

Sustainable Horticultural Crop Production in Colombia: Coffee

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Introduction.

I chose the Republic of Colombia because they are one of the world leaders of coffee. I have never known much about the country's sustainable practices and it would only make sense that a country known throughout the world for their coffee would have practices and development plans to make their product more environmentally friendly.



Fig. 1 Colombia Political Map (CIA Factbook).

The Republic of Colombia, commonly referred to as Colombia, is the fourth largest country in South America. It is the third largest Spanish-speaking country in the world, and with a total area of 1,138,914 sq km, Colombia is the twenty-sixth largest country in the world and slightly less than twice the size of Texas. (CIA Factbook, 2010) Colombia is in the Western hemisphere of the world and because the equator runs through the country, Colombia is in both the Northern and Southern hemispheres. Its capital, Bogotá, is located at the geographic coordinates of 4° north and 72° west. The terrain of Colombia is defined by the Pacific Ocean, Caribbean Sea and the Andes Mountains. These three features mold the land of Colombia into

flat coastal lowlands, highlands in the center of the country, and lowland plains in the east. There are 3,208 km of coastline and 6,309 km of land borders. Colombia shares borders with Panama, Ecuador, Peru, Venezuela and Brazil. (CIA Factbook, 2010) Colombia is also partly located along the Pacific's Volcanic Ring of Fire. Colombia has roughly fifteen major volcanoes that have been known for their deadly eruptions.

The climate of Colombia is described as tropical along the coasts and in the eastern plains and cooler and more temperate in the highlands. Trade winds often affect the climate of Colombia as well as the phenomenon of El Niño. The altitude ranges from 0m at sea level to 5,775m at Pico Cristobal Colon, Colombia's highest peak. The temperature range changes approximately 2°C every 300m. Because of this drastic change in temperatures Colombia's altitudes are the most influential aspects of their vegetation patterns. (Britannica Encyclopedia, 2010)

There are six different vegetation zones in Colombia that are based upon the altitudes in which they lie. Areas that are below 1,000m are known as *tierra caliente*, the tropical region where the tropical crops are grown. *Tierra templada*, the temperate zone, is the most productive vegetative zone in Colombia; it lies between 1,000m and 2,000m. The *tierra templada* is also the best growing area for Colombia's coffee growers. The next zone lies between 2,000m and 3,200m. This zone is the colder climatic zone that is used to grow wheat and potatoes, known as the *tierra fría*. Beyond 3,200m is the beginning of the alpine climatic range of Colombia. From 3,200m to 3,900m is the *zona forestada*, or forested zone. From 3,900m to 4,600m is the *páramos*, a treeless grasslands area. Above 4,600m is the *nieves perpetuas*; this area constantly has temperatures below freezing and constantly has snow caps on the peaks of the mountains. (Britannica Encyclopedia, 2010)

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Sustainable crop production is becoming an ever more popular way of thinking about how to produce food for the domestic population. With limited fossil fuels slowly becoming scarcer, companies globally are trying to figure out a way to become more “sustainable”. The U.S. National Environmental Policy Act (US EPA) defines sustainability as “[to] create and maintain conditions under which [humans] and nature can exist in productive harmony, and fulfill the social, economic and other requirements of present and future generations of Americans.” Globally, the most referenced definition of sustainability comes from the 1987 Report of the World Commission on Environment and Development which is “meeting the needs of the present without compromising the ability of future generations to meet their own needs.” (US EPA) Sustainability in agriculture is focused on reducing the amount of fossil fuels that are used in production, lowering expenses such as electricity and heat, and producing a crop with as little to no chemical input to get great quality and yield of crop.

The Federación Nacional de Cafeteros de Colombia (FNC), or the National Federation of Coffee Growers of Colombia, is Colombia’s largest non-profit organization. The FNC is focused on the sustainable growth of coffee growers and their product. Their motto is: “First the coffee grower, then the rest.”(FNC) Sustainability for them is “neither a tendency nor a trend; it is our reason for being” (FNC). The FNC does not necessarily have an exact definition of sustainability, but they believe that providing aid for the growers will create an environment that will be sustainable. They also take part in scientific research and development projects, coffee tree renovation programs, and other programs that recognize sustainable coffee growers in Colombia.

