabiro, Rwanda.*
Source: https://www.oneacrefund.org/uploads/all-files/June14.JPG

*Machine used for drying coffee beans in Central America*

Source: https://photos.travelblog.org/Photos/108131/483024/f/4865694-Machine_used_for_drying_the_coffee_beans-0.jpg

## ASIA PERSPECTIVE: CROSS CURRICULUM PRIORITY

Around 1600, Baba Budan smuggled the first coffee seeds out of Arabia and into India during his pilgrimage to Mecca. In 1699, the Dutch successfully planted the first coffee plants in Java, Indonesia.

Today, about a third of coffee is produced in Asia. Vietnam is the second largest coffee producing country in the world and Indonesia the fourth largest. The main Arabica producing countries are Indonesia and India, and the ain producing Robusta countries are Vietnam and India.

### Red cherries: Hanchibetta plantation, Poli betta village, district of Kodagu, Karnataka, India

Source:http://socialdocumentary.net/exhibit/REZA_./2245

This plantation has been operated by the Rodrigues family for four generations. Seasonal workers are paid by the quality and quantity of coffee cherries they gather and sort.

An inspector passes by the mounds of red cherries. After his approval the cherries are placed in sacks.

### Kumbrikhan plantation, Chickmagalur district, Karnataka, India

Source: http://socialdocumentary.net/exhibit/REZA_./2245

Coffee beans are laid bare beneath the sun. After separation from their first layer of red skin, they are fermented for several hours.

Then the men fill large baskets with wet coffee beans, and pour them out onto the terrace. The men appear to follow steps that form a chessboard creating perfect domes of coffee beans.

A woman then bends down and spreads all of the moist coffee beans on the floor, lining them up, allowing each one of them to dry under the sun. For twenty-four hours, they are constantly turned so not a single bean can escape the sun's heat.

Once beans are fully dried they are put in bags for storage, ready for sale.

## ENVIRONMENTAL COFFEE ISSUES

- Climate change
- Water pollution
- Water fotprint
- Carbon footprint
- Soil erosion
- Waste
- Use of pesticides and fertilisers
- Deforestation
- Decining biodiversity

## DEFORESTATION FROM COFFEE PRODUCTION

It is estimated that 37 of the 50 countries in the world with the highest deforestation rates are also coffee producers. Already one million ha of forests in Central America have been cleared for sun-grown coffee farming.

### Future threats to deforestation

By 2050, the coffee industry will need to triple production to meet global demand. This requires the current area of land under coffee production (about the size of Iceland), to increase to an area about four times the size of Costa Rica.

*'Coffee production a future driver of deforestation, could threaten the last remaining intact tropical forests and the services they provide: carbon storage, provision of fresh water, and biodiversity that aids in food provision.'* h

Source: ttp://www.conservation.org/NewsRoom/pressreleases/Pages/Future-Demand-and-Climate-Change-Could-Make-Coffee-a-Driver-of-Deforestation-.aspx

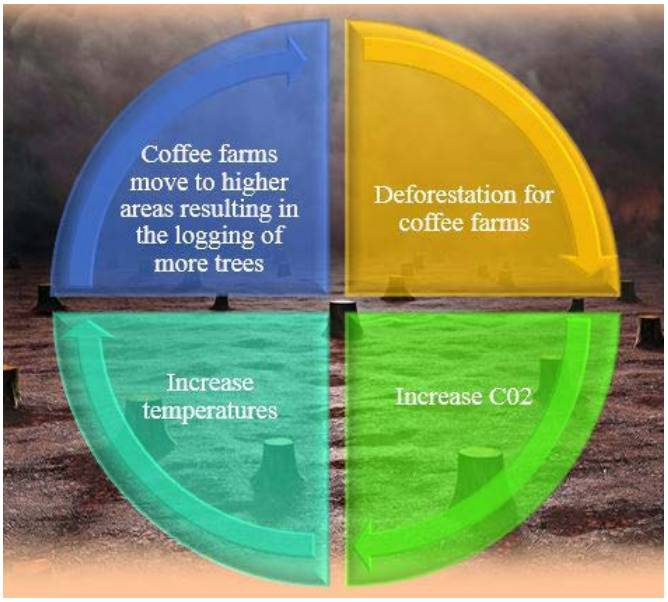
*Deforestation for coffee production* Source: http://mesoamerican.org/wp-content/uploads/2015/06/coffee-threatens-forests-deforestation.jpg

