

## Sugarcane Production

Team Unknown

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### Introduction

*Effort Analysis: Student-A 33%, Student-B 33% and Student-C 33%. We equally shared the work, splitting it three ways.*

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Sugarcane was one of the primary industrial crops in the colonial period. Discovered first in India, this giant grass provided a new type of sweetener that was more effective and easier to produce than the previous sweetener, honey. Every culture that came in early contact with sugar cane found it extremely favorable as a sweetener and even viewed it as a health product; it quickly became a cooking staple and it became something regularly taken with men in their travels. Sugar cane, however, remained relatively secret until the early 18<sup>th</sup> century, but by the 19<sup>th</sup> century was considered a necessity globally.

Sugarcane was the predominant driving force behind the colonization of the tropical islands, the industrialization of Brazil and the economic boom of nations where the slave trade was feasible and sugar cane was easily grown. In fact sugar cane was one of the first commodities to be referred to as an industry (Smith, 1975, 58).

However, sugar cane recently found a new economic calling; “in the last 30 years, Brazil wrote a new chapter in the history of sugarcane production, the first time not driven by colonial powers and the consumption of sugar, but substantially driven by domestic policies fostering bio-ethanol production to increase energy self-reliance and to reduce the import bill for petroleum” (Zuurbier, 2012).

The Caribbean was a hub for the development of sugarcane production from the 1600’s to the early 1900’s. The transformations of islands were not only environmental, but also social and cultural. The sugar empire that was created through the creation of mass scale sugar mono-crop plantations and the perpetuation of the triangular slave trade shaped modern political views and the ethnic composition of the Caribbean, as well as the cultural aspects of the islands and most importantly, the dietary composition of most of the world.

Aside from the apparent cultural implications, there was also a significant amount of environmental degradation that occurred. Soil erosion and mass deforestation were the direct result of European groupthink (Diamond, 2005, 435) in which the islands were stripped to make room for sugar cane crops and thus the natural fuel resources were completely depleted. Its establishment in the Caribbean was the driving factor behind the formation of the colonies, the current ethnic composition of the islands (due to slavery), and the political structure of the World and the current dietary practices of all people on Earth.

In the United States, sugar cane is grown in Texas, Louisiana, Hawaii, Puerto Rico, and Florida, with the largest crops in Florida. The state accounts for more than 40 percent of the sugarcane grown in America (Wilkinson, 1989, 6). In 2007, Florida sugar production accounted for just fewer than 50 percent of the nation’s sugar production (Baucum & Rice, 2006, 3). Sugar corporations, which grow and mill their own sugar,

make up 65 percent of Florida's sugar production, while independent growers account for 25 to 30 percent. The remaining sugar cultivation is done by "independent producers" which sell their product to one of four sugar mills in Florida (Baucum & Rice, 2006, 6). Palm Beach County accounts for 75 percent of Florida's sugar production, while the remainder occurs in Hendry, Glades, and Martin County (Baucum & Rice, 2006, 1). Lake Okeechobee, a portion of the Florida everglades, is neighboring all counties in which sugar cultivation occurs (Baucum & Rice, 2006, 1). According to the U.S. Sugar Corporation website, the soil type of Florida along Lake Okeechobee is referred to as muck and "provides most of the nutrients needed to produce" sugarcane ("Agricultural manufacturing," 2011). On each acre of corporate sugarcane in Florida there are 30,000 stalks of individual sugarcane, and in 2008 one acre could feed a total of 137 Americans for one year (Baucum & Rice, 2006, 8). According to the United States Department of Agriculture, Florida produced 1,660 metric tons of sugarcane in 2012-2013 (Haley, 2003, 9).

However, Florida sugar cultivation has historically degraded the surrounding environment, such as the Florida Everglades. Thus, an ecological lens, which assesses the societal, political, and economic settings present, is vital to understanding past and present Florida sugar production (Hollander, 2008, 9).

Brazil was one of the first countries to produce sugarcane. From then on, Brazil and sugarcane would be intertwined. Although no longer the center of the economy, sugarcane production still has a strong foothold in the revenue of the country. What makes Brazil an interesting case study is how they utilize the resource for more than what it has been historically. Brazil is making its way to center stage on fuel alternatives. Brazil is not just the number one producer of sugarcane, they are also at the top for ethanol fuel. They are using a portion of their arable land specifically for the cultivation and production of ethanol. After the oil crisis, Brazil felt they needed to investigate other forms of fuel and not have such a dependence on oil. They want to be a guide for sustainability and according to a news report in 2008 by Brazil Sugarcane Industry Association (UNICA), other countries are using the country as an example for their own endeavors in seeking out alternative fuel and energy sources (UNICA 2008). There are still the downfalls in the industry however, especially when it comes to environmental degradation, as well as social issues.

