

Molly Carroll

Wayzata High School

Plymouth, MN

Costa Rica, Factor 6: Sustainable Agriculture

Costa Rica: The Fight against Monoculture in the Cacao Industry

Costa Rica is a country full of contradictions. On one hand, it has beautiful beaches, mountains, and rainforests, along with one of the most stable Central American governments. Yet, on the other hand, there exists significant concerns for an improved economy and diversity of diet. Large percentages of farmers still only produce enough for subsistence and rely solely on their harvests for any source of income. The vast and enormous biodiversity of Costa Rica, and its uniquely situated and protected rainforests, is a national treasure barely tapped to promote sustainability. Concerted efforts to protect the biodiversity will improve the economy and availability of food for Costa Ricans and potentially others around the world.

These comments will focus on the case study for protecting the biodiversity and sustainability of the cash crop that is currently in high demand around the world, cacao. This crop is a tree/bush that produces seedpods twice per year. The seeds are processed and roasted to yield cacao and later, chocolate. Cacao is generally grown in countries located around the equator. Costa Rica, situated just above the equator, has the perfect climate for cacao to thrive. Costa Rica grows 700 tons of cacao per year (2013) or approximately .01% of the world's chocolate production (Ramsey). This level of cacao production makes Costa Rica's chocolate industry an integral part of the country's economy and culture.

Costa Rica is a country where farming is the primary employment. Approximately 1/5 of the workers are involved in farming, including large-scale industrial farming. The other major component of the economy is tourism (World Fact Book). The tourism industry is primarily located on the coasts and bigger cities. Many people travel to Costa Rica for "eco-tourism" to see the protected rainforests, which is a large majority of the county. A major drawback to the tourism and agriculture industries is the poor maintenance of the roads and infrastructure. The frequent rains make it difficult to maintain the major travel routes due to erosion (Cespedes). This erosion additionally affects the ability to transport food crops for distribution and sale, and significantly contributes to food loss (Global Food Security Index). The price of cacao sold from

Costa Rica fluctuates daily depending on sales from around the world. The supply and demand depends on the amount of cacao available for purchase. For example, the weather and tree diseases can decrease the supply (The Story of Chocolate).

The average family size is a nuclear family of a working father, a homemaker mother, and one to three children. Many families are closely tied to older generations and often live within several miles. The homes are generally a concrete square with many windows and a large porch. More families are trending toward single family or functional single families with the father employed far away and the mother taking care of the family. More women are working outside the home in the hospitality industry, especially food service. A large aspect of the Costa Rican culture is being friendly. It is rare to walk past someone on the street or in a town and not say hello. People are more than willing to happily help out with anything that someone may need (Cespedes).

The Costa Rican government strongly emphasizes education. The literacy rate is at 95%, by far the highest in the South America region (Kast-Myers 23). Costa Rica provides free education to children up to grade twelve. However, families pay for uniforms and other fees. Many children drop out after early elementary because of the required fees or long commutes to upper school. Local schools have a proscribed curriculum, but wide latitude with teaching methods. When I visited a local school, the students were learning math, science, and reading, but lacked a language teacher. A focus of the schools was to have basic English fluency to aid the tourism industry and obtain well paying job. However, teachers who are able to properly teach English were very few and travel to many schools to give bi-monthly lessons. The University of Costa Rica is also subsidized by the government but is highly competitive for entry (World Fact Book).

Basic health care is available to all and subsidized with availability by the government. However, care for complex medical conditions and medicines are more limited, often requiring travel for long distances to receive the care (World Fact Book). Food Security is an issue in Costa Rica, not so much in the quantity of food, as the prevalence of malnourishment is approximately five percent, but in the variety of available foods. This contributes to the lack of adequate micronutrients in the diet (Food Security Index). The Costa Rican diet is primarily based on rice and beans with added vegetables and fruits, with little to no meat. The food is either grown on the family's farm, a small plot of the garden, or bought from local markets. Many families will have fruit trees in the yard, including mangos, bananas, pineapples, and citrus. Other foods include beans, squash, corn, eggs, rice and coffee (Cespedes). Families generally do not have funds to purchase goods outside of the farms. The Gross Domestic Product (GDP) of Costa Rica is 73.9 billion for 2016. Costa Rica falls on the lower end of all the countries in terms of GDP (Global Food Security Index).

The environment is tropical, but can vary between the coasts. The regions include the dry rainforest areas, the "wet" rainforest, and the cloud forest in the mountains. With frequent

rainfall, the country is susceptible to high humidity and hurricanes, and has two active volcanos. The higher elevations have significant erosion concerns and intermittent sunshine due to rain and mists. This produces a lush ecosystem, but presents some difficulty because of the ease of spreading fungus and other diseases (World Fact Book).

