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The Mean Bean: the Biological, Economic, and Social Consequences of Soy Bean an Production Within the Brazilian Amazon

Randal James Davis
Regis University

THE MEAN BEAN:
THE BIOLOGICAL, ECONOMIC, AND SOCIAL CONSEQUENCES OF SOYBEAN PRODUCTION WITHIN THE BRAZILIAN AMAZON

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Randal James Davis

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Thesis written by

Randal James Davis

Approved by

_____

Thesis Advisor: Dr. Catherine Kleier

_____

Thesis Reader: Dr. Peter Bemski

Accepted by

_____

Director, University Honors Program: Dr. Thomas Bowie

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PREFACE AND ACKNOWLEGEMENTS

I remember hearing first about tropical deforestation in my first grade classroom. The teacher described the situation from a third person vantage: 50,000 species are lost annually to deforestation, one and one-half acre of rainforest is lost every second, and 90 of Brazil's indigenous tribes have been lost since the 1990. When my teacher spoke regarding the loss of tropical rainforest, I remember feeling both stunned and saddened. I felt separate from the issue – rainforests were not near Colorado, therefore I had nothing to do with the destruction. I viewed the destruction as one might view a massacre in a foreign country: it is obviously an evil action; I did not make this action, and I am, therefore, from the results.

This logic was not enough for me; I remained confused. Why would people throw away such a beautiful abundance of life? This question has haunted me throughout my education. While never being the sole focus of my studies, it is something I have researched within several research papers, and now, my senior thesis. This paper is my attempt at coming to a better understanding of the destruction within the Amazon, and is the first of, hopefully, many efforts to take a stand against this deforestation.

I would like to thank Catherine Kleier, Ph. D. for her efforts and direction throughout the writing process, specifically as my thesis advisor. I would also like to extend gratitude to Peter Bemski, Ph. D., my thesis reader. His advice early in the writing process has made the topic both approachable and meaningful; his experiences in Brazil have made me stride to make the voice of those in Brazil heard throughout the paper. I would like to thank Thomas Bowie, Ph. D., for his direction throughout my time

at Regis University and within the Honors Program. Together, these three professors are responsible for the completion of this thesis; I would not have finished without their careful guidance. Finally, I would like to thank my family and friends for lending an ear during soybean rants; I will never be able to repay their patience.

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"I speak for the trees, for the trees have no tongues."

Dr. Seuss, The Lorax

INTRODUCTION

The providences of Brazil contain one-third of the earth's remaining rainforests (Butler, 2008). It is hard to imagine a rainforest accurately until one sees it in person; the impenetrable amount of green fills every increment of one's vision. The species density within the rainforest is incomprehensible; more than fifty per cent (approximately five million) of the world's plants, animals, and insects live in tropical rainforests (Taylor, 1996). We currently have domesticated more than two hundred crop species from tropical rainforests; indigenous populations use more than 2,000 plants (Smith, Williams, & Plucknett, 1991; Taylor, 2004). Cain, Bowman and Hacker (2008) noted that 25% of all medicines have products with plant derivatives in the rainforest; researchers have only tested 1% of all Amazonian plants for use within medicine.

The importance of the rainforest spans beyond the reach of species richness. As global warming carries on, the tropical rainforest supplies twenty per cent of the world's oxygen (Taylor, 1996). The tropical rainforest, coined the "Earth's Lungs" by some environmentalists (Greenpeace International of Brazil, 2006), carries special pertinence to global climatic patterns. Fearnside (2005) reported that the Amazon Basin, once

thought to recycle fifty per cent of its water, actually recycles twenty to thirty per cent; while this may seem to somehow decrease the value of water recycling throughout the basin, it actually implies that some vapor escapes into other regions. He noted that some of the water vapor enters the Pacific (travelling to Columbia), while other vapor reaches through Brazil, Paraguay, Uruguay, and Argentina. Some of the vapor even travels across the Atlantic, and into southern Africa. The presence of this water vapor then affects the hydrological system on a global, rather than regional, scale.

One can easily gain a sense of the value of the rainforest, even after reading only a few of these statistics. However, the Amazon, like every other habitable place on earth, has a culture and a history of its own. Explorers valued the Amazon for the very reasons stated – the expansion of forest offered beauty and treasures unique to only this area. Yet it also housed populations of natives; a figure of three to five million Indians were scattered throughout the Amazon, living in a successfully mutualistic relationship which European explorers cancelled out only after ten thousand years of existence (Revkin, 1990). Colonization brought changes to the culture: new diseases, new ways of life, and new technologies. It shifted the green landscape of the Amazon to a cultivated land, at sometimes leaving only a wasteland where sacred tropical forests once lay.

Conservation biologists, environmentalists, and politicians largely contest the leading cause of tropical rainforest deforestation within the Brazilian Amazon. Statistically, the single greatest source of deforestation lies within the massive cattle ranches of Brazil's Mato Grosso region (see Figure 0.1, Butler, 2008). By examining the root need for cattle ranching, however, one soon realizes that economic development

(both in Brazil and globally) calls for expansion of cattle herds. Butler also observed that, when Brazil experiences an economic rise, the Amazon experiences an equally notable increase in deforestation. One could state that economic growth and expansion is the leading cause of the deforestation and would be accurate to an extent. To gain a better understanding of the need for cattle production, one must question the necessity for cattle; specifically, one must question the demands raising the production of cattle within Brazil.

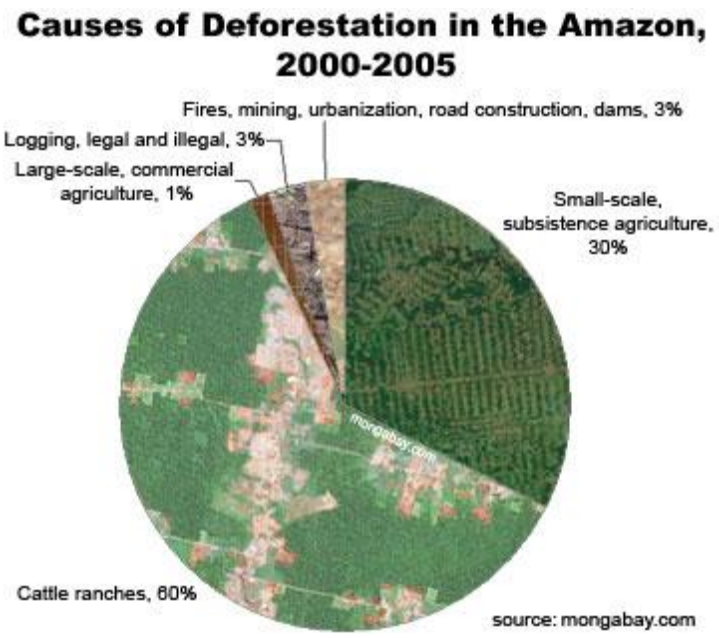

Figure 0.1 Statistics supported by recent studies depict that cattle ranching is currently the leading cause of deforestation (Butler, 2008)

As cultural changes and globalization have taken place, more countries are now turning to consumption of meat. Meat exports increased eight-fold from 1990 to 2004 (when examining beef, pork, and poultry). Brazil is a major provider of beef – supplying 190 million cattle; appeal to Brazilian meat has increased as concern regarding the use of genetically modified (GM) feeds and foot-and-mouth disease has developed (Brown, 2005). Brown (2005) also noted that Brazilian beef exports increased from 200,000 tons in 1995 to 1.4 million tons in 2004; poultry and pork exports have seen similar increases.

The need for cattle increases the need for feed, and it is here that soybeans meet deforestation.

Soybeans are an enormous source of protein (forty per cent by volume [Joseph, 2007]), and have been implemented as feed since the collapse of Peruvian fish markets in the 1970s (Brown, 2005). Farmers process 90 per cent of soybeans farmed for use as animal feed, while nearly sixty per cent of the processed foods consumed contain soy protein (Lambert, 2008). The United States was once the leading exporter of soybeans; Brazil has slowly risen to this claim (Arbivatae, 2005). With the call to increase production of biofuels within the U.S., farmers have replaced the soybean production with corn, a source of ethanol (Butler, Mongabay, 2008). The U.S. has left a large share of the market for other soybean producers to claim; Brazil is one such producer. The land for Brazilian soybean production has increased from 1 million hectares (1970) to 24 million hectares (2004 (Brown, 2005)), a clear indication that their agricultural priorities have begun shifting to reflect the needs of a changing world. Since the time that Brazil started producing soybeans, domestication has resulted in plants that are more prepared for the Brazilian climate, further increasing growth within the industry (Nepstad, 2006).

The land for Brazil's agricultural expansion must come from somewhere; the recent history of deforestation follows closely with the growth in both Brazilian beef and soy industries, but originated very distantly. Amazonian deforestation began with the presence of European settlers in the 1400s; Revkin (1990) claims that the spread of roads throughout the region during the previous decades have only been a continuation of these efforts for personal gain, as best shown through the history of Brazil's settlement. In the

1500s, myths of unimaginable wealth drew explorers in the fashion of Francisco Pizarro. While seeking gold, they also encountered spices; their exploration carried them into the forest of the Amazon. Where Francisco Pizarro's Spanish blade brought the end of the Incan civilization, the thick forests of Central America stopped his brother Gonzalo as he attempted to find and conquer other civilizations. His companion, Orellana, continued on, while Pizarro returned to Peru. Orellana encountered the river system later deemed the Amazon in respect to tales of heroic battles against tall white women, baring similarity to the Amazons of Western mythology. Orellana found no gold, and the spices grew unevenly throughout the landscape – providing a completely unsuccessful expedition; may such expeditions would continue over the next few centuries.

Explorers misunderstood the sophistication of the so termed Amazonians in a misconception similar to that of the Central American native civilizations. The people viewed as "savages" (Revkin, 1990), were quite the opposite; Stone and D'Andrea (2001) reveal that the populations cultivated corn, manioc, Brazil nut and cashew trees (in fact, the cultivation systems are still in use). Recovered pottery, terra cotta sculptures, and war clubs show the development of the civilizations. The culture living amidst the forest was a treasure the explorers missed, as did historians until only recently.