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### **Caribbean Case Study**

*Effort Analysis: Student-C 90%, Student-A 5%, and Student-B 5%. This was Student-C's case study and therefore she wrote the entire section. Student-A and Student-B both edited this section.*

*Word Count: 1,216*

The development of the Caribbean to produce sugar cane was—historically—one of the most significant transformations of land and culture. The demand for sugar cane resulted in a mass scale shift from diverse small-scale farms to sugar mono-crops and the need for cheap labor, which was the foundation of the triangular Atlantic slave trade. Sugar cane quickly became a global influence: intensely changing western diet and influencing the ethnic composition and political structures of our modern world.

Prior to the 19<sup>th</sup> century, sugar was considered a luxury, but with its early distribution in the 17<sup>th</sup> century quickly became a preferred taste and necessary ingredient for cooking. This evolution of the resource (from luxury to necessity) drove the colonization of the British West Indies (the Caribbean) and other nations where sugar cane cultivation could thrive (such as the Americas). The demand for labor prompted the slave trade from West Africa and indentured servants from India and Asia and this migration of people is the reason for the current ethnic mix of many nations that have been settled since the 1700's (Levy, 1980, 103-123).

I chose to focus on two specific examples within the Caribbean since between the Greater and Lesser Antilles each island was affected in extremely different ways. To demonstrate these vast differences I chose to explore Nevis Island, one of the northernmost islands of the Lesser Antilles and Barbados, one of the southernmost islands of the Lesser Antilles. Both Islands are relatively small, between 35 and 166 square miles, especially when compared to the islands of the Greater Antilles (such as Cuba or the Dominican Republic at 18,000-42,000 square miles). Yet one tiny island managed to become the most significant grower and exporter of sugarcane in the world

(Barbados), and the other experienced a fatal collapse which caused a mass emigration from the island due to utter societal and economic failure (Nevis Island).

My case study focuses on two locations during a specific time, the 1700's, due to its significance as the starting point of the "Sugar Revolution" in the Caribbean islands (Higman, 2000, 213-236). The first and largest sugar plantation was settled on Nevis Island and lasted between 1750 and 1810. Researchers published "Fueling the Fire: Examining Caribbean Colonial Relations between Humans and the Environment" and recently made observations concerning the exploitation of the resources on the island. The resources, primarily wood and sugar, demonstrated how the demand of one contributed to the depletion of the other and caused hardship for the inhabitants of the island during this time. The "examination of interrelationships through the comparison of fuel sources from four distinct plantation activities provides a narrative about the plantation owner and workers, and their attitudes toward the environment, economics, and plantation society" (Britt, 2010, 54).

For the researches exploring these relationships, wood (as a primary resource) was a necessity for the survival of the sugar industry (Britt, 55, 2010). Wood was used for the construction of all of the homes and buildings, for the tools necessary for production and for use within the home as a fuel source for cooking and heating (Britt, 55, 2010). By examining the distribution of wood on the plantations the scientists could chart the environmental impact the exploitation of the resource had, as well as how this depletion of the resource affected the decisions made (Britt, 56, 2010).

Initially, the abundant amount of fuel allowed for large plantations to be built (some of the largest ever recorded) and thus many slaves to be imported. The sugar cane industry boomed due to the stable climate and copious amounts of free labor, and demand from Europe spurred the need for even more sugar cane and even more free labor (Britt, 57, 2010). As wood began to deplete, and sugar cane production and the import of slaves continued to rise, plantation owners were forced to make decisions concerning resource availability. The available wood left on the island was used for sugar production because that was economically smart for the plantation owners. The researchers observed (through midden piles in the slaves' quarters) that the slaves were forced to utilize the soft woods (which were of no use for construction or fuel) and the shrubs of the island, which directly resulted in the extinction of all species of soft wood trees and shrubs (Britt, 62, 2010).

The direct effect of fuel extinction, in turn, left plantation owners with another fiasco for fuel. They initially imported wood from their direct trade partner, North America, but this proved too expensive for plantation owners ([as shown in historical documents] Britt, 65, 2010) and the economy of the plantations crashed. The failure of Nevis Island was somewhat of an experiment for later settled plantations in the Caribbean that also directly relied on wood as a fuel source for sugar cane production. The utter success of sugar cane production in Barbados may have pulled from these past experiences and developed a system of trade (the Atlantic triangular slave trade) that supplied fuel in addition to cheap labor (Levy, 1980, 71-102).

Two authors deemed the transformation of the Caribbean as the "Sugar Revolution", and contribute various cultural and societal shifts to its development (Higman, 2000, 213-236) (McD Beckles, 2006, 27-52). Barbados was the poster child for success in the sugar plantation industry; white plantation owners from Cuba and the

Dominican Republic often traveled to Barbados to “observe the plantation system and sugar technologies,” and the islands of Barbados and Jamaica were frequently referred to as the “sugar islands” (Higman, 2000, 224)(McD Beckles, 2006, Intro). “Barbados staged the first West Indian sugar revolution,” which was social and economic (Higman, 2000, 225). While the “revolution” stripped the island of its resources, it also cleared land for larger plantations. From 1875 to 1920 the sugar revolution swept through the Caribbean, and the “demographics quickly shifted towards enslaved Africans,” which resulted in the majority ethnic population we still see in the Caribbean today (Higman, 2000, 237) (Levy, 1980).