Even though the FNC is not associated with any political party, they still abide by national and international regulations for sustainable development (FNC). The FNC is associated with the Inter-American Development Bank, the United Nations Development Programme, and the United States Agency for International Development, as well as many other groups that support sustainable growth.

The International Coffee Organization (ICO) is another group that influences coffee production in Colombia. The ICO encourages development for sustainable coffee economies. They work alongside with many international organizations that thrive for sustainable development. The ICO addresses sustainability spreading awareness to growers and producers about the effects that non-sustainable practices will have on their market. (ICO) The ICO bases the information that they teach growers from the International Institute for Sustainable Development (IISD) which has produced countless programs, communities, and initiatives around the world.

It is not clear where or when coffee originated. There have been many stories that have been passed down through the generations. One of these stories claim that coffee was first discovered in Ethiopia by a goat herder who noticed the strange, jittery behavior of his goats after they ate red berries that came from the indigenous coffee trees (ICO). Another story, believed to be more accurate, is of slaves that were taken from what is now Sudan, to their work camps in Yemen. These classic trade roads lead to Mecca through the sea port that was named 'Mocha', which is commonly associated with coffee today. It is also known that Yemen had been cultivating coffee since around the 15th century. (ICO)

The Arabians cultivated and produced coffee throughout the 15th and 16th centuries. They loved the product so much that they started to build small gathering areas around Mecca. These were the first ‘coffeehouses’ known in history. The Muslim people called these places ‘kaveh kanes’ and they were places where men would gather, play chess and gossip as well as conduct business and other social agendas (ICO). These coffeehouses were comfortable gathering places and were highly decorated with silks, fine linens and gold. They quickly became popular throughout the Muslim culture and they spread across the entire Arabian region.

Coffee later spread to Europe and Asia through trade between Arab nations and European nations. The most notorious event in coffee history was with the Dutch during the 17th century. The Dutch smuggled coffee plants out of Arabia and illegally brought them to their colonies in India and home to Holland to be produced commercially (Ultimate Coffees). The Dutch were the first people to grow coffee in greenhouses. Their colonies in India served as the primary exporter to many European countries. Java was the leading producing colony for the Dutch; they thrived up to the early 18th century. The Dutch colonies eventually became Indonesia which is currently the fourth largest producing area for coffee. (ICO)

It was not until the early 18th century when the first coffee tree was planted in South America. Similar to Asia and Europe, the Dutch were the first to cultivate coffee in South America. They brought the coffee plant to their colony of Surinam in 1718 and immediately set up plantations throughout the area. The French soon established their own colonial coffee plantations in French Guyana and numerous plantations in Brazil. The British too, set up an industry of coffee in their colonies. The first was Jamaica, around 1730, which still exists today and presently has one of the most expensive varieties of coffee in the world. (ICO) These first

colonial plantations were the beginning to what has become a cash crop economy for the entire continent.

It is believed that coffee was first introduced to Colombia by the Jesuit priests that left Europe during the late 16th century and early 17th century. In 1835, the first exportation of coffee from Colombia was recorded. A shipment of 2,500 bags of coffee was delivered overseas to the United States. (Equal Exchange) In the 1860s, Colombia established coffee as its major export and created tariffs which produced the primary source of government income. Colombia's niche in the coffee industry grew rapidly. In 1875, it was recorded that 170,000 bags of coffee were exported to the United States and Europe. (Ultimate Coffees)

Problems began to rise at the turn of the century. Since coffee was such a large revenue producer, many Colombians wanted to take part in the coffee industry and disputes over land ownership broke out. A land reform bill was passed in 1930 to try to resolve the problems with individual land ownership. The bill helped a little but did not fully succeed until the 1980s when 10% of the farmers became independent owners of 80% of Colombia's arable land. (Equal Exchange)