As Portugal began settling the Brazilian domain, the 1700s brought about expeditions for slaves, wealth, and territorial expansion. Tangible trade items replaced the myths of gold. Explorers now sought oils, minerals, rare woods, and exotic foods (Revkin, 1990). The findings drew the attention of biological explorers; even Charles Darwin found himself drawn to the diversity of the rainforest (Stone & D'Andrea, 2001).

Other explorers included Alfred Russel Wallace, Richard Spruce and Henry Bates. Bates returned to England with a collection totaling 14,712 species; Europe had never seen descriptions of 8,000 such species (Revkin, 1990). The exploration and expansion within the Amazon continued slowly until the 1800s, introducing trading posts, missions, and foreign diseases (Stone & D'Andrea, 2001); the European settlement forced the native populations to live as hunter-gatherers within the forest. The same culture that suppressed native culture later deemed it savage.

As myths of gold dissipated, explorers discovered a new wealth: rubber trees (Stone & D'Andrea, 2001). When something scratches its bark, *Hevea brasiliensis* releases a milky sap with an elastic quality and a natural insecticide (Revkin, 1990). In the early 1800s, manufacturers found several uses for this product, deemed rubber, including bottles, syringes, and boots. The product was not entirely useful because it lost its elastic quality when exposed to heat or cold; Charles Goodyear discovered that the addition of sulfur cancelled out this property (Revkin, 1990; Hunter, 1997). Henry Ford unsuccessfully tried to establish plantations for rubber in the 1920s and 1930s (Stone & D'Andrea, 2001). The industry would extract one trillion dollars worth of rubber (Revkin, 1990), all while exploiting Brazilian workers with unfair business practices and careless burning in between collecting seasons (Zmekhol, 2008). By 1970, industrial expansion had deforested an area roughly 100,000 km^2 (Fearnside, 2005).

The exploitation of rubber also brought about the clearing of roads through the forest (Zmekhol, 2008). While times had changed, the same forest that once stopped Gonzalo Pizarro still made transportation a daunting task. Every time trappers created a road, they in turn attacked the security accompanying the density of thickets; Greenpeace reports that eighty-five per cent of current deforestation occurs within thirty miles of a major roadway (Greenpeace International of Brazil, 2006). With paths through the virgin forest, foresters had access to rare timber (Butler, Mongabay, 2008). Rubber industries paved the way for the destruction of forestry for use in furniture and fine wood goods; thus began the industry of illicit timbering, which continues even today. The most valuable trees for timbering are large trees; such trees require even more roads. As such roads are created to reach the trees, entire roadway systems begin to form. These roads create a "fishbone" pattern (see Figure 0.2), explaining the roadway statistic presented by Greenpeace (2006).

Figure 0.2 A "fishbone" deforestation pattern arises from the network of roads created as loggers and farmers penetrate the rainforest (NASA, 2000)

While timbering and rubber tapping brought about deforestation through roadways, full exploitation did not occur until the 1960s. During this time-period,

generals and planners governing Brazil proposed programs to transform Amazonia with ranching and farming to meet the expanding demands of beef as globalization progressed (Stone & D'Andrea, 2001). The Brazilian leaders offered free land in the Amazon to those who were willing to colonize the forestland (Zmekhol, 2008). This massive land development and colonization held obvious implications of disaster for the Amazon tropical rainforest: each settlement brought about another wave of deforestation as tappers and loggers cleared the land for an increasing number of roads.

While this expansion was damaging, the rainforest would soon face another challenge. Brown (2005) documented the 1972 collapse of the Peruvian fisheries. These fisheries were once the leading source of protein for animal feed, and replacement fisheries were not readily available; soy meal, with its high protein content, was an obvious candidate. Brown (2005) also stated that the U.S. had implemented soy meal into their feed twenty years earlier and stood as the primary producer and exporter of soybeans. In order to insure their supply of animal feed, the U.S. placed an embargo on all of their soy exports following the Peruvian fishery collapse. This motion restricted the global feed industry, creating a need for the development of soybean plantations in new countries. Brazil became that source; Joseph elaborates, "By 1989, Brazil's yield of soybeans was 24 million tons, up from just 1.5 in 1970" (2007). This sixteen-fold increase of crop production could not take place without reflective developmental changes: from 1981 to 2006, the industry led to the destruction of an area larger than the entire state of California (Greenpeace International of Brazil, 2006).

The domino effect of land clearing had taken off. Hungry for economic growth, Brazilian federal government created policies to try to integrate the region with the Brazilian economy and take it out of the hands of international intervention. They offered colonization programs and financial incentives for those interested in created large-scale cattle ranches throughout the 1970s and 1980s (Fearnside, 2006). Just as the forest had hindered the transportation of lumber and rubber, soy and beef required roads for transportation (Greenpeace International of Brazil, 2006). The Brazilian government paid for the creation of these roads (Fearnside, 2006). However, competing markets of beef (largely from the United States and Europe) steadied the market for Brazilian exports (Brown, 2005); furthermore, presence of foot-and-mouth disease within the Amazonian herds until the mid-1990s (Fearnside, 2005). While the economic demand for Brazilian beef may have been subdued, the impact of the agricultural expansion was devastating. Fearnside (2005) also reported that the agricultural development had clear-cut 587,000 km^2 of Amazonian forest by 1990. Twenty years of development had done nearly six times the damage that five centuries had managed to complete.

European trade policies would soon deliver a boost to Brazil's economy. As technology allowed, the U.S. began replacing traditional domestication procedures with genetic manufacturing (GM); such crops now account for eighty-five per cent of United States feed crops. European Union trade policies restrict the import of all GM crops and of any livestock fed by such crops (Joseph, 2007). Brazilian soybeans were not GM, thus the Brazilian feed and livestock were eligible for exportation to Europe. Brazil became a leading exporter of non-GM soy to the E.U., accounting for six million tons, or one-half,

of their soy imports (Nepstad, 2006). Further increasing the demand for Brazilian beef, Great Britain and the U.S. experienced the Mad Cow scares in 1996 and 2003, respectively (Murphy, 1996; Hildreth, 2004). By 2003, Amazonian deforestation in Brazil had reached 648,500 km^2 (Fearnside 2005).

Greenpeace International of Brazil recently stated that the global demand for soy is now the leading cause of deforestation within the Brazilian Amazon (2006). Throughout history, the expansion of the Brazilian economy has failed to take into account the people of Brazil; today is no exception (Zmekohl, 2008). The companies initiating the deforestation of the rainforest are completing the task in unethical slash-and-burn techniques. While slash-and-burn techniques once were able to support communities, the agricultural expansion has reduced the amount of time that populations are able to let the land lay fallow for soil restoration and recovery (Rainforest Saver, 2009). With the increased land demand, these techniques are detrimental to the soil (Brown, 2005), and to the people (Revkin, 1990). Most detrimental to the people of Brazil, however, are the methods incorporated to create and cultivate soybean plantations.

As the forest is penetrated, the roads allow access to clear land illegally. Oftentimes, large-scale companies steal the land from indigenous people and small-scale farm industries by simply shoving them aside. Once established, individuals looking for jobs at the plantations arrive; the companies fool them with promises of ethical pay in exchange for their work. Corporations rooted within the United States are responsible for inhumane working conditions and even conditions of slavery within these plantations (Greenpeace, 2006).

The production of soybeans in the Amazon is the leading cause of deforestation. Corporate powers, including those rooted in the United States, incorporate slash and burn techniques and inhumane treatment of employees as a means to reach their economic success. The results are devastating to Brazilian people, future development in Brazil, and to the global wealth in the Amazon. Current agricultural development techniques will not allow Brazil to achieve the maintainable success that they desire.

"To me, a 40 percent increase in deforestation doesn't mean anything at all, and I don't feel the slightest guilt over what we are doing here…. We're talking about an area larger than Europe that has barely been touched, so there is nothing at all to get worried about."

Blairo Maggi, governor Mato Grosso, "O Rei da Soja"

CHAPTER 1: SOYBEANS IN THE AMAZON

The name Mato Grosso translates as "dense forest" (Joseph, 2007). A couple hundred years ago, this area looked quite different; even over the past 30 years, the difference in the landscape shocks those who see it (Zmekhol, 2008). Roads to transport soybeans and other industry products now replace the sea of trees. Where scattered villages once filled the land, Zmekhol (2008) also observes, now large towns rest as requirements of the Brazilian economic development. A rising tower of intimidating foliage seems to stand watch over endless rows of *Glycine max,* but, in reality, this crop continually threatens the existence of such majestic trees (see Figure 1.1).

THE PATH TOWARD DESTRUCTION

Tropical rainforests once covered fifteen million square miles of land (Revkin, 1990), of which eighty-five million hectares of land once stood mostly covered by tropical forests within the regions of Acre, Rondônia, and Mato Grasso (Williams, 2002). Colonization of the New World led to the exploration (and eventual exploitation) of new lands and new cultures; within 250 years, European influence would alter virtually all vegetation, land, and land uses throughout the Atlantic islands and the Americas,

including the forests (Williams, 2002). European expansion would change the world permanently.

The indigenous peoples of the Amazon were far from savage; they practiced different forms of agriculture for more than 10,000 years prior the European conquest, incorporating advanced cultivation techniques that still in use today (Stone & D'Andrea, 2001). South American Indians of the Tupi-Guarani population, "practiced a shifting, slash-and-burn, swidden cultivation, and grew crops of manioc, maize, squash, beans, peppers, and peanuts" (Williams, 2002). News of riches within the region brought wave after wave of colonization attempts. As European slave trade spread to the region, the indigenous people lived as tradition now depicts them; the natives retreated to the forest to live as hunter-gatherers rather than in their farm and town communities (Stone & D'Andrea, 2001). Latin America proved to be an invaluable source for European exploitation.

Figure 2.1 This photograph shows the visible lines formed as rainforest is destroyed to make way for cattle land and soybean plantations in Brazil (Baleia, 2008).