Perhaps the sugar revolution in Barbados provided a model for how big businesses run today, for sugar plantations were the biggest “privately owned enterprises and their owners among the richest men”; sugar plantations were not only a model for capitalism but also for the industrial revolution, because the plantations were using the most advanced technology available for that time period (Higman, 2000, 236). Not only did the sugar revolution help to shape modern economics, but also how people view the environment as a resource to be exploited for economic gain. Many scientists can prove that the sugar revolution—not only on Barbados, but also throughout the Caribbean—shaped the environment through massive deforestation and soil erosion (Richardson, 1997, 177-180).

The case studies in the Caribbean verify that sugar cane, on a local (Caribbean) and global scale had impacts on the views that multiple societies have on the environment, and how we view these environments as malleable to our needs and demands. Sugar cane prompted the trans-Atlantic slave trade, as well as the economic growth that contributed to the beginning of the industrial revolution and the modern political and business views of modern culture. Modern ethnic groups can attribute their location to the production of sugar cane throughout the World, especially in the Caribbean and the Americas, where sugar cane growing was the most successful.

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### **Brazil Case Study**

*Effort Analysis: Student-A 90%, Student-B 5%, and Student-C 5%. This was Student-A's case study and therefore she wrote the entire section. Student-B and Student-C both edited this section.*

*Word Count: 1,008*

Brazil's economy is known for going in cycles, where a commodity becomes the center of their economy, but then gradually decreases to where it eventually becomes obsolete as the center. Sugar is one of these commodities, however it still remains a vital part Brazil's economic activities. The Portuguese came to Brazil in 1532 and began cultivating sugarcane after finding out that the soil and climate was ideal. By 1560, the production of sugarcane was dominating the economic sphere of Brazil. The Portuguese needed a strong labor force because sugarcane is a labor-intensive crop. The natives were proving to be inadequate, so therefore, imported slave labor was introduced. By 1650, Brazil was exporting roughly 30 million kilograms of sugar and with it securing the number one spot for world supply of sugarcane. However, 30 years after sugarcane became Brazil's main economic commodity, the West Indies replaced them in the sugar market (Taylor 1970, pg. 267-280). "In Northeastern, sugar took several cycles and several hundreds of years to completely dominate the land, but, as labor was only transported to Brazil in connection with the sugar industry, dominated the economy long before it dominated the land," (Taylor 1970, pg. 280).

There was a period of stagnation in the sugarcane industry where the government was forced to try and control the industry by trying to maintain the production and pricing of sugar. This period was followed by a major push for world export not only by the world economy, but also the sugar sector as well. Brazil was once again the world leader in sugar exports. To accommodate for Brazil's increasing demand for exported sugar, they began increasing their use of planted land for sugarcane production, but that meant they were decreasing the amount of planted land available for food cultivation (Nunberg 1986, pg. 56-59). Here was where Brazil began its trend of annually increasing land use for the cultivation of sugarcane and bringing sugarcane into a new capacity in the economy of Brazil.

Today, Brazil is the leading producer of sugarcane with 25 percent of world production and 50 percent of the world export. There are currently 413 sugarcane mills in operation. The sectors annual revenue is roughly US \$28 billion and US \$16.2 billion from exports. In terms of land use, as previously mentioned, Brazil began a trend of increasing the hectares of land being used to cultivate sugarcane (Phillips, 1 Aug. 2012, slide 2). In 2004, there was 5.634 million hectares planted to sugarcane. The amount of hectares continued to increase and in 2010 there was 9.830 million hectares (Barros, 2010, pg. 2). The Brazilian Sugarcane Industry Association (UNICA) reported that along with those roughly 9 million hectares for sugarcane production, there was also 4.6 million hectares for sugarcane specifically for ethanol, the new forerunner for the use of Brazil's sugarcane production (Phillips, 1 Aug. 2012, slide 5).

Ethanol is an alternative fuel source that can be produced from sugarcane. It was

not introduced as an alternative to gasoline in Brazil until 1931, roughly 25 years after Henry Ford created the first automobile that ran on ethanol, or often referred to as flex fuel. Ethanol did not really get momentum until the first oil crisis of 1973, when the Organization of Petroleum Exporting Countries (OPEC), protested against the Yom Kippur War by creating steep oil prices. The price of a barrel of oil went from US \$600 million to US \$ 2.5 billion over the course of the next year and therefore the Brazilian government decided to create the National Alcohol Program (Proálcool). The Program was an organization that created incentives substituting ethanol for petroleum-based fuels. Due to this program, there was a rise in cars that ran on ethanol. But in 1979, there was another oil crisis. These two oil crises propelled Brazil to begin the search for a solution to curb their clear dependence on foreign oil. The country is now the second leading ethanol producer, only just behind the US (which produces its ethanol from corn.) Brazil is working on figuring out how to fuel not just cars, but planes and other modes of transportation as well (UNICA, 2012, timeline).