### Threats to cloud forests

Climate change is expected to change the location of coffee farms as they will be forced to move to higher cooler mountain sites. This movement will threaten cloud forests and national parks in Honduras. Strictly High Grown (SHG) coffee shares the same elevation as cloud forests that will be deforested to make way for coffee farms. In addition, vast quantities of firewood are required to fuel industrial coffee dryers.

Conservation International (CI) works with coffee farmers, traders, roasters and retailers to promote environmentally and socially appropriate growing practices, and make coffee a sustainable agricultural product.

### Links between cklimate change and deforestation




### Carbon footprint of coffee production


Diagram: https://s-media-cache-ak0.pinimg.com/736x/4d/6a/68/4d6a683784663860a3af18e429196365.jpg

## WATER FOOTPRINT OF A LARGE CAFÉ LATTE

When you hand over $3 for a cup of coffee have you ever wondered about its water footprint? In fact more than 200 litres of water is required to make one large café latte from the coffee seed to the restaurant. This is only an average figure as the consumer and coffee shop owner are unaware of how much water is used by the farm producing the coffee, milk and sugar. Some farms would use more water than others.

In general the least amount of water is used in the coffee shop to brew the coffee and the largest quantity of water is required to grow the coffee bean. Most of the world's coffee requires a water source to ferment and wash the coffee prior to drying the beans.

**Answer the following questions:**

- What is the water footprint of a large café latte?
- How much water is required to grow the coffee bean?
- How much water is required to produce the milk in your coffee?
- How much water is used to make the lid and paper cup for your cup of coffee?
- Do you take sugar with your coffee? How many litres are required to process the coffee and grow the sugar?
- If coffee beans are produced in a water poor region what is the impact on the environment?
- How can you reduce water consumption?

Adapted from http://www.guardian.co.uk/sustainable-business/key-questions-finite-planet

| PRODUCT | LITRES OF WATER |
|---|---|
| **Grow coffee** | 142.8 |
| **Brew coffee** | 0.05 |
| **Process coffee and grow sugar** | 7.6 |
| **Produce milk** | 49.4 |
| **Plastic lid, paper cup and sleeve** | 8.1 |

*A plot of young coffee plants in Finca Limoncillo, Nicaragua..*
*Photo: Dennis Tang* Source: https://www.thesolutionsjournal.com/wp-content/uploads/2016/03/OTG_Santoyo_Figure2.jpg

## IMPACTS OF CLIMATE CHANGE ON COFFEE PRODUCTION – THE HEAT IS ON!

Many of world's 25 million coffee farmers are smallholders and have little capacity to adapt to a hotter world. Already they are experiencing a decline in coffee yields and quality and an increase in pests and diseases. Often their only source of livelihood this decline could result in a larger number of farmers experiencing poverty.

### Impacts on production

**Escalate**

- Diseases. In 2012, a heatwave in Central America, resulted in Coffee Leaf Rust, decimating more than 50% of coffee crops. This disease will increase with climate change.
- Pests: A temperature increase of 1°C–2°C will increase Coffee Berry Borer numbers, causing a decline in coffee crops