The Incan conquest of Francisco Pizarro in 1532 brought about myths of untold wealth, including the legend of El Dorado (Revkin, 1990). Following his brother's success, Gonzalo Pizarro led an expedition from the eastern slope of the Andes in search of legendary forests of cinnamon trees and a land of gold by Lake El Dorado (History

Reference Center, 2003); equipped fully, they hoped to exploit the land for its spices and gold (Revkin, 1990). Brazilian natives often refer to the Amazon as "Infierno Verde," the Green Hell; the tough landscape of the jungle provided little food, and the climb over the mountains was devastating to the expedition party (History Reference Center, 2003). Orellana took a portion of the party to look for food, but never returned. Pizarro returned to Peru, where he accused Orellana of desertion (Stone & D'Andrea, 2001).

Orellana and the men continued downstream, carried by heavy currents. Starvation still challenged the explorers, but they soon encountered friendly natives; they built a larger ship and continued onward (History Reference Center, 2003). Tribes became more hostile as the men progressed on their journey; they encountered tall, female archers who directed the battle. The resemblance of these women to the Amazons of Western mythology lent their title to the region, deeming it the Amazon. The explorers' reports inspired two centuries worth of expeditions throughout the territory in vain attempts to discover the lands of spices and gold (Revkin, 1990). The Europeans brought new weapons, farming techniques, missions, trading posts, and, worst of all, diseases to the region (Stone 2001; Williams 2002); the taming of the Amazon had begun.

MODERN GROWTH AND COLONIZATION

European explorers encountered many new forest products while meeting the indigenous tribes, including: turtle oil, Brazil nuts, cocoa, fragrant oils and rare woods, minerals, cashews, papaya, passion fruit, and pineapple (Revkin, 1990; Williams, 2002). In an ironic twist, Europeans soon would ignore the very products that first drew them to

the region as they tried to make the Brazilian land their own. Preferring to invest in an already stable economy, rather than explore the use of new plants, the European settlers introduced non-native plants (primarily sugarcane (Williams, 2002)).

A kind of social hierarchy began to take place within Brazil, with those who were white receiving Portuguese rights for land and forest while officials separated the natives into *adelias* (towns created by the government and placed under the administration of Jesuit and Franciscan missionaries). Settlers expanded their holdings by illegally occupying additional land ("squatting"). Farmers began establishing sugar crops and herds of cattle, often incorporating damaging slash-and-burn techniques when they cultivated the land. As they cleared forests, they also discovered gold deposits, drawing even more settlers (Williams, 2002). One should note, however, that this period only saw the cultivation of land for personal use (Stone & D'Andrea, 2001). The damage to the Brazilian landscape began to unfold.

Shortages of timber within Europe brought about a new wave of deforestation. The Portuguese foresters soon learned that the soil Brazilian Amazon was not as forgiving as their homelands. When they felled trees, saplings would not grow out of the stumps; new trees typically grew only within forests. The logging industry did not blossom within the territory, especially when loggers began cutting onto the "private" individual holdings of farmers (Williams, 2002). The forest would continue revealing new wealth to the European community.

South America experienced its first commercial agricultural development throughout the 1700s (Williams, 2002). In 1735, the French explorer Charles-Marie de

La Condamine brought the first samples of rubbery material to Paris (Hunter, 1997). The product, extracted most efficiently from *Hevea brasilienis*, would not become completely useful for quite some time due to the influence thermal conditions hold on its elastic state (Revkin, 1990). Indians had used the product to produce bottles, torches, shoes, and soccer balls; Europeans would use the product for syringes, boots, and erasers (Revkin, 1990; Hunter, 1997). Sugarcane plantations spread quickly to the region, though transportation made the crop too expensive to become feasible. Finally, the farmers found success when planting coffee beans in the lands of Latin America, deeming it their "green gold" (Williams, 2002). Roads began to form as the farmers transported crops from the regions; in 1867, the Santos-São Paulo railway paved the way over the inconvenient mountains of Serro do Mar. Williams (2002) also noted that more transportation accessibility led to more settlement, which led to more forest clearing for food plantations and cattle herds. The source of transportation needed to carry this region into a commercial agricultural state curbed Brazilian development.

The population of Brazil kept increasing slowly. In the early 1800s, Charles Goodyear discovered that the addition of sulfur cancelled out the temperature-volatility of rubber; the process became known as vulcanization. Europeans invented many new products out of rubber, harnessing its ability to retain shape, resilience, and pliability. By the end of the century, Henry Ford would invent the automobile, and the need for tires would lead to heavy exploitation of the product (Hunter, 1997). The century saw one trillion dollars worth of rubber extraction from the Amazon (Revkin, 1990). The

expansion developed the population of rubber-tappers, further increasing the need for agricultural growth to sustain the workers.

AGRICULTURAL EXPANSION AND THE NECESSARY EXPANSION OF SOY

The expansion of the coffee and rubber industries required the growth of inland big cattle ranches to support the sustenance requirements of the growing population well into the 1900s. Meanwhile, the lack of true highway systems made transportation throughout the country tedious; it took 6 weeks to reach the trade-hub Porto Velho from the southern portion of the country (Williams, 2002). To meet this call, the government constructed the first two Brazilian highways, Belém-Brasilía and Cuiabá-Porto Velho (BR-364, or the "Trans-Amazon Highway" (Middleton, 2000)), in 1958 and 1968, respectively (Kirby, et al., 2006). The development of the highways brought about further expansion into the area.

Where the tropical regions were previously inaccessible to easy trade routes, coaches could now reach the area by 3 or 4 days hard travel (Williams, 2002). The new roadways made the region passable and habitable; the military dictatorship of the 1960s began a series of poorly planned, expensive expansion measures to transform the tropical region into cattle ranches and farmland (Stone & D'Andrea, 2001). The government began giving "colonists" land to bolster the economy (Zmekhol, 2008), and convinced donors to finance the construction projects and colonization (Stone & D'Andrea, 2001). More than two million people settled along the Belém-Brasilía highway within its first twenty years (Kirby, et al., 2006), both legally and illegally (through squatting, Fearnside, 2008). During the 1980s, INCRA (National Institute for Colonization and Agrarian

Figure 2.3 A photograph of BR-364 in 1984 shows just how difficult transportation was before the paving was complete (de Souza, 1984).

Figure 2.2A photograph of the same portion of BR-364 in 2006 shows how much the area has changed (SkyScraperCity, 2006).

Reform) recognized illegal settler claims, but was overwhelmed due to the sheer volume of claims. The Brazilian government responded to the growth in 1981 by creating POLONORESTE (The Northwest Brazil Integrated Development Program), a program backed by World Bank to support 35,000 settlers. This program was not enough, and was overwhelmed after the government completed paving BR-364 in 1984(making it an all-weather road (Williams, 2002; Fearnside, 1987)). The paving of the road (and subsequent modern development) further reflects the role of roads within Brazil's population expansion (see Figures 1.2 and 1.3). While the economic expansion of Brazil required additional roads, other global developments were requiring a higher production of soybeans.

The demand for agricultural expansion within Brazil came from a somewhat unexpected source: the 1972 collapse of the sizable Peruvian anchovy fishery. The fishery supplied one fifth of the world's total catch, putting an obvious strain on the anchovy industry. Furthermore, the anchovies were a leading source for protein supplements used within the animal feed industry. The United States had incorporated soy meal protein within their feed industry twenty years prior and stood as the world's leading producer, but, in 1973, Washington placed an embargo on soybean exports in an effort to calm the inflation of their domestic food market. The result was a skyrocket in the price of soybeans, and no natural supplier (Brown, 2005).

The Brazilian government saw the opportunity for expansion within the soybean industry; they expanded research to include the domestication of soybeans specifically for the soy of Brazil. The growth of this industry further stimulated the expansion of the

transportation infrastructure (Brown, 2005), offering further explanation for the construction of highways. The successful implementation of this research, paired with the timely development of highways, resulted in a soybean production growth from one million tons in 1969 to over 15 million in tons in 1980 (Brown, 2005). The presence of foot-and-mouth disease within Brazilian herds prevented the growth of an international beef market until the mid-1990s (Fearnside, 2005), but Brazil quickly became one of the world's leading producers of soy feed.

SOYBEANS AND DEFORESTATION

The importance of the soy industry to Brazil's developing economy becomes clear. The Brazilian economy began to develop around the production and exportation of soybeans. The economy required people to move to support the agricultural growth. The migration of additional people to the region required a larger amount of cattle and food crops for consumption. The increased demand for cattle required a larger amount of soybeans for feed. Without the soy industry, the Brazilian economy is missing a fundamental link. Throughout the development, the soybean plantations and cattle growth cause both direct and indirect deforestation.

Transporting the soy feed led to the exploitation of the established highways, further increasing deforestation. Tropical rainforest foliage is very dense; farmers construct roads to their farms and settlements in order to transport the soy for exportation. Eighty-five percent of all deforestation occurs within 30 miles of a major roadway due to soy plantations and additional deforestation to newly penetrable forest (Greenpeace International of Brazil, 2006). Pfaff's analysis of satellite and socioeconomic data reveal

that increased road density in a county leads to increased deforestation within that county and in neighboring counties; paired with evidence that distance from markets is inversely proportional to the amount of trees felled, it is not hard to see the impact of roads on deforestation (Pfaff, 1997). There are more than 105,000 miles of unauthorized roads within the Amazon, most of which are constructed illegally by loggers seeking to reach rare hardwood trees in the heart of the rainforest. Once the loggers have located and chopped down such trees, they have little choice but to construct roads to transport them out (Wallace, 2007).

Reinforcing this concept, Pfaff (1997) indicates that deforestation is higher in areas with lower population density. Lower populations would correlate to a small group of loggers making primary cuts to get the illicit timber; as they are logging, the rate of deforestation would obviously increase. With the land cleared and roads established, the land is ripe for farmers and workers to move in. Because the primary cutting has already taken place, deforestation rates decline in comparison to the high rates exhibited surrounding the actions of the illicit loggers: deforestation rates decline with the increase in population density because there are fewer trees to fell.