Although Brazil is making a name for itself in alternative fuel and looking for sustainable ways of living, there are some downsides to sugarcane production. “Among the major problems linked to sugarcane cultivation is soil degradation caused by erosion and compaction” (Martinelli and Filoso 2007 pg. 886-887). When cultivating sugarcane, the management practices leave the extensive hectares of land bare. To prepare for cultivation, grassland is cleared and it is at this point, along with periods of crop harvesting and re-growth, that the soil is bare and most prone to wind and rain erosion. To prepare for planting the stalks of sugarcane, heavy machinery must be used. The weight of the machinery compacts the soil, destroying its porosity. Greenhouse gases being deployed into the air are also an environmental concern. The straw and leaves of the sugarcane are burned for harvesting as a management technique. As one can imagine, the burning releases aerosol particles into the atmosphere, which aid in climate change (Martinelli and Filoso 2007, pg. 887-888).

Humans have a large impact on the production of sugarcane, what with the high demand. The start of heavy labor use for this cash crop began, as previously state above, with the replacing of the Native Brazilian peoples with enslaved Africans. Although there is machinery to help in the process of clearing the field for planting sugarcane, the harvesting is normally done manually. Slave did end in Brazil over a century ago, but much has not improved the conditions in which the workers are to harvest. The sugarcane workers are constantly exploited with long hours, poor pay, and the added consequence of possible health issues due in inhalation of smoke from burning the fields (Martinelli and Filoso 2007, pg. 892-893). The production of sugarcane may be in the benefit of Brazil’s economy, but that does not mean that it is in the benefit of its labor force.

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### **Florida Everglades Case Study**

*Effort Analysis: Student-B 90%, Student-C 5%, and Student-A 5%. This was Student-B's case study and therefore she wrote the entire section. Student-C and Student-A both edited this section.*

*Word Count: 1,389*

As stated above, Florida is the largest producer of sugar cane in the United States (Wilkinson, 1989, 6). Sugar production in Florida has historically pushed devastating ecological impacts on the Florida Everglades, and Aaron Schwabach writes in *Free Trade and the Everglades* that the "brutal assault" first began with the completion of the Florida East Coast Railway to southern Florida (Schwabach, 2002, 303). Schwabach notes that early settlers had trouble clearing the land for agriculture, and after cutting proved unsuccessful, they turned to burning (Schwabach, 2002, 303).

Alec Wilkinson writes in *Big Sugar* that the fires "[cleared] the fields of wildlife" and from a distance resembled "disasters, like air strikes, like war" (Wilkinson, 1989, 20).

The soils of the Everglades are highly flammable and the land burned down to rock, "leaving a desert useless for agriculture." Schwabach writes that any soil that could be cultivated, wasn't suitable for agriculture, and couldn't support cattle due to the low amount of nutrients in the soil (Schwabach, 2002, 303).

Another obstacle for sugar agriculture was the task of draining. Hamilton Disston, led the first attempt to drain the wetlands for sugar cultivation in 1881 (Hollander, 2008, 21). Disston and Associates bought four million acres of swamp land for 25 cents an acre. After cultivating sugarcane and sucrose content, which was "reportedly the best [on] record to date" Disston eventually expanded his sugar cultivation, encouraged by the 1890 McKinley Tariff (Hollander, 2008, 24). The tariff placed a two-cent per pound sugar bounty on domestically grown sugar, which promoted domestic sugar production and discouraged sugar imports from Cuba, among other locations (Hollander, 2008, 24). However, Disston was "financially and managerially overextended" and was forced to close (Hollander, 2008, 25). However, after Disston's failure, sugar boosters and

administrators still viewed southern Florida “awaiting northern capital investment and energy to transform it into real estate for the production of agricultural commodities” (Hollander, 2008, 25).

The federal Swamp and Overflow Act critically shaped the framework in which Disston and many other Americans viewed their rights to control and shape the ecological landscape. The act, passed in 1850, allowed states to “construct the necessary levees and drains to reclaim the swamp and overflowed lands therein” and clearly reflected a “lack of understanding of the nature and significance of wetlands,” (Neimark & Rhoades, 88).

Sugar boosters had a very large impact on the ecology of the Florida Everglades. Many saw Florida as a state that could decrease the need for foreign sugar trade “by producing tropical commodities” (Hollander, 2008, 30). Boosters argued this at the global level, at the national level they argued the U.S. should be spending millions to buy sugar they could produce domestically. At the local level, they argued that sugar cultivation would supply the economic base for the expanding farming industry (Hollander, 2008, 37). Early scientific studies found that when ingested, sugar provided U.S. soldiers with more endurance, and in WWI military planners viewed sugar as strategic (Hollander, 2008, 75).