Many organizations were developed during the 1900s to help communities of coffee farmers prosper; the most well known being the FNC which was established in 1927. The FNC has done a lot of work to create opportunities for the small family owned coffee growers they represent. In 1959 the organization that created the famous Juan Valdez® character and the 100% Colombian Coffee Logo®. They are still around today and are the world's largest rural NGO; non-government organization. (FNC)



Fig. 2 Juan Valdez®, 100% Colombian Coffee Logo®; Café de Colombia

Colombian coffee growers have always used traditional techniques to grow and produce their coffee. The crop is grown in the fields on the slopes of the mountains. Their farms are located between 1,000m and 2,000m. The coffee plants traditionally have been planted under shade trees to help control the quality of their product. Older plantations had nitrogen-fixing leguminous trees planted throughout the area to help treat the soil. (Britannica Encyclopedia, 2010)

Today, Colombia's agricultural crops make up 9.1% of the country's GDP which is \$400.3 billion (2009). Colombia's labor force is approximately 20 million, which 22.4% of that is in the agriculture field. (CIA Factbook, 2010) Colombia has a total land area of 1,138,914 sq km. Of that area, 2.01% is arable land, 1.37% permanent crops, and 96.6% is listed as other land use; whether it is unusable for agricultural purposes or it is used civically or it is unusable tropical rainforest. (2005) Colombia has 9,000 sq km of irrigated land (2003) and 2,132 cu km of renewable water resources (2000). Every year there are 10.71 cu km of fresh water withdrawn from water resources and 46% of that fresh water is used toward agricultural.

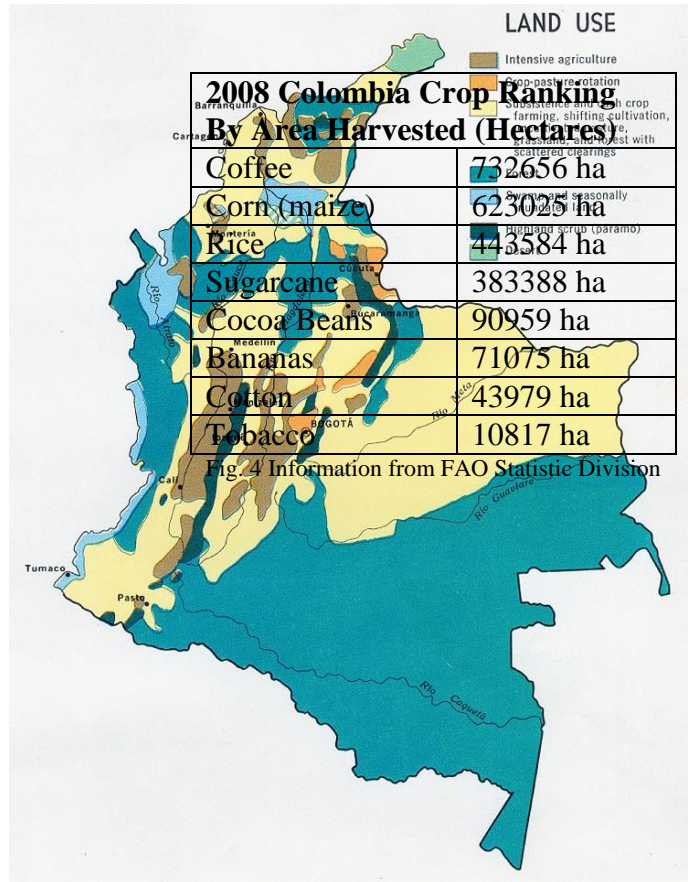


Fig. 3: Land Use Map of Colombia, 1970; (The University of Texas Libraries)

Coffee is known as Colombia’s number one crop, but there are other crops that Colombia grows in their tropical climate. Some of the top crops in Colombia are cut flowers, bananas, rice, tobacco, corn, sugarcane, cocoa beans. (CIA Factbook, 2010) The Federación Nacional de Cafeteros de Colombia states that there are about 500,000 coffee growers in Colombia. Ninety-five percent of those coffee growers are small, family owned groups that have plantations that are five hectares or smaller. (FNC)