Once the initial logging has taken place, a domino effect initiates. After the farmers have established their property and farmland, they create smaller roadways to connect to the larger roadways. More loggers are able to penetrate the thinning rainforest. As the frequency of such timbering increases, so does local farm production; with increasing farm production comes increasing transportation of goods. As more transportation takes place to areas deeper into the Amazon, road expansion takes place,

often forming illicit highways. Greenpeace noted the existence of one such highway, 75 miles in length, accounting for more than 100,000 acres of soy plantations and another 247,000 acres for sale near the road (2006). The cycle is never ending; every step produces a greater propensity of deforestation on the next revolution.

Some farmers have tried to step away from the destructive practices. Jack Chang (2007), a reporter for McClatchy Newspapers, reported the story of Vigillio de Souza Pereira. Pereira, a Brazilian farmer, made the transition to sustainable farming in 1994. The switch allowed him to export his environmentally friendly wood at a higher price. Untouched timber forests were too appealing for other loggers; they harvested most of his trees. While officials were able to seize some lumber, they could not guarantee that the loggers would not return. The ranch nearly shut down, and what remains now looks like the battered landscape of deforested Amazon: charred stumps rest where trees once stood tall.

THE PRESENT STATE OF SOYBEAN PRODUCTION AND DEFORESTATION WITHIN THE BRAZILIAN AMAZON

Brown (2005) reported that the European Union banned the importation of genetically modified (GM) crops and GM fed livestock in the late 1980s. The United States was, at the time, the largest producer of soybeans, but had begun introducing GM crops to increase production. As the E.U. was no longer able to acquire soy feed or livestock from the U.S., Brazil became a more viable opponent in the supply of both beef and soy. However, foot-and-mouth disease still occurred within Brazilian cattle herds until the mid-1990s (Fearnside, 2005). Further impeding the growth of the cattle

industry, transportation infrastructure was inadequate (Nepstad, Stickler, & Almeida, 2006); somehow Brazilian growth continued. Nepstad, Stickler, & Almeida proposed that it was likely to the ability of investors (including drug dealers as a laundering technique (Fearnside, 2005)), and land speculators to obtain land deeds more easily (2006). Brazilian titling requires land to be under "productive use," and one of the easiest ways to accomplish this status is through the establishment of pastureland. Fearnside (2005) also noted that soybean production in Brazil was insignificant in the 1980s and 1990s, as researchers had not yet developed beans appropriate to the lands and climate of Brazil.

By the late 1990s, researchers had domesticated soybeans appropriate for the Brazilian Amazon. Transportation developed around the investment of large companies, such as Cargill and McDonalds; new deepwater ports opened, facilitating the investment in paved highways. The E.U. went through an outbreak of bovine spongiform encephalopathy (BSE), causing panic regarding their meat industry and need for an alternative protein supplement; with the ban on GM products, Brazil's soybeans were an obvious candidate. Population growth within developing countries has brought about an increased demand for livestock (Nepstad, Stickler, & Almeida, 2006). Finally, U.S. demand for ethanol led to an increase in corn production, directly influencing a decrease in soybean production (Butler, 2008). All of these factors created a perfect storm for the development of soy and beef industries within Brazil.

Greenpeace International of Brazil released, "With global demand for soy on the rise and limited room left for expansion in the grass and scrublands to the south, soy is

now leading the advance of the agricultural frontier into the Amazon rainforest, making it the leading cause of deforestation today" (2006). In 2005, soy had become Brazil's number one export commodity; one-fifth of the entire Amazon tropical rainforest had been destroyed (Arbivatae). In 2005 and 2006 alone, approximately 6,500 square miles of rainforest was destroyed (Wedekind, Tofu's Underbelly, 2007). While there is still time for change, the current trends clearly spell trouble for the Brazilian Amazon.

"We – human beings – are part of 'biodiversity.' We are dependent on the whole food chain down below us."

Darrell Merrell, heirloom vegetable farmer

CHAPTER 2: THE BIOLOGICAL IMPORTANCE OF TROPICAL RAINFOREST ECOSYSTEMS

Soybeans are, in the very least, a leading cause of deforestation within the Brazilian Amazon. In 2008, Amazon deforestation accounted for a loss of an approximate 4,600 square miles (Butler, Mongabay, 2008), with approximately twenty-percent of the total Brazilian rainforest deforested by August 2008 (The Associated Press, 2008). With the Brazilian Amazon containing approximately 40 per cent of the world's remaining tropical rainforests (Laurance, et al., 2001), this deforestation carries a heavy price.

Some view the loss of tropical rainforest in the Brazilian Amazon as a mere consequence encountered upon the road to development. Blairo Maggi, governor of Mato Grosso and leader of the soy industry (even deemed "O Rei da Soja", "the King of the Soy", by the Brazilian press), approached the question with a tenacious edge, "I don't feel the slightest guilt over what we are doing here…. We're talking about an area larger than Europe that has barely been touched, so there is nothing at all to get worried about" (Joseph, 2007). One can make the argument that the deforestation of Brazil is only the

shadow of the economic development that occurred when settlers developed Europe and the United States (Middleton, 2000; Joseph, 2007). This argument does not necessarily hold through, with all implications fully understood.

The United States did not progress through the massive deforestation unchanged. Between 1870 and 1970, settlers cleared 500 million acres of virgin forests, plowed more than 99 per cent of tallgrass prairie, drained a majority of several states' native prairie wetlands, and overgrazed much shortgrass prairie to sagebrush or scrub. This action drove the extinction of the passenger pigeon, the Carolina parakeet, and the ivory-billed woodpecker (Terborgh, 1992). The thirst of the United States for economic development spurred the complete transformation of its land. Introduced populations now threaten the existence of native populations; each species lost carries with it implications. The spread of invasive species throughout the Brazilian *cerrado* serves as an illustration to what the future might hold for the Amazon rainforest (Carvalhoa, Júniora, & Ferreirab, 2009).

History has carried Brazil throughout tremendous exploitation, as shown through the Spanish conquest and expansion until present. While history has brought increased amounts of deforestation (an area larger than the size of California has been lost in the last 25 years (Greenpeace International of Brazil, 2006)), it has also brought the scientific understanding of the implications behind the timbering industry. While the United States developed almost unfettered, current understanding shows that the Brazilian climate, or even the global climate, cannot support such unrestrained growth. However, the resources at stake are vast; the region is largely unfamiliar to the world, with the obvious exception of Brazilian inhabitants. Thusly, the implications of deforestation are easy to

overlook. As understanding increases, the effects of deforestation within the Brazilian Amazon generally fall under two, non-exclusive categories: threat to biodiversity and threat to climate.

EFFECTS ON BIODIVERSITY WITHIN THE BRAZILIAN AMAZON

Biological diversity, coined *biodiversity*, is the variety of species. The true comprehension of biodiversity within the scientific community spawned from studies conducted in rain forests not too long ago. In 1982, Dr. Terry Erwin, an entomologist from the Smithsonian Institution, performed the research that would shape the new perception. Before the study, scientists estimated the number of species on earth to be around two million. Erwin reached an estimate of thirty million potential arthropod species by fumigating selected rainforest trees and quantifying the organisms collected. Through three seasons, 19 trees yielded 1,200 species of beetles (Terborgh, 1992). The diversity encountered revealed not only how little scientists understood about biodiversity, but also the role of tropical rainforests within species diversity and species richness.

The scientific perception has increased greatly since the work of Erwin; most scientists now agree that more than half of all species live in the tropical rain forests; to date, scientists have documented 1.8 million species. Total estimates of species on earth vary from ten to 100 million total species (Middleton, 2000). Smith, Williams, and Plucknett (1991) briefly discussed the presence of several economically important species within the Brazilian Amazon: rubber (*Hevea brasiliensis*), cacao (*Theobroma cacao*), piquiá (*Caryocar villosum*, an ideal candidate for fruit and commercial foresting

harvests), and copaiba (*Copaifera* species, useful as a medicinal ointment, oil, or biodiesel alternative). At least 80% of the world's diet originated in tropical rainforests, including corn, rice, potatoes, squash, yams, oranges, coconuts, lemons, tomatoes, and nuts and spices of all kinds (Cain, Bowman, & Hacker, 2008). Farmers have domesticated more than 24 species in Amazonia alone (Smith, Williams, & Plucknett, 1991), while indigenous populations have implemented more than 2,000 (Taylor, 2004). Tropical rainforest agriculture derivatives account for twenty-five per cent of all commercial pharmaceuticals, yet researchers have tested less than one per cent of the total number of plant species for potential medicinal uses (Cain, Bowman, & Hacker, 2008). Scientists can only make guesses as to what the full extent of the Amazon's biodiversity offers, but markets often fail to see the importance of this potential (Union of Concerned Scientists, 2002).

The diversity within tropical rainforests has confounded scientists for ages, but a basic understanding of rainforest biology is necessary to gain a full understanding of the damage caused by soybean production and the associated deforestation. Terborgh (1992) attributes part of the tropical rain forests' biodiversity to their relatively large areas and minimal temperature variance due to climatic symmetry across the equator, but admits that this only reveals part of the answer. Part of this logic complies with the concept that one larger area of land will carry more species diversity than smaller, isolated pieces of land, even if they are of the same size. With the fragmentation of the Brazilian Amazon, especially with timbering roads, deforestation separates species into many smaller, isolated "islands" of trees. By separating the organisms, the forestry interrupts natural

genetic drift; where species would have been able to interact with larger population numbers, they must reproduce within a smaller sample of organisms. Another hypothesis (Janzen, 1967) suggests that the species of the rainforest are unable to tolerate large degrees of climatic variation; the mountains within the tropics would change temperature and humidity to the point where smaller groups would be isolated.

There are a few implications for either scenario. In early models, one might see populations begin to separate by their characteristics. Middleton (1991) raises such an example, where a rubber plant's close relative is resistant to South American leaf blight (*Microcyclus ulei*). If deforestation separated these plants when a case of fungus spread throughout the region, it could mean the extinction of an entire species. This model, of course, is not the only scenario ending in species extinction. If enough geographical separation took place between different organisms, or if over-exploitation occurred, they would not be able to reproduce.