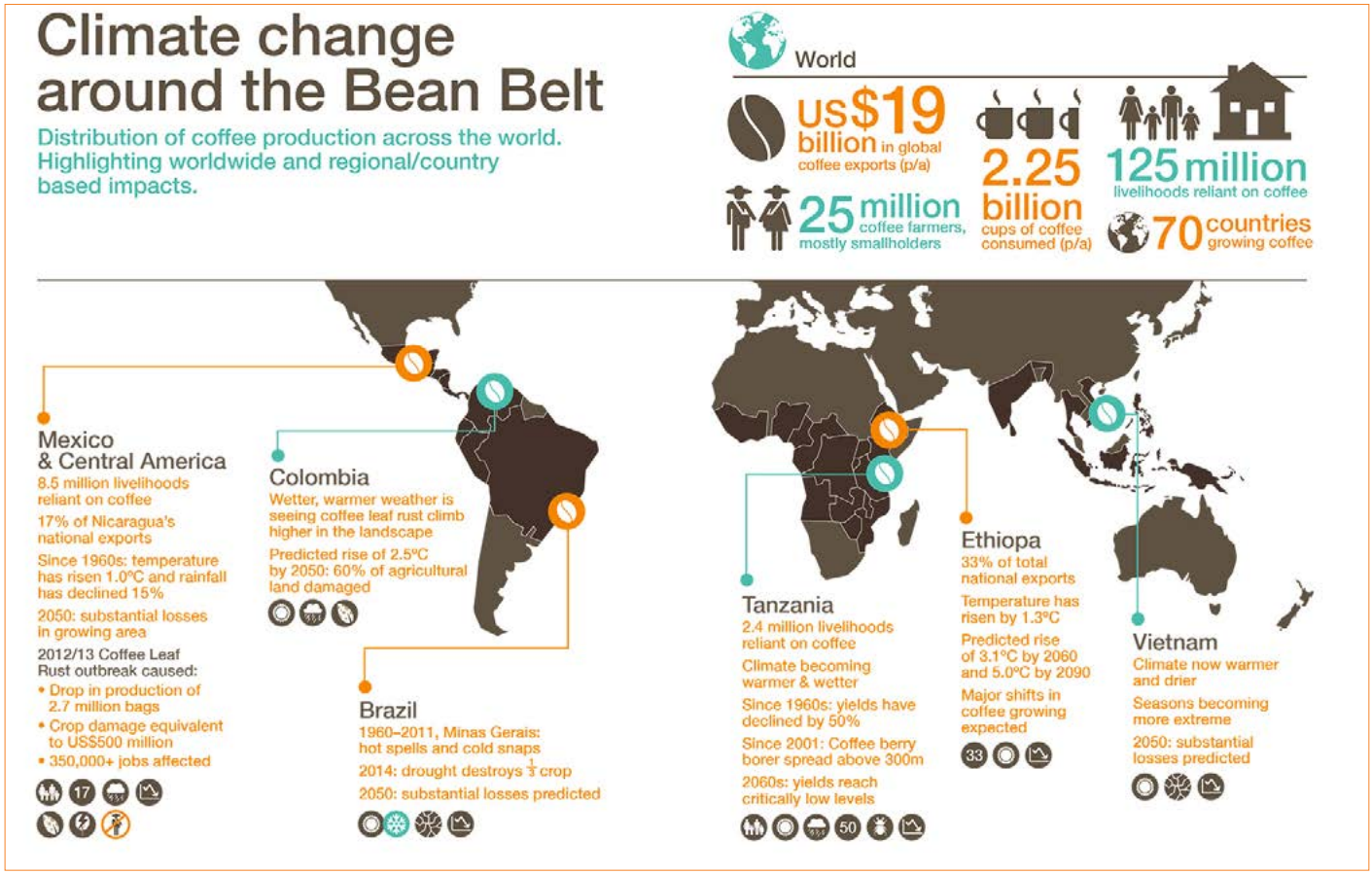
**Decline**

- By 2050, Climate change predicted to
  - Halve coffee-growing areas that support 120million people in 70 countries
  - Decline low altitude coffee farms and expansion of farms in higher altitudes
- By 2080 wild coffee, an important genetic resource for farmers, could become extinct

## CLIMATE CHANGE AFFECTS COUNTRIES LOCATED AROUND BEAN BELT

Rising temperatures, changes in rainfall patterns, and increasing pests and diseases are already making life harder for coffee farmers living around the Bean Belt. However, by 2050 what will be the impacts if the warming trend continues?