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Modern Colombian coffee production has many processes to it. With the organizations that have been put into action to help make Colombian coffee growers produce sustainable products, like the FNC, a lot of measures are taken to make sure that their coffee is the best it can be. Production of coffee in Colombia starts with the selection of the coffee variety to grow. Colombian coffee growers use 100% Arabica coffee beans. All of the coffee selected for certain areas of Colombia is scientifically researched in the labs of Cenicafé, one of the world's most advanced research facilities for coffee production. (Café de Colombia)

After the coffee bean is selected it is planted in the fields. Most of Colombia's coffee farms are in the same locations as they have been for the past decades. Coffee grows best in Colombia on the slopes of the Andes and Sierra Nevada mountain ranges. These mountains are unique because they are the only places in the world where coffee can grow at elevations of up to 2,000m. The tropical climate of Colombia helps with the growing process. They receive plenty of rain and experience periodic droughts. (Café de Colombia)

Colombians have used pesticides in the past and are now struggling with soil and water quality issues. It is one of the biggest concerns with trying to produce a sustainable crop. (CIA Factbook, 2010) Colombia also suffers from air quality from automobile pollution; especially near the more urban areas such as Bogotá. Currently, the FNC and other organizations are paired with international organizations such as the International Institute for Sustainable Development (IISD), the United States Agency for International Development (USAID), the United Nations Development Programme (UNDP), the United Nations Division for Sustainable Development (UNSD) and others to remove the use of chemicals in the production of Colombia's agricultural crops. (FNC)

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Colombia has had a lot of success in the past with coffee. They quickly became second highest in production and exports of coffee in the world. Historically, they have always had fairly sustainable practices. Over the past century, there has not been a great deal of changes to the way they produce their coffee. They have grown coffee on the slopes of the Andes and Sierra Nevada Mountains since the crop was introduced in the early 17th century. (Equal Exchange) Colombians have had issues with pest management. Many Colombian coffee growers use chemical pesticides to manage insect pests, however, these pesticides have caused problems. The soil and water quality has been significantly damaged by the overuse of these pesticides. Air quality is poor too because of the vehicle and gas powered machinery emissions. (CIA Factbook, 2010)

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Colombia has a well designed sustainable development strategy, but there are always going to be challenges when trying to obtain goals. Some of the challenges are presented in Colombia's National Sustainable Development Strategy (NSDS). Currently, Colombia has done well with managing their resource consumptions by producing more than they consume. Their current resource statistics are: they produce 50.58 billion kWh and only consume 38.59 kWh of electricity; they also produce 670,000 bbl/day of oil, consuming 291,000 bbl/day of oil; and they produce 9 billion cubic meters of natural gas while consuming 8.1 cubic meters of natural gas. (CIA Factbook, 2010) So far these statistics are good for maintaining sustainable fuel source practices. However, enforcing laws to the entire population, to keep these good practices going, would present a challenge. Educating the public is a good idea, but how do you educate the older population that have been operating the same way for their entire life? How will this NSDS be

funded? These are just some of the challenges that face Colombia in their goal in obtaining sustainability.

If Colombia can overcome these and other challenges, the rewards would outweigh the challenges greatly. If Colombia became even more self-sustaining for all of their electrical, gas, oil, and other production input needs, then they could potentially have full profit returns for all of the products they produce. If all of the inputs of a product are managed by the producer, self provided and not purchased from an outside source, then they would have a positive balance for production finances; it would be similar to a landscaping firm that grows its own plants. If Colombia can research into new clean/renewable resources for production, then they could have an increase in GDP; they could also have less CO₂ emission and create a better balance within the environment and its ecosystems. Getting the current population educated on sustainability will be a great challenge. Colombia can educate the younger population well, and then there will be greater rewards once those young people enter the workforce.

In order to implement sustainable development, Colombia needs to do a number of things. They are off to a great start by having a strategy written out, with obtainable goals, and methods on how to achieve these goals. They need to act on their goals right away. There needs to be cooperation with all of the groups and organizations involved with the strategy. Colombia needs to have financial support to begin, and continue, the strategy. In general, other needs are good organization, leadership, endurance, persistence and eventually maintenance. Without core needs being met Colombia's sustainable development strategy will fail to produce and/or fail to continue sustainable practices in the future.