Such species extinction is not outside of imagination. Researchers recently discovered that the amount of land per rainforest fragment needed to maintain the current bird species richness within the tropical rainforests was already larger than that currently held (Cain, Bowman, & Hacker, 2008). Species extinction has begun in some tropical rainforest areas where settling has taken place, such as Costa Rica. Monteverde, Costa Rica, was the only place in the world where the golden toad existed naturally; it was also the location where American Quakers retreated from World War II. This toad was once a proud symbol of Costa Rican heritage; it became extinct in the late 1980s (Terborgh, 1992). Surely, such species devastation takes place without the knowledge of the

scientific community; the Brazilian Amazon is not immune. While researchers have not even identified all tree species within the Amazon, estimates are that twenty to thirty-three per cent of Amazonian trees would become extinct under current deforestation rates (Butler, Mongabay, 2008). However, the threat does not end at biodiversity.

CLIMATIC EFFECTS WITHIN THE BRAZILIAN AMAZON

Deforestation is the most visible effect of soybean production within the Brazilian Amazon, but accompanies equally lack-luster impacts to the Brazilian climate. The climatic impacts of soybean production include changes in the global hydrological system, increased net emission of greenhouse gas, increase in temperature extremes, changes in nutrient exchange, and changes in soil composition. Before approaching these changes, however, one must first understand the unique climatic offerings of the Brazilian Amazon.

Geographical positioning of the Brazilian Amazon provides minimal temperature fluctuation throughout the year (23 to 27°C throughout the year (Terborgh, 1992)). As the title of tropical rain forest might suggest, the Amazon lies between the Tropic of Capricorn and the Tropic of Cancer. Sunlight strikes the surface of the earth at a ninety-degree angle, providing sun exposure for twelve hours a day consistently throughout the year (Butler, Mongabay, 2008). As the name also suggests, the region characteristically receives high amounts of rainfall: at least 2,000 mm (80 in.) annually (Terborgh, 1992). High humidity results from the high levels of sunlight and rainfall; researchers hold that the Amazon recycles twenty to thirty per cent of its water, suggesting that the other

seventy percent is cycled to other locations (Fearnside, 2005), exhibiting its role within the global hydrological system.

Greenhouse gas exchange has become the highlight of many studies over the recent decade as the threat of global warming has become evident. The Union of Concerned Scientists released a report (2002) briefly discussing the role of forests within carbon sequestration. Within the United States, forests serve as carbon "sinks", sequestering more carbon than they emit; this is due to the reestablishment of growth on abandoned land, changes in logging practices, suppression of wildfires, and increased growth of trees from higher levels of carbon dioxide. The net carbon flux within the tropics, however, is around zero; the forest allows for the balance of carbon exchange. As the Amazon tropical rainforest accounts for 40 percent of South America, it provides one of the greatest resources for global carbon sequestration (Butler, Mongabay, 2008; Union of Concerned Scientists, 2002). Amazon trees contain carbon equivalent to 1.5 decades of the current annual carbon emissions attributed to man (Soares-Filho, et al., 2006).

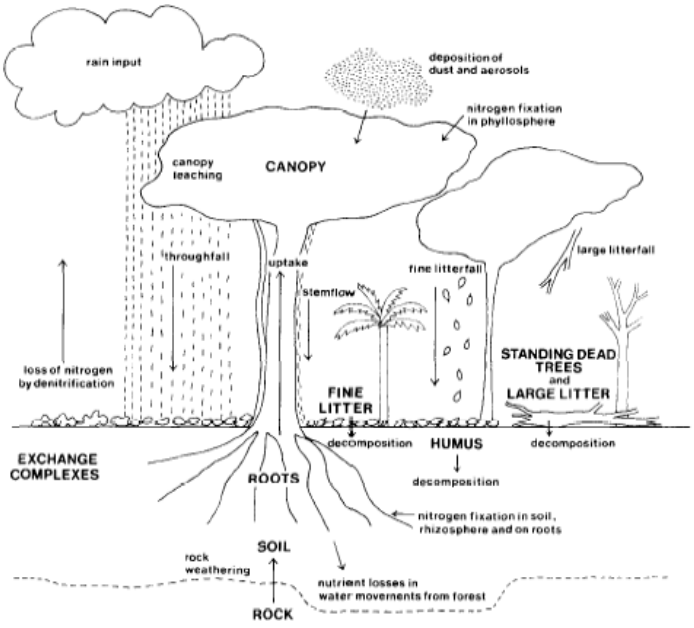

Figure 2.4 This diagram depicts the nutrient recycling process within tropical rainforests (Proctor, 1987).

Nutrient exchange within the virgin (primary) tropical rainforest is very complicated. Proctor (1987) discussed nutrient cycling within primary rainforests, regarding nutrients to include all elements essential to plant growth other than carbon, hydrogen, and oxygen (see Figure 2.4). Nutrients enter the rainforest with rain, deposition of dust and aerosols, fixation by microorganisms (nitrogen), or through weathering of rock (except nitrogen); they are stored primarily within the canopy, flowing downward as more rainfall enters the system or as organic materials decompose. Plant roots take the nutrients up, starting the cycle over. The cycle is not perfect, however; nutrients are lost primarily through erosion, fires, loss in drainage water. While tropical rainforests are fertile, the soil is generally nutrient poor. What the soil lacks in nutrients, however, the climate makes up for in rapid decomposition and nutrient recycling (Terborgh, 1992).

CLIMATIC CHANGES RESULTING FROM SOYBEAN PRODUCTION AND DEFORESTATION

The first obvious effects of soybean production within the Brazilian Amazon deal with pesticide and fertilizer uses; indeed, farming the crop pollutes local water tables (Nepstad, Stickler, & Almeida, 2006). A study on pesticides (Hurtig & Sebastian, 2003) discussed the dangers of agrochemical use. Developing countries account for 25percent of deaths associated with pesticides; toxic pesticides that may be too dangerous to be sold in countries where they are made are left completely unregulated. Furthermore, working conditions are poor, and protection is limited. Estimates suggest that 80 percent of diagnosed acute poisonings in Central America stemmed from organophosphates,

carbamates, and paraquat – three pesticide types incorporated therein. This study did not take into account the additional damage occurring with increased levels of runoff.

Farmers must implement lime, manure, and other nutrients to rise beyond the natural limitations of the Amazonian soil because it is not very fertile to begin with (Brown, 2005). Nitrogen in the ground rests in an unusable form; the addition of such fertilizers converts it into a form usable for biological processes. However, excess converted nitrogen runs off into the groundwater. Streams act as filters for the natural levels of nitrogen, but the excess nitrogen they are unable to process could lead to the depletion of oxygen and death of aquatic life (United Press International, 2008).

The majority of rainforest deforestation takes place in close proximity to roads. The roads draw in settlers, farmers, ranchers, and loggers. As individuals move in, the canopy becomes thinner and thinner (Brown, 2005). The sunlight responsible for the overwhelming vegetative growth now becomes responsible for the loss of soil fertility; as the soil gains exposure to the direct light, no canopy is present to protect the natural moisture. The soil dries, and plants begin to die off; with limited protection from the sun, temperatures increase dramatically (Galovich, Sander, Watmough, & Innes, 1996). With a now dry climate, the understory becomes vulnerable to fire (Nepstad, Stickler, & Almeida, 2006).

Individuals clearing the rainforest usually use slash-and-burn techniques to conqueror the thick growth. While they may hold restricted intensions for the fires that they start, the dried soil fosters the undergrowth to a state of kindle (Nepstad, Stickler, & Almeida, 2006). These fires are a leading cause of human-caused carbon dioxide

emission (Union of Concerned Scientists, 2002). Even if human-induced burnings were controlled, the now-dry climate fosters natural fires; the driest periods of the year are now the annual fire season (Brown, 2005). The fire consumes the nutrients within the soil, removing what little nutrients were present for future vegetation. The lack of plant life furthers the process of erosion, rendering the soil useless and susceptible to forming dust storms (Galovich, Sander, Watmough, & Innes, 1996). This depleted soil is now the foundation for the future pastures.

Without moist soil, the territory of the rainforest breeds a much different atmosphere. Fearnside (2005) discusses the "hydrological regime" of the rainforest in detail. When precipitation falls within the deforested areas, it quickly runs off, washing away whatever nutrients may be left. Areas once characterized by rivers and streams fall victim to flash flooding. Increased deforestation has led to reduced water recycling and sharing, as exhibited by blackouts caused by low water levels in hydroelectric reservoirs outside of the Amazon. Interestingly, deforestation actually increases the amount of precipitation experienced at the edge of deforestation; this could possibly create an illusion of climatic improvement as deforestation progresses. The edges are actually taking water from natural jet streams – further weakening the greater region's atmosphere. After the increase, a downdraft forms which delivers dry air to the edge of the forest. This inhibits additional rainfall, leading to further drying of the edges. The thirsty forest edges dry, leading to more fires and the continuation of the destructive cycle.

The reduced amount of forest also means the reduced amount of carbon sequestration (Union of Concerned Scientists, 2002). Furthermore, the combustion of forest during fires releases additional carbon dioxide (Fearnside, 2005). With the deforestation complete, the carbon dioxide released does not have a host of sequestration; thus, each time the cycle of deforestation progresses, it releases new amounts of carbon dioxide into the atmosphere without compensation. What was once a local ecological issue now holds unknown global climatic repercussions. Worse yet, greenhouse gases released through other global actions further compound the issue as temperatures increase and carbon dioxide builds in the atmosphere.

"Destroying rainforest for economic gain is like burning a Renaissance painting to cook a meal."

Edward O. Wilson, American naturalist, biologist, and author

CHAPTER 3: THE PRICE OF DEVELOPMENT

The basic schematic of soybean production in the Brazilian Amazon covered up to this point is, at a first-glance, simple to follow. The growing global population and economic development of countries has lead to a heightened demand for meat production. In turn, this demand has stimulated the development of new feed industries; due to high protein content, soybeans are a leading feed choice. The production of soybeans and cattle ranching within Brazil have required the development of transportation systems and farming plots. These plots threaten the Amazon rainforest. While the forest destruction holds obviously detrimental implications, the developmental decisions made within Brazil have caused harm to the Brazilian society.