### Climate change around the Bean Belt




Infographic:http://www.climateinstitute.org.au/verve/_resources/TCI_infographic_Bean_Belt_Map_standalone-01.jpg

### Coffee leaders' comments on climate change

*"What we are really seeing as a company as we look 10, 20, 30 years down the road—if conditions continue as they are—is a potentially significant risk to our supply chain... If we sit by and wait until the impacts of climate change are so severe that is impacting our supply chain then that puts us at a greater risk."*

Jim Hanna, Director, Environmental Affairs, Starbucks

*We have a cloud hovering over our head. It's dramatically serious. Climate change can have a significant adverse effect in the short term. It's no longer about the future; it's the present."*

Mario Cerutti, Green Coffee & Corporate Relations Partner, Lavazza

*"Changing climatic conditions and rising global temperatures pose one of the most significant threats to world coffee production."*

International Coffee Organisation

Source: http://fairtrade.com.au/~/media/fairtrade%20australasia/files/resources%20for%20pages%20-%20reports%20standards%20and%20policies/tci_a_brewing_storm_final_24082016_web.pdf

## AVOIDING CATASTROPHIC SCENARIOS

### Strategies

- increase the longevity of each planting of coffee, so owners will not move to other areas and clear more land (decrease deforestation)
- grow organic coffee – reduces use of pesticides and fertilisers
- reduce sun-grown coffee by reviving shade-grown coffee, to protect plants from the heat and evaporation and reduce deforestation
- diversify crops grown e.g. converting to other crops such as Teff in Ethiopia
- develop more resilient production systems
- moving coffee farms up-slope, so they benefit from a cooler climate
- open up new areas to grow coffee such as in Australia
- promote sustainable farming – economically, socially and environmentally eg. Selva Negra, Nicaragua

## AUSTRALIA

Coffee has been grown in Australia for over 200 years.

Two major production regions are:

- northern New South Wales/subtropical SE Queensland
- tropical north Queensland

Coffee from each region has different flavours due to diverse climates and soils.

Coffee production in Australia is:

- 100% Arabica beans
- low in caffeine
- no pests and diseases
- free of chemicals
- fresh from the plantation

Source: Australian Subtropical Coffee Association (ASTCA) – http://www.astca.org/


Source: http://www.outbackcrossing.com.au/Cooking/images/coffee-growing.jpg

## ETHIOPIA: COFFEE PRODUCTION AFFECTED BY CLIMATE CHANGE

Ethiopia considered the birthplace of the coffee plant, is now the world's seventh largest producer of coffee. The commodity comprising of 28% of the country's exports, provides valuable employment for 15 million people.

Between 1960 and 2006, Ethiopia's average annual temperature rose by 1.3°C. As a consequence coffee farmers in the mountains of Eastern Harar experienced:

- rising temperatures
- more frequent droughts
- poor access to water and irrigation
- poor soils that do not hold water for long periods
- increase in pests and diseases

As coffee has become an unreliable source of income many farmers have resorted to growing a small hardy bush called Khat (Catha edulis) because:

- the leaves produce an amphetamine-like narcotic drug
- fetches twice the price of coffee in weight at market
- requires little attention, no fertilisers and can be harvested all year round
- source of cash for poor rural people

However, it is detrimental to health of an increasing number of addicts. Dried khat pictured below.

*Teff:* Source: http://world-crops.com/wordpress/wp-content/uploads/Teff-1.jpg

### Effects on Ethiopean coffee farmers

Good years: When the price of coffee is high a farmer is able to feed and clothe family, send children to school, and pay for basic healthcare

Bad years: Farmers may neglect or abandon their coffee plants and try growing 'something else' such as khat

## ALTERNATIVE TO COFFEE – IS IT TEFF?

Ethiopia is the home of Teff, a nutritious grain found in supermarkets all over the world. Grown by 6.3 million farmers, crops cover more than 20% of the land under cultivation. The Ethiopian government aims to increase production as it helps reduce malnutrition and increases income. Additionally, by converting farms from producing coffee to Teff could be the answer to the coffee problem.