There has been a major effort in Costa Rica to set aside land as protected rainforest. A consortium of government, non-governmental organizations, corporations, and universities have worked cooperatively to expand the protected environmental study areas and have established world headquarters of environmental study in Costa Rica. It is the recognition that environmental protection and study of the critical biodiversity is important to the world's food supply and important discoveries of new medicines (Cespedes). Most of the funding for agriculture research in Costa Rica comes from the government, with some support from international agencies. There is an opportunity to expand the private corporation collaboration, especially in advancing opportunities for small farmers in funding research and transportation (Perez)

Theobroma Cacao trees are grown in a band around the equator in the tropical heat, sometimes called the "Cocoa Belt". The climate must be between 25-27°C (77-81°F) with no excessive wet or dry periods. The ideal amount of rainfall is between 125 and 250 centimeters per year. Due to the cacao tree and its sensitivity to strong winds and direct sunlight, the tree grows best and is most productive in the shades of other trees. The cacao tree prefers soil that is fertile, slightly acidic and well drained, but also capable of storing some water to fall back on in drier times (*Theobroma Cacao*). Cacao plants begin to produce fruit after five years and can be as tall as 40 feet; however, most farmers do not let the trees grow past 13-28 feet. The cacao tree flowers all year round, in two cycles of six months. Thousands of minuscule white (female) and pink (male) flowers adorn the stem and branches and when the bud matures, the flower is open for less than a day. When the flowers are fully open and the male part of the flowers release their pollen and it is left up to ants and tiny flies to pollinate the female part of the flowers. Only the flowers that are fertilized will develop into cacao pods over a period of about five months. Less than forty of the original thousands of flowers will eventually develop into cacao pods. A cacao pod contains 20-40 seeds or cacao beans typically one to three centimeters long. The seeds are encased in a sweet- sour white pulp ("About the Cacao Tree"). The pulp, however, is not a part of the final chocolate process.

Cacao beans are very nutritious; they consist mainly of fat (50%) and carbohydrates (25%). In addition, cacao contains proteins, theobromine, niacin, minerals (including calcium, iron, potassium, magnesium, sodium, and phosphorus) and vitamins A, B1, B2, and B6. (*Theobroma Cacao*). With such a small yield of the seeds each flowering, and the very high demand for cacao around the world, it is important to ensure these plants survive. The flavor of the cacao beans is not only dependent on the variety, but also on the soil, temperature, sunshine, and rainfall. Now, it is possible to buy chocolates made with cacao beans from one single region and compare aromas and flavors; these chocolates are often referred to as specialty chocolates.

Specialty chocolates command a premium price and are significantly different from ordinary chocolates. The ordinary chocolates are made with mostly cheap cacao beans from several regions and with more than one cacao variety (“About the Cacao Tree”).

There are three kinds of Cacao varieties, Forastero, Criollo, and Trinitario. The majority of the world’s cacao is from Forastero (85%) and it is mainly grown in Africa, Ecuador, and Brazil. Forastero has a high yield, grows faster, and is much hardier and less susceptible to diseases. Forastero cacao has purple-colored beans and is used to give chocolate its full-bodied flavor. It additionally has some bitter components and a milder flavor. Its bitter taste has a short duration and little after-taste, which is why it is often blended with superior cacaos. The Criollo tree produces cacao that is valued for rich flavor and is a component of the finest chocolates. However, the tree is more fragile and harder to grow in most locations because it is most susceptible to environmental stresses. The beans have a white to pale pink color. The taste has little classic chocolate flavor, but it is rich in the duration of secondary notes (Theobroma Cacao). Less than 5% of the world cacao is this variety, but it is an important variety to Costa Rica. The quality of Criollo is what makes the demand for cacao grown in this region so great. The Trinitario is a natural hybrid resulting from the cross-pollination of Criollo and Forastero. Legend attributes this variety to the island of Trinidad. After a hurricane destroyed the local Criollo crops in 1727, the people of Trinidad assumed all the trees were dead. The plantations were replanted with Forastero, but spontaneous hybrids appeared. Trinitario has its aroma and rich flavor from Criollo and its resistance to disease and its productivity from Forastero. Trinitario yields vary in pod and bean characteristics because the parents have highly contrasting characters. Trinitario is predominantly used where fine flavor cacao is needed (“About the Cacao Tree”). Trinitario represents about 12% of the world's cacao production. It is mostly grown in Mexico, the Caribbean islands, Colombia, Venezuela, and in parts of Southeast Asia (“The Different Varieties Of Cacao Beans”). In Costa Rica, the most common types of cacao grown are Trinitario and Criollo (Ramsey).