Additionally, a large 1926 flood took 300 lives in the Moore Haven, Florida area and sent panic through the Everglades Drainage District, as the residents were unable to cope with the flood levels (Schwabach, 2002, 303-304). Schwabach writes that a rational, financially based response to these events would conclude that the funds needed to transform the land for successful agriculture outnumber the sum of profit made in cultivation off the altered landscape (Schwabach, 2002, 304). Hollander writes in *Raising Cane in the 'Glades* that sugar boosters found a rationale in promoting a sugarcane industry within “national concerns over flood control, navigation, and food self-sufficiency” (Hollander, 2008, 62).

Thus, with funding from the federal government, the Hoover Dike came into existence, and thus drainage maintenance was turned over to the Army Corps of Engineers (Hollander, 2008, 101). The Hoover dike, when completed in 1960, would be “85 miles long, 125-150 feet at its base, [and rise] 34 to 38 feet above sea level” (Hollander, 2008, 101). During construction of the Hoover Dike, in 1946 and 1948 large floods overwhelmed Florida land, both agricultural and domestic (Walker & Solecki, 2003, 319). As a response to these floods, the “Central and Southern Florida Project for Flood Control and Other Purposes” formed (Walker & Solecki, 2003, 319). It consisted of the “1954 Eastern Perimeter Levee,” the “1959 Everglades Agricultural Area,” and the “1963 Water Conservation Area” (Walker & Solecki, 2003, 319). Once completed, these projects formed “720 miles of levees, 1000 miles of canals, 200 gates and water control structures, and 16 pumping stations (Walker & Solecki, 2003, 319). Altogether, said projects completely rechanneled the natural path of the water, altering biological and ecological patterns Student-Cke.

Neimark et al. says in the Environmental Debate that such draining, diking, channeling, and manipulation of the waters in this system as an encouragement for agricultural lands “was a recipe for destroying the system” (Neimark & Rhoades, 163).

The poor labor system, too, is worth noting. Sugarcane production in Florida was done primarily “in the absence of white men” (Wilkinson, 1989, 41) and presumably

white women. Alternatively, nearly 90 percent of sugar cultivation in alternative areas of the United States such as, Ohio, Michigan, and North Dakota was done using Mexican workers (Hollander, 108). Historically, Haitians and Hispanics cultivated the agricultural land for sugarcane production in Florida (Wilkinson, 1989, 63). In the 1920s, “racial wage differentials” emerged in the south, thus making African Americans a source of cheap labor for the sugar plantations as well (Hollander, 132-133). Much of the sugarcane planting process has become mechanized since 1995, with the exception of the actual cane planting (Hollander, 260). Thus, sugarcane cultivation was still “dependent on stoop labor to plant the row by row over tens of thousands of acres” (Hollander, 241).

In terms of a political context, the Cuban Revolution stimulated Florida sugar production in that the United States eliminated sugar trade with Cuba, thus placing a high demand on domestic sugar production (Walker, 319). Within five years sugar production in Florida was transformed, as sugar capitalists invested in Cuba sought out Florida for the development potential and United States market shares. Hollander notes that eight mills were added to the original two and sugar production increased five-fold (Hollander, 2003, 67).

Not surprising, domestic sugar production also shaped human consumption. Between 1830 and 1930, American sugar consumption jumped from “12 to 110 pounds” per capita (Hollander, 2003, 63). Early scientist W. O. Atwater developed the first research on “food and digestion” and found that “hard-working Americans should consume more calories than their European counterparts” (Hollander, 2003, 64). Later scientists, influenced by Atwater’s teaching, approved of fats and sugars as “they packed a large amount of calories into a small amount of food” (Hollander, 2003, 64). Additionally, canned food gained dietary value at this time because of the presence of sugary syrup used in the canning process (Hollander, 2003, 64).

As noted previously, the human interaction with sugarcane enacted a relationship largely molded by present political and societal forces. After the completion of the “Central and Southern Florida Flood Control Project,” an estimated 70 percent of the natural water flow was rechanneled away from the “lower Everglades, including the national park” (Hollander, 2008, 149). Years later, in 1893 the governor of Florida started the Save our Everglades program, which aimed at bringing restoration to the everglades (Hollander, 2008, 246). When Americans began to view “the Everglades (...) from worthless swamp to cherished wetland” (Hollander, 2008, 9) a mindmap shift occurred in the minds of many.