THE BEAN AND THE PROCESS

Soybeans are a major staple to the diet of most U.S. citizens, whether they know it or not. Lambert (2008) noted that soy is in nearly sixty percent of the processed foods they consume, and that soy used as feed accounts for about ninety percent of soybeans produced. To the Chinese, it was a staple in *chiang-yiu*, soy sauce. In turn, *chiang-yiu* was called *show-yu* by the Japanese. From here, the word was contracted to *so-ya*, and then to *soy-a*. Sometimes Europeans still call it soya, while Americans generally deem it

soy. Charles Linnaeus deemed the bean *Glycine max.*, with *Glycine* meaning sweet (Kahn, 1985).

The bean is unique, and serves as an ideal agricultural feed source. An average sixty-pound bushel of soybeans contains 35% protein, 18.5% oil, and 5% fiber; when crushed, it yields eleven pounds of oil and thirty-eight pounds of 44% protein meal (Maier, Reising, Briggs, Day, & Christmas, 1998). As a comparison, this is three times the protein of wheat or corn, three times that of eggs, twice that of beef, and twelve times that of cow's milk (Kahn, 1985). Soy plays a vital role in feeding and bulking up livestock and other agricultural animals; producers crush eighty-five percent of soybeans (the other fifteen percent remain uncrushed), of which they use ninety-eight percent as feed. The producers separate the protein meal from the oil, and use ninety-five percent of that oil in food production. They use the remainder in soaps, biodiesel, and fatty acids (Soyatech, 2000). The magic of the bean continues.

Lambert (2008) deemed the bean "one of nature's Swiss Army knives", in reference to its multiple uses. Ford recognized the bean as a potential industrial ingredient; manufactures have used parts of it in "bottle caps, pencils, diesel fuel, dusting powder, enamel, disinfectants, paints, face cream, firefighting foam, linoleum, nitroglycerin, cement, wallboard, oilcloth, and varnish" (Kahn, 1985). Kahn (1985) also noted that, for a while, a Ford vehicle contained at least two-pounds of soy product. The bean's flexibility has taken it far beyond the roots of soy sauce, but as you have seen, its production has come at a cost.

The bean brings complications beyond the field and into the household. For Brazilian workers, the bean means the change of life. Soy is a "remarkably non-labor-intensive crop to grow," with only one worker needed for every 400 hectares (Lambert, 2008). Genetically modified versions are more expensive and resistant to herbicides, a detail that explains the presence of such GM soybeans within the United States. Lambert (2008) also stated that mechanical harvesting is the most efficient means to gathering the ripe crop, further separating the independent farmer from the large-scale farmer. The pesticides associated with soybean plantations drain into local water sources, changing life in yet another way for the local populations (Fearnside, 2001). Unfortunately, the social implications carry on further.

ECONOMIC DEVELOPMENT, OR SOCIAL REPRESSION?

The increased technologies introduced with the European settlement of the Amazon changed life in the tropical rainforest forever. While the native populations cut or burned perhaps 1 hectare per year (leaving large trees, as they were unapproachable with the limited technology), the mestizo populations were able to forest more than 3 hectares per year (conquering even the larger trees). Where the forestry of large hardwood trees changed the structure of the rainforest, the European influence and trade system changed the social scene of Brazil forever. The sugar industry, introduced in 1560 and ruling Brazilian economics for the following century, increased the destruction of Amazonia and her people: slaves worked in the intense heat through the backbreaking work of clearing trees, hoeing land, building and managing sugar mills, and harvesting

the cane (Williams, 2002). A social caste system formed, and the indigenous that survived disease and "civilization" were at the bottom.

The following centuries saw economic changes: gold speculation replaced sugar cane production in the 1700s, cattle ranching replaced gold speculation in the 1800s, and coffee plantations joined cattle ranching in the late 1800s and early 1900s. However, the same basic social structure remained. From the early times of sugar production, the Portuguese influence had placed those who were whitest as the head of land and forest patronages. As deforestation carried the Brazilian workforce deeper into the rainforest, the ranchers and farmers found an ever-ready work force in the indigenous populations. The development brought changes to the living standards of the indigenous people, including the poisoning of water (through mercury use in gold speculation), the destruction of river systems (through remains after foresting and intentional damming), the loss of fish populations (through river drought and mercury poisoning), and destruction of soil suitable for sustenance crop growth. Governance over the tropical rainforests was limited; land speculation through squatting was common, and remains so to this day. Each economic twist required additional transportation infrastructure, additionally requiring the destruction of more forests and the exposure of new indigenous peoples to a new lifestyle (Galovich, Sander, Watmough, & Innes, 1996).

The 1900s brought about the complex relationship between rubber tappers and the indigenous people of the Amazon, as revealed by Denise Zmekhol's documentary *Children of the Amazon* (2008). Rubber tapping began yet another force of oppression against the natives. When tappers first settled the forest, they, too, offered the indigenous

cultures they met a piece of "civilization", in the form of tools, clothing, and disease. The indigenous of Brazil fell victim to yet another economic revolution, one that established even more footpaths through the forests and left more natives in conditions of forced labor.

The military government gave land to settlers in hopes of achieving economic success, but failed to leave a plan to protect the Amazon or the indigenous populations inhabiting the forest (Zmekhol, 2008). The settlers assassinated tribal leaders and entire villages; in 1993, an entire village of Yanomami Indians was massacred (Galovich, Sander, Watmough, & Innes, 1996). As the native cultures died, so did songs, stories, and religions. The tappers lived amongst the natives in the forest, using the same agricultural riches that had sustained people in the forest for centuries. Eventually, many natives became tappers themselves (Zmekhol, 2008).

The end of struggle and repression was far from being over. While tappers were originally an adversary to the forest and her people, they soon fell victim to the same policies that carried them into the Amazon (Zmekhol, 2008). The Brazilian government, thirsty for development, begin implementing massive policies that would support the development and destruction of the Amazon rainforest through massive land-right grants and fiscal incentives. Specifically, the policies supported the formation of cattle ranches and the associated agricultural development (Nepstad, Stickler, & Almeida, 2006). Throughout the 1970s and 1980s, land rates in Brazil were at a premium, while the Brazilian government was pushing for economic stimulation (Fearnside, 2005). They supported migration to the Amazon regions through subsidization and lowered interest

rates on credit (Zmekhol, 2008). The Brazilian policies on land rights were lacking, and enforcement was minimal at best (Wallace, 2007). People migrated to the Amazon because freshly cleared land was easy to squat upon; additionally, the government supported the foundation of new agricultural entities as the primary source of economic growth (Fearnside, 2005). The increased migration brought new violence as large-stake ranchers forced small-stake farmers, indigenous, and rubber tappers off the land they wanted to plant (Nepstad, Stickler, & Almeida, 2006). Zmekhol (2008) records that several tribes have almost become extinct.

Where tappers and the indigenous had once competed for land rights, they now met the same challenges. The majority of the tappers were of mestizo decent, placing them in the same social category as the indigenous tribes. With new people relying upon the forest, territorial disputes became common. Where policies supported the migration of new settlers, they directly worked against the tappers and indigenous/mestizo tribes. Whether direct or indirect, no educational programs were in place to support the tappers and tribes people. (Zmekhol, 2008). The policies had to change, but the change was not going to come easy.

The tappers stood against the deforestation; resistors such as Chico Mendes began protesting the destruction of life in the forest and the associated educational repression. Through extensive lobbying, both in Brazil and abroad, Mendes made the plight of the indigenous and the rubber tappers known throughout the world (Revkin, 1990). This action gave the people a much-needed voice, but he also brought about danger to those standing in the way of "progress". Mendes began receiving death threats; a family man,

the tapper hired bodyguards in an effort to protect himself and his family. In 1989, the murder of Chico Mendes brought about more global attention to the conflict between the tappers and agricultural development in the Amazon (Zmekhol, 2008).

According to Revkin (1990), the death of Mendes brought about political and social upheaval, as discussed regarding Senator Robert Kasten. Upon hearing of the murder, the United States lamented the loss – complete with poor word choices. Senator Kasten stated in his speech, "The fact is, we need [the rainforests] and we use them – so they're our rain forests, too". The Brazilian government had felt that the United States were too involved in the Amazon even before Kasten's remark; this speech was simply fuel on the fire. The true plight at which Mendes fought for began to become lost within petty arguments, but eventually brought about new policy changes and support. While new policies intended to increase native land reservation holdings and reduce deforestation, what transpired was quite different (Zmekhol, 2008).

MANAGEMENT OF THE AMAZON

Brazil's government is stuck in a very difficult position. On one hand, the indigenous cultures and rubber tappers face repression and the rainforest is threatened by the agricultural development taking place; on the other hand, the country has a chance to continue massive economic expansion by taking advantage of the current shortage of soybeans. In recent years, they have decided to pursue economic expansion. While the expansion is not necessarily taking place by legal means, the increased exportation of soybeans is stimulating the economy (Wallace, 2007).

The policies enacted since Mendes' death have been mostly ineffectual (Zmekhol, 2008). Fearnside (2005) outlines the means of regulating Brazilian deforestation throughout the 1980s and 1990s. Primarily, the Brazilian government attempts regulation through repressive measures (ironically, upon the foresters this time), that remove licenses, placing fines, or performing inspections. Interestingly, these measures have had little to no impact: the rates of deforestation seem to correlate most fittingly with the state of Brazil's economy.

As Brazil entered an economic recession in 1987, increasing agricultural land holds in the cheapest way possible became the priority of many ranchers. Deforesting the tropical rainforest was the quickest and cheapest way to increase such land holds. The government's efforts to reduce the deforestation by punishment and policies were limited and ineffective until Brazil's "Plano Real" reform of 1994. These reforms increased the access to capital, and the years' election increased the availability to credit; as a result, 1995 saw a peak in deforestation (Fearnside, 2005). Nepstad, et al. (2006) reported additional attempts of regulation, including: the creation of 8-million hectares of land along the BR163 highway in which tilling was prohibited, the designation of 5-million hectares of park reservations, and the imprisonment of dozens of environmental enforcement agents suspected of corruption. While these measures undoubtedly decreased deforestation to a degree, they were still taken amidst attempts to expand the same industry that lead to the corruption the measures hoped to restrain. Furthermore, the policy makers did not give the policies the support necessary for true enforcement.