Some critical gaps in understanding the concept of sustainable development can create problems down the future. It is vital that the thought process behind creating a sustainable strategy is well thought out and reviewed. Not knowing the area that is to be developed is a gap that will result in incorrect sustainable practices for that area. Also, not knowing about the methods and inputs being used to create a sustainable product will result in the failure of the product's outcome. To prevent critical gaps in understanding from ruining the project, research must be done.

There is still a lot of research that needs to be done. Typically, around the world, most of the current research being done is to find cleaner and/or renewable fuel sources. These fuel sources would ideally be used in automobiles and industry, or to produce electricity sustainably. There are a lot of ideas out there; ways to harness energy from the sun, wind and water are the three basic concepts. Other ideas consist of researching more chemically based products like hydrogen fuel cells, cleaner nuclear power, and ways to get rid of or recycle the waste products without having a negative impact on the environment. (Exxon Mobile)

There are also research opportunities other than discovering new fuel sources. Research can be done on practically anything that is used in the production of a product. Researching to find out what kind of lighting sources; growing media, growing temperature, soil drainage, soil moisture retention, soil acidity, soil alkalinity, or UV exposure, exc.; will produce the best crop; crop size (height, width, weight, volume), yield (quantity), texture, flavor, aroma, appearance, and whatnot. Researching to find out what style of heating or cooling system works the most efficiently while still producing a quality product. Researching what style or size growing facility produces the highest quality crop. Researching how to properly manage pest control without the over use of chemical pesticides. Is there a formula that can be developed that is organic and will

manage pests but not damage the soil or water systems? This is something Colombia could improve on. There also could be research done to find out the life spans of new sustainable products. Research could be done to answer practically any question that comes to mind.

With new research, there will be questions that will need answers: What is the best way to conduct research or trial test experiments for this input or product? How can we make this input or product more sustainable? How can we get the most efficiency out of our current energy usage? How can we reduce CO₂ emissions without causing negative changes in our finances? How will the finances of the company be affected from using new sustainable inputs for production? How will the consumers react to our new sustainable production practices? How will consumers react to new sustainable inputs or products? How will our production practices affect future generations? How will this input or product affect future generations? If our company doesn't have the resources to conduct new research, what can we do to help the community become more sustainable?

There are advantages and disadvantages to becoming sustainable. Cost is the biggest disadvantage to becoming sustainable. Not only does it cost financially to become sustainable, it also takes a long time to become sustainable. It is not possible to become completely sustainable over night. It takes a lot of trial and error to find the right production inputs; it usually takes a few years for crop fields to become totally depleted of all chemical substances; and it can sometimes take a while for growers to become sustainably certified. The advantages are completely associated with the crop and the environment. Becoming sustainable means helping the environment; leaving a small carbon footprint; and knowing you made a difference in the future of the world. The crops that are produced are also considered healthier because of the lack of chemical inputs.

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Sustainable inputs and products cannot be marketed until they have been researched and tested. Coffee is one of Colombia's largest and most successful agricultural commodities. (Britannica Encyclopedia, 2010) To help with the process of becoming sustainable, coffee beans will need to continually be tested to help in the designing of a future sustainable, controlled-environment production facility. Through these tests the Colombian coffee growers can get a better understanding of how to sustainably grow and produce coffee.