### Coffee versus cash crops in Ethiopia

| COFFEE | TEFF |
|---|---|
| Non-food | Food (high value) |
| Primarily export market | Primarily domestic market |
| Large and small scale production | Small-scale production |

## NICARAGUA, SELVA NEGRA: SUSTAINABLE MANAGEMENT

- Name of coffee farm: Selva Negra
- Location: Nicaragua, 1,200-1,600masl.
- Coffee: Arabica coffee is grown in a shaded environment, protected by native trees.
- Environment: fertile volcanic soil enables high quality beans to be grown.
- Maintenance: weeding, controlling pests, mulching and pruning shade trees.
- Technology: its laboratories developed organic weed and pest controls.
- Processing: the cherry produces several layers of material, including cherry pulp and the mucilaginous layer (honey-like coating):
  - cherry pulp (skin) is removed and diverted to a worm farm, to make compost
  - honey water causes contamination if poured into waterways. Instead honey water is recycled in biodigestor tanks to produce natural gas, used in kitchens. The excess water is so pure it is used to irrigate grass for cattle during the dry season.
- Mill: is designed to work without water. The water is only used to push the coffee cherries through the system and to remove stones and debris. The system uses 40 times less water than many traditional commercial coffee mills.

*Biodigestor tank recycles honey water. Photo: S Bliss*

*Coffee nursery contains coffee trees and new shade trees. Photo: S Bliss*

*Grounds of the Selva Negra Coffee Estate.*
*Source: https://commons.wikimedia.org/wiki/File:Selvanegrafromchapel.JPG*

The Selva Negra is a community of over 600 people including workers and their families. At the end of the day the farmer tallies the harvest of each picker. Picking is piece work – the higher the tally, the higher the pay. The beans are bagged and taken to the mill by truck and then deposited in large bins where they are processed. These employees experience a high quality of life as they are supplied with housing and the site has a medical clinic, school and convenience store.

*Selva Negra workers homes. Photo: S Bliss*

*Coffee waste used to make compost. Photo: S Bliss*

## NICARAGUA, SELVA NEGRA: FROM SEED TO SERVICE

The Selva Negra Coffee Estate won the Specialty Coffee Association of America (SCAA) Sustainability Award. Today it functions as an Eco-Lodge, Coffee Estate and Organic Farm. The property supports a restaurant with locally grown vegetables, organically fed, free range pigs and cattle and award winning shade grown coffee.

### What makes Selvba Negra Farm sustainable?

#### Environmental issues

- grows shaded coffee
- little use of artificial fertilisers
- uses mechanical not chemical weeders
- uses ecological processing – less water and no contamination in rivers
- makes compost from coffee pulp
- uses mucilage to produce methane gas
- limited use of wood for cooking
- sun drying preferred to kiln drying
- reduces carbon footprint: carbon credits
- conserves energy: solar water heaters
- conserves water and reuses wastewater
- composts 15 million kilograms of compost every year

#### Social and Economic issues

- provides a fair salary to workers
- improved conditions for workers – housing and sanitary conditions
- provides nutritious food for workers
- provides a school for workers' children up to sixth grade
- offers education scholarships
- provides adult and children's library
- runs baseball teams and special occasion celebrations.
- maintains a medical clinic
- Rainforest Alliance Network supports its efforts to meet stringent environmental, social and economic sustainability standards.

## ACTIVITIES

1. List the countries in the Bean Belt.
2. What are the two main types of coffee grown around the world?
3. Refer to the diagram and explain the role and importance of the natural environment in the production of coffee.


4. Monoculture is the agricultural practice of producing coffee in some areas. It unfortunately relies on high levels of fertilisers and pesticides and large quantities of water.
   a. What is meant by the word monoculture?
   b. Research the large water footprint involved in the production of coffee.
   c. Suggest strategies that could be implemented to ensure the coffee crop is sustainably managed.
5. Explain the following statements
   a. *'Growing coffee for export rather than growing food crops for poor people suffering hunger, is social injustice'.*
   b. *'Coffee is tied to colonialism, slavery, child labour and environmental degradation'.*
   c. *'Coffee has long stood for both privilege and poverty.'*
6. Using ICT go on a coffee tour – http://www.selvanegra.com/en/activities/coffee-tour/
   a. Refer to website from seed to cup and explain the coffee process – http://www.selvanegra.com/en/c_seed.html.
   b. Prepare a PowerPoint presentation on Selva Negra focusing on sustainability: environmental, social and economic