Today, sugar companies and environmentalists continue to dispute the best use of the land in and around the Everglades Agricultural Area. Most recently, the “Florida Water Management District Board” ruled that U.S. Sugar Co. could continue farming 9,000 acres until 2018 (Reid, 2013, pp 2). However, they are required to pay “\$25 per acre per year” as they are using land, which is meant for everglades restoration (Reid, 2013, pp 2). Environmentalists predict that such a tax will put much of the costs for Everglade restoration in the hands of the taxpayers (Kennedy, 2013, pp 1). An everglades restoration project, implemented by the Florida governor and federal officials, aims “to improve water quality across the region” by building “stormwater storage and treatment” to limit the farming contaminants leaking into everglade water downstream (Kennedy, 2013, pp 2-3).

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**Discussion**

*Effort Analysis: Student-C 33%, Student-B 33%, and Student-A 33%. We split the work equally.*

*Word Count: 1,693*

In the Caribbean, of the two case studies explored both had some similarities yet the outcomes of each were directly opposing. On Nevis Island, it is easy to exhibit the collapse that occurred as discussed in chapter 14 of Jared Diamond's "How Societies Choose to Fail or Succeed" (2005). In this case, the plantation style society erected so quickly that there was no time to properly look ahead for future environmental issues depleting the fuel source would have, and the implications of having to provide enough fuel and food for the increasingly dense population that inhabited the island as a workforce.

The intensive deforestation that occurred demonstrates Diamond's theory of a society failing to anticipate a problem before it arrives. In the case of Nevis Island, the extinction of species and thus the extinction of fuel was not anticipated in the clearing of land for crops and the use of wood (softwood and hardwood) and shrubs to provide fuel for daily activities. With forethought, it may have been possible for the plantation owners to recognize this issue and perhaps planted specific types of shrubs in an area of the plantation as to allow the native indigenous plants to regenerate.

Hardin's "Tragedy of the Commons" can also be witnessed on Nevis Island with the self-interested of private plantation owners and their desire for maximum return for their profits. In the space of the commons, which was the entirety of the Island, the plantation owners who owned the two largest plantations (of only four total) continued unrestrained population growth even while recognizing the depletion of a commodity necessary for survival (Diamond, 2005, 1248). In this system, which had no governance system or moderation laws, profit margins were maximized without care for the sustainability of the resource. This may not have been the case in Barbados, however, due to what Ostrom's article *Tragedy of the Commons Revisited* discusses concerning the need for communication and resource accounting, which by the time Nevis had failed Barbados had figured out (Ostrom, 2007, 15186).

Lui's complex feedback loops can be observed primarily in the case of Barbados. Complex feedback loops, which can be defined as the reciprocal interactions of people and nature, occur within the system of the demand and supply loop sugar cane created (Lui, 2007, 1513). The initial demand from the British colonies created the creation of the supplier (the Caribbean Islands), which created a need for cheap labor. The labor force needed fuel for survival and for sugarcane production, which initiate a reciprocal trade of fuel for sugar, and slaves for money produced by the sugar and to produce the sugar. An increasing global population and therefore increased demand for sugar further spurred the slave trade for increased work and increased production. This trend continued until, first, slavery was abolished (although 'indentured slaves' continued, and much of the farm work is now done with high tech machinery) and the global attraction to 'liberty' yellow corn that now provides cheap sweeteners for the processed foods first world countries are now addicted to.

In "The Value of Nature and the Nature of Value," Daily et al. writes that "ecosystems are poorly understood, scarcely monitored, and (in many cases) undergoing rapid degradation and depletion" (Daily, 2000, 395). She goes on to say that full appreciation of an ecosystem's resources is often only understood in their collapse (Daily, 2000, 395). These words of warning mirror almost perfectly the story of the ecological failures in the Florida Everglades. As noted in the Swamp and Overflow Act, many Americans viewed these ecosystems, if altered successfully, as prime areas for agricultural land and real estate development (Neimark & Rhoades, 1999, 88). Once drained, leveed, rechanneled and dredged, the nation lost much of its critical "flood moderators and biological goldmines" (Neimark & Rhoades, 1999, 88). By rechanneling the natural flow of water inhabiting the Florida Everglades and the agricultural area surrounding it, the Army Corps of Engineers, the federal government, and sugar administrators were critically degrading and depleting the ecosystem. As mentioned earlier, years later, restoration efforts are now trying to return the ecological history of the land and water.

In *Land Use, Environment and Social Change*, Richard White argues that, “cultures very often shape their environment” (White, 1991, 8). This is evident in the case of Florida as early settlers who sought out to be farmers even in the face of their natural environment. The landscape presented difficult obstacles to cultivating sugar such as, burning and draining. Even so, White notes “Americans have celebrated the frontier farmer” (White, 1991, 35). To these Florida settlers, they may have been acting as “[bearers] of civilization, [founders] of new communities, [conquerors] of the wilderness” or even explorers (White, 1991, 35). Just as the market farmers of Island County were focused on the market value of crops, thus increasing profit, the Florida farmers too failed to see “the beauty of” the Florida ecosystem, which flourished with a complex water system (White, 35) Instead, “they sought utility” (White, 1991, 35).