Wallace (2007) reported the plight of protection agency agents working for Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais Renováveis (IBAMA). The workers struggle against "grileiros," land squatters who forge land deeds and occupy the land through militant means. When farmers find the grileiros occupying their land, they can contact the IBAMA for support. In many cases, the IBAMA agents travel with far too limited supply of arms. They must purchase the gasoline to get to the locations of land squatting out of their own pocket. Some offices do not even have the internet.

Regulating the agricultural expansion is only one part of the larger need. The repression of the tappers and indigenous was what originally stimulated Chico Mendes to speak for his people (Zmekhol, 2008); the people of the Amazon are still not protected by their government. Zemkhol (2008) shows that the government established land reserves for the tappers and the indigenous , but, with the limited regulation of the agricultural industry and the grileiros, the plots of land have done little in means of social support (Wallace, 2007). Foresters all but ignore the reservation designations, as highlighted by Stephan Schwartzman (within Wallace, 2007): "Where Indian lands begin is where deforestation ends". Deforestation takes place even on the reserves; the loggers steal the land from the natives using logging as a tool to claim the land.

Following the death of Mendes, more people became activists for the cause of the Amazonian populations; the 2005 murder of Sister Dorothy Stang stands as proof that the repression still remains today. Buncombe tells the story of Sister Dorothy Stang (2005). Stang was an American activist and part of the Sisters of Notre Dame de Namur (a convent established to fight for social justice, specifically among poor women and

children). Following the death of Mendez, she carried on his vision by teaching sustainable agriculture and speaking out against deforestation. She read her killers a passage from the Bible before they murdered her. International patrons set up funds to help support the Amazonian populations (Revkin, 1990). Unfortunately, not all Americans stand against the deforestation and exploitation of Brazilian people that accompany the production of soybeans.

BRAZILIAN SOYBEANS AND INTERNATIONAL INFLUENCE

They primary resource regarding international influence on the Brazilian soybean industry lies within a two-year study completed by GreenPeace International of Brazil (2006). As the global demand for soybeans has grown, necessary support from foreign credit has become available through U.S.-based multinationals acting as both buyers and bankers. These corporations – ADM, Bunge, and Cargill – together finance approximately 60% of the Brazilian soy industry. Each of these businesses have primary corporate offices in the U.S. (ADM is based in New York, whereas Bunge and Cargill are based in Minnesota), and they provide soy as feed for both European and American meat producers. The report revealed several questionable business practices (see Table 3.1).

The three industrial giants directly support the paving of the "Soy Highway," BR163, an action that will doubtlessly increase the amount of deforestation. Bunge and Cargill also supported the construction of a second, illegally constructed highway through supporting farmers who build along the road (more than 100,000 acres of soy lie on the road). Furthermore, they constructed grain storage silos along the road. GreenPeace (2006) estimates that this could influence 2.6 million acres of tropical rainforest.

MAJOR TRADERS IMPLICATED IN ILLEGAL PRACTICES AND AMAZON DESTRUCTION

	ADM	Bunge	Cargill	Grupo André Maggi
Built infrastucture in the Amazon				
Number of silos within the Amazon biome	4	6	13	13
Port and storage facilities			●	●
Illegal export facilities - Santarém			●	
Received international financing				
Public banks – International Finance Corporation (IFC), World Bank				●
Private banks – Rabobank, HSBC, etc				●
Bought from farms involved in land grabbing				
Membeca Farm – Manoki indigenous land, Amazon biome		●	●	
Lavras Farm – Amazon biome			●	
Bought from farms inside proposed protected areas				
Rio Azul Farm – Parque Estadual das Castanheiras	tbc*	tbc*	tbc*	tbc*
Bought from farms employing slave labour				
Roncador Farm – Amazon biome	tbc*	tbc*	tbc*	tbc*
Vó Gercy Farm – Cerrado		●	●	●
Tupy Barão Farm – Amazon biome				●
Vale do Rio Verde Farm – Cerrado		●	●	●
Bought from farmers along illegal soya highway				
Saul Stefanello – Amazon biome			●	
Giovani Zamberlan – Amazon biome			●	
Eliseu Zamberlan – Amazon biome		●	●	
Agenor Favarin – Amazon biome		●		
Bought from farms planting GM soya				
Antonio Galvan, President of the Agricultural Union of Sinop – Amazon biome	●	●	●	●
São Carlos Farm – Amazon biome	●	●	●	●

*tbc - to be confirmed

Table 3.1 Greenpeace International of Brazil (2006) conducted an in depth study tracing the business practices of three United States multinational corporations (ADM, Bunge, and Cargill) and soy baron, Blairo Maggi. Their findings show that each was involved in several illegal practices.

All three corporations are guilty of constructing illicit storage silos near the Amazon rainforest. In fact, their facilities account for two-thirds of such facilities within the region. Cargill has even gone as far as constructing an illegal port facility, completely against the objections of local people and without completing proper environmental impact assessments. As if that were not enough, the corporation ignored court orders to complete such assessments, all while completing trade operations. Cargille and Bunge have constructed other silos in Brasnorte, a region close to a territorial reserve designated for the Manoki tribe. They have also purchased soy from a farm that has illegally cleared the territory. Silo construction and deforestation may seem not surprise the average consumer, but the violations do not end there, nor has the Brazilian government taken much action (Greenpeace International of Brazil, 2006).

The three corporations have each refused to sign the National Pact for the Eradication of Slave Labor. In three separate examples, they have also purchased from farms incorporating slave labor. Between 1998 and 2004, government inspectors released 215 slave laborers from Roncador Farm. The working conditions of these workers included: working sixteen-hour workdays (seven days a week), living in plastic structures without beds, drinking from cattle watering holes or barrels that once stored oil and lubricants, and purchasing restricted to farm shops for inflated prices. Other slave farms exist: Similarly, Vó Gercy (supplying soy to Cargill and Bunge, guilty of slave labor in 2002), Tupy Barão (supplying soy to Bunge after a raid freed 69 slaves in 2004), and Vale do Río Verde Farm (supplying soy to Cargill and ADM, guilty of using 263 slaves in 2005) (Greenpeace International of Brazil, 2006). In 2004, there were an

estimated 25,000 Brazilian laborers trapped in debt slavery (Nepstad, Stickler, & Almeida, 2006). One cannot possibly know how many similar operations are currently in existence, but one must hold the understanding of the true cost of soy.

"Inhabitants of underdeveloped nations and victims of natural disasters are the only people who have ever been happy to see soybeans."

Fran Lebowitz, journalist

CONCLUSION

Brazil is a country that has experienced centuries of exploitation with little progress in terms of economics. Global expansion has brought the demand of for meat production to an all time high. As soybeans provide a high amount of protein per bean, are able to be harvested mechanically, and can be modified to be resistant to pesticides, they have proven to be the choice agricultural feed grain. In fact, soybean meal is the world's leading protein source, and has the highest protein quality and overall nutrient composition of all common plant protein sources (Waldroup, 2007). Brazil has taken the demand for meat and soy production as an opportunity to expand their economical standing as an agricultural producer. As many European nations will only import non-GM soybeans and non-GM fed animals, Brazil has replaced the United States as the world's leading exporter of soybeans. Soybeans have become their number one export (Arbivatae, 2005). The current methods of development are having detrimental effects upon the tropical rainforest and upon the Brazilian people.

The wealth of the Amazon is both undeniable and astounding, accounting for more than half of the world's plant, animal, and insect species. It provides countless

pharmaceutical products, more than 3,000 fruits, and more than 20% of the world's oxygen. Furthermore, it offsets our presence through carbon sequestration (Taylor, 2004). The Brazilian Amazon contains about 40% of the worlds' remaining tropical rainforests; sadly, the location also hosts the highest rate of forest destruction (Laurance, et al., 2001). The Brazilian Amazon is slowly dying, and researchers project that, by 2050, the current agricultural expansion will remove 40% of the remaining trees in the Amazon (Soares-Filho, et al., 2006).

Cattle ranches currently occupy 80% of the land deforested in Brazil from 1996-2006 (Butler, Mongabay, 2008); a study conducted by GreenPeace International of Brazil has recently found that the production of soybeans has accounted for nearly half of all deforestation – in 2003, and one-third of the Amazon tropical rainforest clearing (2006). High production cattle ranching requires a ready and available feed source; for Brazil (and other major meat producers), soybeans are the perfect feed. As the Brazilian agricultural sector continues to expand soybean plantations and cattle ranches, more and more forest is lost. It is important to understand that cattle ranching requires the production of agricultural feed; this establishes soybeans as the leading cause of deforestation, and the leading threat to the biological powerhouse that is the Amazon. While biodiversity and the atmosphere fall victim to the destruction, the social atmosphere of the Amazon also changes.

Soybean plantations directly affect the people of the Brazilian Amazon in a number of ways. First, farmers plant the soybean plantations upon land that either 1) once hosted cattle ranches, but is now barren, or, 2) once was virgin rainforest, but has

been destroyed through slash-and-burn deforestation. The indigenous and rubber tapping populations could use this land for sustenance farming, rubber tapping, or gathering the Amazon's natural products. Second, the plantations require far fewer employees than the previously reigning rubber tapping industry did due to effective pesticides and mechanical harvesting; this equates to a loss of employment positions. Furthermore, the very way of life changes as migration introduces new cultures.

The development tears the families within the Amazon. The children want to learn the "way of the white", but the older natives frown upon this development. Languages and religions are lost as elders pass away (or, in some cases, as ranchers and their gunmen murder them). The competition for land and lack of suitable employment forces the villagers to work with the loggers that destroy their home. This labor, when discovered by the other villagers, leads to banishment (Zmekhol, 2008). Deforestation is only the first step of soybean production, and only the first step of social extortion.