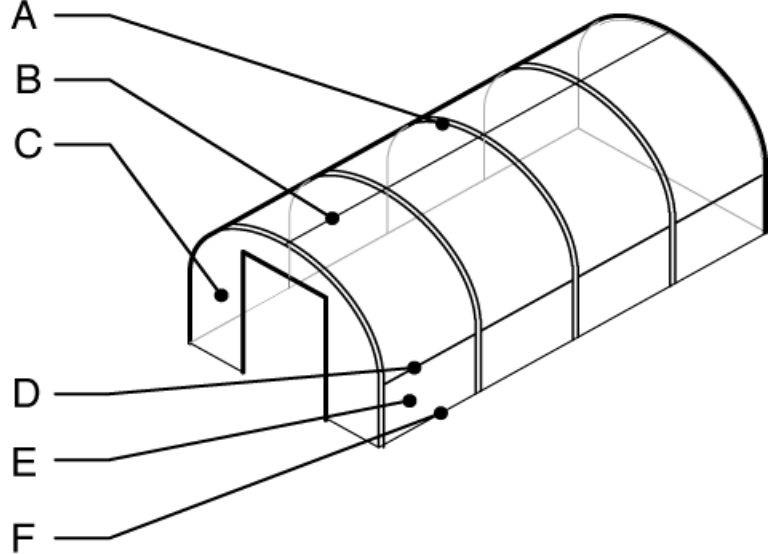
Coffee is produced in large fields, however, for these tests a controlled environment is needed to eliminate as much variables as possible during the experiments. Since we don't want any unwanted variables throwing off the results, a high tunnel styled hoop house will be used as the production facility. High tunnels are unheated, plastic-covered structures that provide an intermediate level of environmental protection. (6th edition, Greenhouse Operation & Management) High tunnel systems were chosen because of their low cost factor. They are simple structures made of semi-circle hoops in a row, creating a tunnel. Also, since high tunnels are tall enough to walk in, it will be easy to maintain the experiments and collect data without having to remove the polyethylene coverings like you would if you used a low tunnel.

The tests will require two high tunnels; 4 m high, 8 m wide, 20 m long. The site of the test area should have plenty of sunlight and should be away from the city to prevent shadows from casting onto the high tunnels. The tunnels should be orientated so that their length runs from north to south. This is important because it allows the sun to cross over the structures in the same arc as the hoops; also, this will minimize the amount of shadow cast onto the crop from the metal hoops.

To assemble the hoop houses start at one end of the structure (let's say the north end) and work your way down the length of the structure (toward the south) placing the next hoop every 4 meters. When the length of the hoop house is complete, attach the ridge pole using a welding torch. Polyethylene will be used to cover the structure. Polyethylene is a large plastic sheet that will protect the crop from weather conditions; typically lasts 4-5 years. To secure the poly to the structure fasten the poly between

the hip board and the batten board. The ends walls will be left open to allow airflow through the structures. (hightunnels.org)

- A= hoop
- B= ridge pole
- C= end wall
- D= hip board
- E= side wall
- F= baseboard



Once the hoop houses are constructed the tests can begin. For these experiments, only use one coffee bean variety. There are two different experiments, one for each hoop house, each with two treatments and a control; there should be a minimum ten replicates; at least 30 plants for each experiment. All of the specimens should be roughly the same age or stage of growth at the beginning of the experiments. None of the specimens should already be bearing fruit. All of the specimens should stay in separate containers while in the hoop houses.

Experiment A will be testing fertilizers; modern, sustainable fertilizer against animal manure with the control being no fertilizer. Be sure to apply fertilizers consistently throughout

the experiment. This experiment is designed to find out whether modern sustainable fertilizer or animal manure will produce higher quality coffee compared to no fertilizer.

Experiment B will be testing soil types; sustainable mix of compost against peat moss mix with the control being soil dug up from on site. Again, this experiment is designed to find out if there is a sustainable soil type that will produce higher quality coffee compared to the soil present on site.

For each experiment keep weekly records of plant growth, vigor, fruit production and monitor any diseases that may be present. Continue keeping weekly records until coffee berries are ripe for harvesting. Once harvested inspect the fruit for quality and record which treatment produced the highest quality fruit. Other data that can be collected include: fresh fruit weight, dried fruit weight, quality of coffee produced from each treatment. These experiments will continue for three harvests. Each year note any differences in quality within the same treatment compared to the harvest prior. Is there significant difference between the qualities of each treatment's fruit? Is the quality of the fruit consistent each year?

Resources:

Maps provided from Encyclopædia Britannica Online; Hoop house chart from hightunnels.org

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