With such an “expansionist” mindset, (Hollander, 2008, 30) the early Florida settlers were much similar to the market farmers portrayed in White’s narrative of Island County. Their motives were largely fueled by the same “agrarian settlement” which encouraged domestic agriculture “from coast to coast” (Hollander, 2008, 30). However, it’s important to note that such settlers aren’t necessarily committing wrong doings, as their actions are being carried out within the societal, political, and technological systems from which they are accountable. Encouraged by an agricultural societal framework, largely based on economics, the Florida settlers viewed the swampland “wet and unfit for cultivation” (Neimark and Rhoades, 1999, 88).

Today, many Americans view wetlands completely differently. Horwitz & Finlayson write in “Wetlands as Settings for Human Health” that wetlands are “contributors to hydrogen, safe water, [and] nutrition,” (Horwitz & Finlayson, 2011, 682-683). They also provide a setting for recreational human leisure, and offer a buffer to natural hazards such as, tsunamis (Horwitz & Finlayson, 2011, 683). Thus, efforts are now being executed to maintain the health of the nation’s ecosystems (Reid 2013; Kennedy 2013), and the views of many have shifted to an ethic of conservation when considering the state of the nation’s wetlands. Going back to White’s comment of the inherent ways in which culture ultimately shapes the surrounding environment (White, 1991, 8), this cultural mindset shift of conservation has again shaped these wetlands and the Florida sugar industry is now facing expensive restoration projects.

Lui shows us that humans and nature are connected through various outlets that are not just complex, but also not well understood. Reciprocal effects and feedback loops are something that are quite familiar and are noticeable in a multitude of situations, the production of sugarcane being one of those situations (Lui et al 2007, pg. 1). As mentioned above in the case study, Brazil’s management of sugarcane can cause a significant level of soil erosion. On top of the wind and water erosion that happens from the soil being exposed, the compaction caused by the machinery is degrading the porosity of the soil causing a decrease in water infiltration, which furthers soil erosion (Martinelli and Filoso 2007, pg. 887). Because there is such a demand economically for sugarcane in Brazil, the government increases the amount of hectares allottable to sugarcane every year, spreading the rate of erosion around to land that would otherwise be covered. Then add burning to the mix. It is done to manage the crop, however, “burning increases soil temperature, decreases soil water content and bulk density and, consequently, leads to coil compaction, higher surface water runoff, and soil erosion” (Martinelli and Filoso 2007 pg.891). The whole management system causes this repeated cycle of soil erosion

to occur. Lui et al states how the decisions are important because they have many effects. “Both markets and governance can cause decisions made in one place to affect people and ecosystems far away” (Lui et al 2007 pg. 2). Brazil is the number one producer and exporter of sugarcane and the second largest of ethanol. Brazil is expected to consolidate its position as the leading global exporter and will account for over 55% of global trade and over 63% of all additional sugar exports by the close of the projection period (2020)” (OECD-FAO 2011, pg. 8). As of 2010, they were exporting roughly 25 Mt of sugar and are projected to reach a little over 35 Mt by 2020 (OECD-FAO 2011, pg. 8). The demand being made elsewhere around the world by other countries are causing Brazil to rapidly increase their cultivation and production of sugarcane if they want to keep their foothold in the world market. This is decreasing their arable land and the Amazon Rainforest is right there. If Brazil were allowed to start using the rainforest as arable land for cultivating sugarcane, that could have serious ramifications for ecosystems. There have already been ramifications to the soil environment.

Shiva (2008) talked about the oil crisis that we have been and are currently facing with peak oil. “Peak oil and the end of cheap oil make it imperative that we change the way we live. We need to move beyond oil. We need to reinvent society, technology, and economy. We need to do it fast and we need to do it creatively” (Shiva 2008, pg. 1). Although the two oil crisis that Brazil have already gone through were not due to peak oil, they still opened the country’s eyes to the reStudent-Czation of their dependence on a resource that is non-renewable. Shiva calls for new technology that will lead us away from petroleum-based fuels and Brazil is one of the forerunners in that race. They are using their climate conditions to their advantage to grow sugarcane to produce ethanol as an alternative fuel source. However, Shiva also states “soil not oil” (2008, pg 7) is the way to sustainable living. Brazil, well the government and sugarcane sector, not its workers, are not treating their soil with respect. According to Shiva to be sustainable, there must be fertile soils for food and life. If there is not then there cannot be either (Shiva 2008, pg. 6).

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**Reflection:**

*Effort Analysis: Student-C 33%, Student-B 33%, and Student-A 33%. We split the work equally.*

*Word Count: 1,054*

The issues I observed from the mono cropping regarded overpopulation and the exploitation of resources; both variables that could have—in the Nevis Island case—been monitored and kept at sustainable levels (levels that the environment could have supplied for and been regenerated with care). In the case of Barbados, the sheer demand for product spurred an entire global shift of morals (this is a view that Hardin takes into account in his *Tragedy of the Commons*) pertaining to the treatment of the environment in order to achieve the desired resource, and created a political structure based around these beliefs as well (Hardin, 1968, 1248).