Wallace (2007) recounts the familiar story of settlement. The soybean producers purchased (or stole) land from countless small-share landowners. Some viewed the amounts of money offered for the land as far more substantial that it actually was; they now reside in nearby slums. Those who did stay soon found their yards overran by vipers, bees, and rodents attempting to escape the fires and chainsaws destroying their home. Farmers and their workers felled trees to the edge of the properties to make way for the soybean plantations. Animals that the remaining farmers had set aside for food died from liberally applied toxic pesticides. Even those who tried to stay soon found

themselves moving. The destruction of the Amazon tropical rainforest continues to this second, all in the name of wealth.

The established ranches and soybean plantations remove vital employment positions as they implement mechanized processing and harvesting. Both still require limited employment, however. With tappers without trees and sustenance farmers without farms, the plantations have a limitless employee workforce. The plantations force the workers into slave labor. Unfortunately, these plantations are supported directly by U.S. ran multinational corporations (Greenpeace International of Brazil, 2006).

The current business practices driving the economic expansion of Brazil are irresponsible, and even socially barbaric. Destruction of the tropical rainforest is unsustainable; using slash-and-burn techniques to destroy carbon-sequestering trees only expands the footprint left by the destruction. Destroying biodiversity that holds countless industrial possibilities with incalculable value is equally as senseless. Supporting an unsustainable industry through the destruction of indigenous and economically deprived communities only increases the irresponsibility driving the industry. However, simply denouncing the current path to economic development is not enough. Any criticism must be supported by viable and appropriate solutions to the current problems.

TAMING THE BEAN

The global demand for soybeans continues increasing, regardless of the current trends in the Brazilian market. A recent article has projected a possible price increase within non-GM soybeans of six-hundred percent within the next two years (Lambert, 2008). The path to tropical rainforest preservation does not run parallel to the current

economic path that Brazilian government and businesses follow. To create a sustainable and sufficient change, any solution should address the ecology and biology of the tropical rainforest, the delicate nature of balancing a developing economy while moving towards responsible business decisions, and the social structure driving that developing economy. To produce such a solution, there are three basic areas to examine: 1) Brazilian federal policies, 2) farm techniques and procedures, and 3) the role of international involvement.

Many critics have attacked the current Brazilian legislation as being inconsistent; the government has made many efforts to curb the deforestation, but those efforts have failed (Arbivatae, 2005). The current policy focuses on short-term success, rallying colonization and making the land cheap in an effort to extend their grasp on soybean market holdings as far as possible, and as quickly as possible (Laurance, et al., 2001). What it neglects, however, is the future of the Amazon. Current plans focus upon creating large-scale infrastructure to support the expansion of soybean and cattle industries; plans such as these are irresponsible without conducting environmental assessments and cost-benefit analyses (Kirby, et al., 2006), especially when recent studies have indicated that deforestation is highest in the proximity of roads (Pfaff, 1997). Legislatures should make any policy decisions only after considering the complete social and economic costs (Fearnside, Soybean cultivation as a threat to the environment of Brazil, 2001). Having economic expansion as a primary goal, without considering the associated environmental impact, is obviously not going to protect the tropical rainforest from destruction.

Protecting the tropical rainforest could be a wise economic choice. Researchers recently conducted a study modeling expanded Brazilian governance with current economic and ecologic trends. The results showed supported that expanded governance would result in carbon sequestration and the avoidance of carbon emissions greater than that achieved during the first compensation period of the Kyoto Protocol by eight times (Soares-Filho, et al., 2006). Expanded measures of governance should reinforce and expand the protected land reserves (Soares-Filho, et al., 2006); the current reserves have proven beneficial, but they are still very limited.

Absolute restriction on soybean and cattle production would equate to losing positions in the associated global markets. Such limitations would not financially allow Brazil to expand into new, sustainable markets. However, current trends of deforestation will lead to the ultimate demise of the tropical rainforest, and to expansion within the agricultural production industries as the accompanying environmental changes begin to take place. To slow the current rates of deforestation outside the reserves, the government should require additional logging certification (Fearnside, 2001).

Federal subsidies have bolstered the Brazilian market even further than the current soybean shortages would carry the market; as this shortage remains, market growth would be feasible without the support of these subsidies. While the subsidies have drawn farmers into the previously unsettled territory, the high demand of soy and cattle is enough to bolster the economy without additional assistance. The removal of such subsidies would likely cause the market to decelerate, but not enough to cancel growth entirely (Fearnside, 2001). Aside from the subsidies, the government has issued

amnesties forgiving debts or has accepted small payments with a lower interest. In order to return the market to a natural growth, these practices should stop (Fearnside, 2005).

These policies will not be popular amongst soy and cattle barons, but are necessary to slow the current trends of deforestation and allow for a sustainable future economy. To gain support from the opposition, the government can include reward incentives for those abiding to the policies (Nepstad, Stickler, & Almeida, 2006); these rewards could include assistance to adhering farmers. ADM, Bunge, and Cargill have violated so many of the current policies, yet they are still exporting a high value product. By supporting the industries that adhere to the policies as they try to export, the government would be reinforcing the change they desire. Additionally, studies have indicated that involving the indigenous populations in the formation of new policies increases their effectiveness (Fearnside, 2003a).

Whether supported or opposed, new policies will be fruitless without proper enforcement, especially when constructed upon the foundation of decades of unenforced regulations. New policies should expand federal monitoring of the lands (Nepstad, Stickler, & Almeida, 2006). Currently, the agents responsible for policy enforcement are poorly equipped and under supported. Efficient expansion of any new policy would require increasing the number of agents and giving them proper equipment (Wallace, 2007); one must remember that enforcement agents are standing against hired gunmen.

Federal policy may be the foundation for change, but the individual farmer carries an equally important role. With proper farm techniques, the same farmers currently responsible for tropical rainforest destruction could be responsible for restoring the loss.

Biodiversity and interspecies relationships constructs the delicate mechanism of tropical rainforest ecosystems; studies have suggested that hundreds of years are necessary for biodiversity restoration (Brearley, Prajadinata, Kidd, Proctor, & Suriantata, 2004).

Maintaining the biodiversity of the region is not only responsible; it is necessary. Biodiversity and gene variance allows a population to overcome diseases, pests, and climatic shifts; losing this variance requires more pesticides and increases water dependence (Smith, Williams, & Plucknett, 1991; Lambert, 2008). The slash-and-burn techniques currently used may be rapid, but they destroy the nutrients within the soil and damage the atmosphere (Laurance, et al., 2001). Ceasing this destructive clearing will result in soils that are more fertile and will require less deforestation, allowing for land use that is intensive rather than extensive (Laurance, et al., 2001).

Soybeans may not even be the only business avenue to pursue. Studies have shown that using trees not only diversifies a plantation's source of income, but also can increase soil stability and protect water sources. Leguminous trees both add to soil stability and enrich the soil with nitrogen fixation (Smith, Williams, & Plucknett, 1991). While many leguminous trees do not produce common production crops, several produce fruits that could also be used as feed (such as silk tree, gliricidia and sesbania). Some studies have indicated that expanding sustainable gathering industries within the tropical rainforests may be more profitable than expanding the soy industry (Galovich, Sander, Watmough, & Innes, 1996), although the current demand for soybeans makes this an unlikely decision. However, expanding agroforestry and high-value perennial crops would allow for a safe fall should the soybean industry collapse (Smith, Williams, &

Plucknett, 1991). All of these changes are unlikely to occur with Brazil's current low land prices and aggressive development models (Laurance, et al., 2001), but would allow for an economic structure that is more sustainable and appropriate for long-term growth

The final area for examination lies outside of the Amazon. As Brazil's tropical rainforest plays into the global climate schematic, and offer countless benefits through species diversity and potential products, the cost should also be global (Soares-Filho, et al., 2006). The first step towards progress in the Amazon lies in ceasing poor business decisions. The role of Cargill, ADM, and Bunge has established the United States as an unworthy role model. Greenpeace International of Brazil demanded that soy no longer be purchased from companies using slave labor; in fact, they rallied purchasers to no longer buy *any* soy from the Amazon region (2006). They also called for traceability systems that would allow businesses to verify where products are from, under what conditions they were grown, and the overall impact of their production. While ceasing all purchases of soy from the Amazon is unlikely, other changes are reasonable and responsible. If food producers were to implement such a traceability system, the individual would gain a role within responsible purchases. By taking steps towards green agricultural industries, the U.S. would beam as a positive role model for responsible environmental choices.

Direct support is another means by which international supporters can aid Brazil. Some ideas include development banks, commodity groups, and foundations to develop conservation strategies (Smith, Williams, & Plucknett, 1991). Brazil has recently established one such voluntary fund, the Amazon Fund; this allows developed countries, businesses, and other financial entities to support the battle against carbon emissions

through donations (Butler, Mongabay, 2008). As Brazilian funding towards conservation research is limited, international funds could also be channeled to solidify research facilities and local institutions (Smith, Williams, & Plucknett, 1991).

REACHING TOWARDS A POSITIVE FUTURE

Brazilian government has recently began taking positive steps against the destruction of tropical rainforest for the production of cattle and soybeans. While now somewhat dated, increased enforcement within the Mato Grosso region in 1999 showed reduced clearing rates in recent frontiers (Fearnside, 2003b). Decreased clearing in areas of high enforcement reflected a successful effort. Thus, Fearnside (2003b) concluded that is possible for the Brazilian government to stand above the deforestation and to regulate the growing industries. As time has passed, the industries may now have become more entrenched in faulty business practices; this could possibly challenge Fearnside's conclusion. The study conducted by Greenpeace International of Brazil (2006) resulted in a crackdown on Cargill. They are currently reaching the end of a two-year moratorium on buying soy from the Amazon, and were reported as discussing how to resolve the situation (Wedekind, Tofu's Underbelly, 2007). Unfortunately, these two examples of policy enforcement are the only available as examples; while they depict steps in the right direction, the battle remains in the very early stages.

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