7. *'Our taste for coffee has hit forests and biodiversity, but efforts are afoot to make production more sustainable'.*
   a. In groups discuss how green is your coffee. https://www.theguardian.com/environment/2011/oct/04/green-coffee
   b. Explain this diagram

https://static1.squarespace.com/static/569419d3d8af10cf1a8b3b47/t/5733e07820c647c55c589388/1454730137678/

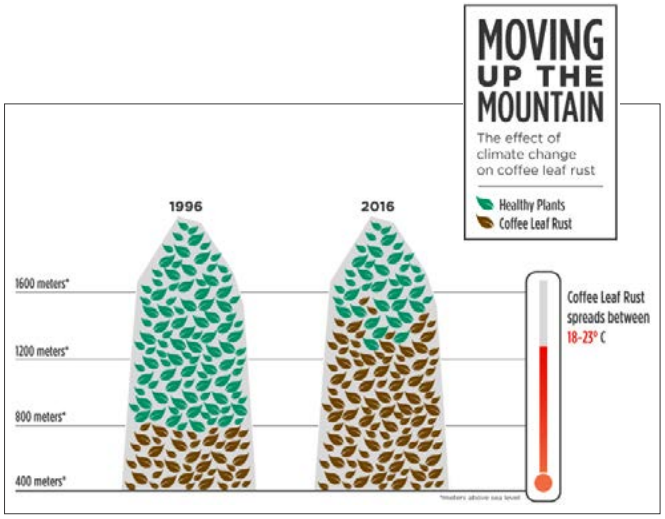
8. Coffee grows on trees – Students research the production process.

   Prepare the following statements on separate cards, students then sequence them in order of the process from 1 to 12.

| | |
|---|---|
| Thousands of carefully selected beans are planted close together in the nursery and covered with rich soil. | The machine removes the pulp from the two seeds (or beans) that are inside the fruit. |
| The beans soak in tanks of cold mountain water for 24 hours and are then carefully washed in fresh water. | After eight weeks the seeds sprout and roots develop. The best plants are selected, transplanted and looked after for six months. |
| When the plants are two feet tall they are planted out in the coffee plantation. | The beans are scooped up into straw baskets and then spread out to dry on open-air terraces. |
| When dry the beans are taken to the mill where machines remove the husk and skin. | It takes three to four years for a coffee tree to grow to full size. The first fruit appears six months later. |
| When the fruits are a rich red colour they are ready for harvesting and are picked by hand. | The olive green beans are tested for quality. |
| The beans are packed for the journey to factories in other countries where they will be roasted, ground and packed for sale. | The fruits are out into bags, loaded onto mules or donkeys and taken to the de-pulping machine. |

Adapted from http://www.dep.org.uk/activities/ge-activities/13/ge13activities.htm

9. Explain the causes and consequences of climate change illustrated in this diagram




Source: http://www.crs.org/sites/default/files/crs-files/revised-coffee-rust-graphic-960w-v3.png


10. Watch the video: Black Gold – http://www.pbs.org/independentlens/blackgold/film.html

    Tadesse Meskela's co-operative in the *Black Gold* movie, grants small scale farmers a living wage. He manages the Oromia Coffee Farmers' Co-operative Union, representing over 74,000 coffee farmers. The union buys coffee from over 100 cooperatives spread across southern Ethiopia. In 2004, the union facilitated the construction of four new schools, seventeen classrooms, four health centres, two clean water supply stations, and in terms of dividends, $2 million was given back to the farmers.

    a. What lies beneath, and beyond, our lives as prosperous Western consumers?
    b. Discuss how the lives of the workers have improved and what measures could be implemented for further improvement.

11. Watch the video: Coffee Production in Asia

    Southeast Asia is now producing high quality Arabica coffee – http://www.youtube.com/watch?v=1P_18o8rK6w