Due to the amazing regenerative properties of sugar cane, its ability for fast growth with minimal impact on the environment, relatively, and the fact that sugarcane was generally already a native indigenous plant to the tropical climate, and not an invasive species, the growth of sugar cane in the Caribbean could be considered fairly sustainable. The practices that were not sustainable were those of the European settlers, to strip the land of all indigenous plant species and thus erode and deforest large areas that had previously contained complex biodiversity. They shifted the demographics of the population to African slaves who knew nothing of the island ecology previously, and therefore could not draw from any prior agricultural practices that were sustainable because they were not in a familiar landscape (Diamond, 2005, 425).

Human impacts to sugar in Florida are clearly worth noting, but sugar has also impacted the human population with interesting implications on sustainability. One example is in a complex system in which human labor is used only to do the planting by hand, as every other aspect of sugar cultivation can be done with machinery (Hollander,

2008, 241). Manual labor appears in present time as well; hand planting was still recorded in Florida as of 2008 (Baucum & Rice, 2006, 4). Thus, “black workers” were “likely the only professional cutters of sugarcane in Florida’s history” because of the hard labor that requires the planter to be constantly “stooped” over (Hollander, 2008, 241). Hollander goes on to say that because of this practice, “sugarcane shaped societal norms” (Hollander, 2008, 241).

This statement is incredibly fascinating, because the physical structure of the sugarcane plant makes it necessary for the stock to be cut by hand, and as Wilkinson notes, the sugarcane fields were void of white men laborers (Wilkinson, 1989, 41). Thus, sugar cultivation created social norms in which large sugar producers exploited minority populations willing to do hard labor.

Ostrom notes that typically “harvesters with a long-term interest in the sustainability of a particular resource system are more likely to invest in rules and norms related to timing, technology and quantity of harvesting” (Ostrom, 2007, 15185). In terms of Florida sugar production, this means that sugar producers could practice farming in a way that might have few effects on the surrounding ecosystem of the Everglades. They could perhaps, limit pesticide use or increase measures to limit drain off entering the fragile ecosystem. Most importantly, they could have chosen not to encourage the construction of a large scale system of dikes, levees, channels, etc., which largely altered the biological and ecological make-up of the Florida Everglades, forever changing the natural path of water to the now cherished wetlands.

Ostrom makes an important assumption that social norms have close ties to sustainability. In the case of Florida social norms influenced the desire to farm, perpetuated the security efforts to control the flooding waters (i.e. the wetlands), and even influenced the appropriate terms of employment, which closely mirrored slave plantations. Years ago, had society been less concerned with controlling the landscape and then reaping it for all monetary value it possesses, perhaps the Florida wetlands may look differently today.

It is becoming increasingly clearer that our earth and its ecosystems are complex, as Lui et al points out. What also is clear is that humans need to come up with a better strategy for survival, and it better be sustainable. “Climate change demands that we reduce fossil fuel use and CO<sub>2</sub> emissions. It also demands that we “power down” through decent Student-Czed and decreased energy use. Peak oil and the end of cheap oil demand a paradigm shift in our conception of human progress” (Shiva 2008 pg. 4). Our world is run by economics, so kudos to Brazil for jumping on the ethanol bandwagon long before most countries. It is amazing what can be achieved when the right motivation is given, like oil barrels costing US\$2.5 billion. However, with the case of Brazil, we can see the good intentions of production that sugarcane, but we also see the bad. Their soil is being highly degraded and their management is causing increases in GHG that everyone in the whole world will have to deal with, including themselves. Even when humans are trying to find a way to live sustainably, they sometimes forget about the road and resources they use to get there.

Hardin reminds us that in terms of tragedy of the commons, “the rational herdsman concludes that the only sensible course for him to pursue is to add another animal to his herd. And another; and another...but this the conclusion reached by each and every rational herdsman sharing a commons” (Hardin 1968, pg. 3). Brazil’s

increasing need for arable land for sugarcane reminds me of the commons. The government and sugar industry find it advantageous to add another couple thousand hectares of planted land for sugarcane production because they are the number one exporter and producer, so they demand calls for it. Each individual mill believes they should be able to take that extra hectare the next year and so on and so forth. It becomes a vicious cycle that they mills cannot stop. Plus the way they degrade their soils, the most certainly need more land to be able to continue the same, if not higher, amounts at harvest. Humans are encouraged to try and change to a more sustainable mode of living, meaning everything we do needs to be changed somehow so future generations have resources. But sugarcane is so embedded into Brazil's economy, how can you go about trying to change and "experiment" new technologies and management strategies while maintaining the produce that is being demanded at the rates it is?

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