The Costa Rican cacao crops were devastated by the fungus *monilial*. The fungus causes the cacao seed pods to rot instead of ripen, preventing any viable harvest of the cacao plants. The fungus also contaminates the plantation for any future harvest. (Fulton) The planters in the 1970’s started to see concerns, but by 1990 almost 80 percent of the crop was devastated. This accounted for a loss of about 70,000 tons of cacao (Fendt). Planters either abandoned this crop or were forced to find other cultivars. Hoping to prevent an outbreak like this in the future, they also looked at better farming practices to protect the new crops, including sustainable planting techniques to encourage shade. In addition, Latin America was struggling with another disease called “Witches’ broom”. Witches’ Broom is a fungus that lands on a tree in the form of spores, and creates a strange pink growth. At first this fungus greatly reduces the tree’s production of cacao, but given time, it is fatal. In the Amazon, where trees are dispersed through the forest, it spreads slowly, but on plantations it moves very quickly (Fulton).

The Costa Rican sustainability organizations are making inroads to developing hardier cacao plants. There is a cacao genetic collection that collects plants and preserves the genetic material to try to prevent another situation like the one faced by the Costa Rican cacao planters. The Tropical Agricultural Research and Higher Education Center (CATIE) is a cacao plant bank and research station that specializes in cacao data collection and innovation. The ability to grow cacao plants is important, but the world's chocolate consumers want rich flavor. CATIE has identified cultivars and crossbred them for both disease resistance and flavor. CATIE has been providing seeds to small farms at no cost to try to help the cacao industry recover, which in turn will improve the economy in Costa Rica. Along with the free seeds, CATIE provides advice on sustainability practices to preserve the environmental resources and improve the yields of cacao. Cacao's preference for shade allows the farmer to utilize the land for multiple crops, and the ability to plant on land without clear cutting (CATIE). Since banana and hardwood trees are tall enough to provide shade, they can occupy the same land as cacao. Cacao is harvested approximately every six months; and with sustainable farming techniques, the farmer can harvest other crops from the same land during other parts of the year. This is ideal for the small plantation model of Costa Rica, but is not as adaptable for other cacao growing areas, like Africa.

Along with new resistant seeds, farmers have started implementing new methods to try to keep their cacao crops as healthy as possible. The methods needed to be simple enough to practice often and also eco-friendly to preserve the land. Farmers can walk the cacao orchards each week and use "machete technology"; harvesting ripe pods, and cutting away diseased pods to keep them from spreading. Farmers can also bury old pod husks to prevent any larvae from hatching and destroying the crop, or to remove soil ant tunnels around the trunk. Ants, specifically leaf cutter ants, cut away at the tree and slowly kill it. Both soil and ants can also carry fungus that could infect the cacao tree (The Story of Chocolate).

Currently efforts are now focused towards getting farms to adopt the new sustainable practices. Additionally, a new seed and various types of cultivars, even in the same farm, helps to protect the farm from devastating fungal infections with more resistant and diverse plants. The farmers that are willing to take the risk and adopt new farming methods can reap rewards. Shade grown cacao is more flavorful, which can yield higher prices to offset the lower yields (Cespedes). Most importantly, the viable cash crop of cacao gives subsistence farmers an income to augment the farming for more than just their family's table. This income has the potential to improve the lives of many citizens. The Costa Rican cacao industry is again on the rise because of the efforts of scientists and farmers working together to overcome challenges.

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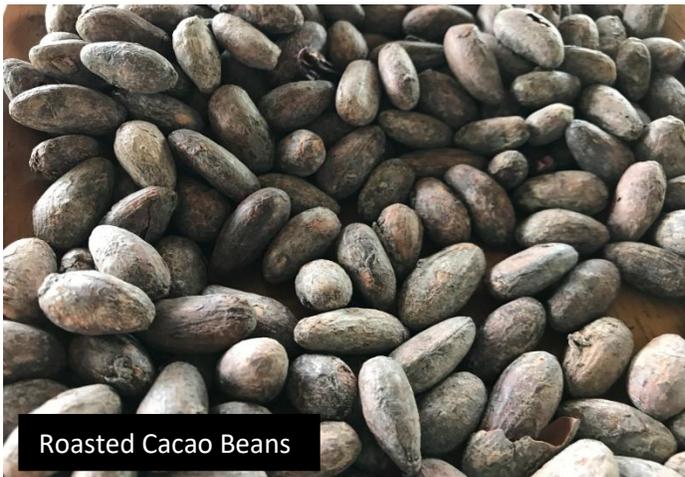
Example of shade foresting technique with cacao (lighter leaves) and banana trees.



Cacao nursery- effort to repopulate with resistant cultivars of cacao



Criollo and Trinitario cacao pods



Roasted Cacao Beans



Cacao pods growing