Sustainability Analysis of African Palm Biodiesel in Ecuador:

An Environmental, Socio-cultural, and Artistic Perspective

By

Naomi A. Tuinstra

A PROJECT

submitted to

Oregon State University

University Honors College

In partial fulfillment of
the requirements for the
degree of

Honors Baccalaureate of Science in Environmental Science

and the degree of
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Presented May 30, 2008
Commencement June 2008

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Abstract approved: ____

William Hetherington

In the thrust to shift away from fossil fuels towards renewable options, Ecuador produces African palm-based biodiesel, which is currently imported by the Unites States. An analysis of this specific interaction was done via personal contact with the industry in Ecuador and extensive literature review of the topic. The results are categorized according to environmental sustainability, socio-cultural sustainability, and artistic representation. Environmentally, and energetically, the sustainability of this endeavor is questionable. Socially, it exacerbates existing social inequalities and further impedes on the lands and cultures of marginalized populations within Ecuador. This report presents a detailed description of the involved processes and parties, as available data allowed. This thesis ultimately generates a set of relevant questions vital for crucial further investigation. With additional quantitative research, the sustainability of this fuel could be determined definitively, contributing to the necessary establishment of sustainability regulations for renewable fuels.

Key words: Biodiesel, African Palm, Renewable Energy, Ecuador, Indigenous

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I understand that my project will become part of the permanent collection of Oregon State University, University Honors College. My signature below authorizes release of my project to any reader upon request. I also affirm that the work represented in this thesis is my own work.

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Naomi A. Tuinstra, Author

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Introduction

The dependency the United States has on petroleum has been of concern for decades and in recent years has been the driving force behind expanding research in alternative fuels. There are three major reasons that the United States needs to reduce its use of petroleum based fuels; they are non-renewable, encourage foreign dependency, and when burned emit a tremendous amount of pollution. Switching to a magical fuel that solves all three of these problems is nearly impossible, which is one of the reasons there are so many different alternative fuels currently being researched and tested for feasibility. One of these fuels is biodiesel, a fuel created through the chemical processing of vegetable-based oils such as canola or soybean oil. Due to the wide variety of vegetable-based oils that can be used in this process, a large number of crops are being used to make this type of fuel across the world.

Attention is increasingly focused on the promising potential of one tropical crop with the highest purported yield per acre of oil; African palm. Production of biodiesel made from this palm is climactically limited, as the crop can only grow in tropical areas that lie within ten degrees latitude north and south of the equator (Jessen 2007). These equatorial regions are tropical rainforests that are usually inhabited by communities who are struggling to survive in our ever globalizing world. These characteristics associated with the palm-oil production process create a complex dynamic between the need for alternative fuels and the potential for the destruction of rainforest and indigenous lands and cultures.

Of the many countries involved in this industry, Ecuador is of particular interest. The United States imports biodiesel from Ecuador, among other countries, linking us as Americans personally to the issues of Ecuador's industry. Indigenous communities are outraged at the way they claim to have been treated by the oil palm plantation industry. They have described their relationship with this industry similarly to the way they are treated by the petroleum industry: unfair and unjust. This particular case of alternative fuel production leads to a number of moral questions as well a need for a thorough scientific analysis of the efficiency involved in its production. There are issues of decreasing yields, soil degradation, deforestation, chemical uses, efficiency (of the palm plant to create oil as well as of that oil to be used as a fuel), land rights, economic disparities (both international and domestic), and transportation.

Objective

The intent of this analysis is to provide a basic framework for a future quantitative analysis of the sustainability[1] of African palm-based biodiesel in Ecuador. This is meant to be a preliminary analysis which assimilates the various aspects associated with the production and distribution of this energy source. Two observations govern the objectives of this document:

1. The necessity of thorough analysis of renewable energy sources, incorporating many fields of science, all of which must be addressed when deciding which are the most

practical and efficient for use. This results in a comprehensive conclusion to the overall environmental sustainability of each energy source.

2. Beyond environmental sustainability, many other factors contribute significantly to the feasibility of each renewable energy source. For all renewables, and especially biofuels, the history, politics, culture, and societal structure of each location in which production and distribution occurs must be addressed. The interplay between these aspects and those of a scientific nature must be considered for each potential source of energy.

Methods

The motivation for this project is as multifaceted as the project is. Personal experience in Ecuador and with renewable energy in general inspired the research. I participated in the Oregon University System Study Abroad program at La Pontificia Universidad Católica de Ecuador from January through July of 2006. During this time, I lived with a host family, took university classes, and travelled throughout Ecuador. The classes I enrolled in informed this project and reflect my personal interests. In addition to Spanish language and Ecuador culture classes, I also took Desarrollo Sustentable (Sustainable Development), Educación y Interpretacion Ambiental (Environmental Education and Interpretation), Artes Plasticas (Plastic Arts), and Dibujo I (Drawing I).

The following summer, after having decided on the topic for this project, I visited the country again to observe and learn as much as possible about African palm biodiesel production in Ecuador. In July of 2007, I was able to talk with industry engineers and agronomists from ANCUPA, and view many plantations. I was also able to meet with some environmental groups opposed to the plantations while I was there.

Since my return from that trip through the completion of this project, extensive literature review was done in both Spanish and English.

CHAPTER ONE: ENVIRONMENTAL SUSTAINABILITY

1. Introduction

1.1. The logic of finding and using fuels

"We cannot solve our problems with the same thinking we used when we created them."

-Albert Einstein

To begin, it is essential to understand how fossil fuels and biodiesel feedstock crops fit into the global carbon cycle. Fossil fuels are essentially organic matter that was deposited in low-oxygen aquatic environments millions of years ago and was covered by sediments. Over time, the organic matter has been exposed to high pressure and temperature as well as various bacterial processes transforming it into the liquid that is extracted for refinement and eventual use as a fuel. The carbon that made up the plants and animals that died to create these deposits of organic matter was once circulating through the active carbon cycle on Earth. When it reached a depth at which it can no longer be recycled by life processes on Earth, it is no longer part of the current carbon cycle as it, without human intervention, would not return to the surface to be used. As oil is discovered below the surface worldwide, this otherwise eliminated carbon is brought back into the cycle, increasing the overall amount of carbon present on Earth in all forms.

Fossil fuel use has created a culture, in many developed, and some developing countries, of unlimited supply for constant use. Current populations have grown used to watching the price of crude oil effect the price paid at the pump, but have not yet had to internalize a change that will not only require a switch from petroleum based fuel to another, but to a combination of several alternative fuels. When discussing the various sources of energy to which the switch may occur, the current dependency on our one type of 'reliable' fuel is obvious. The world is looking for *the* answer to the rise in oil prices and this indicates that one source of fuel will be capable of replacing the current use of fossil fuels entirely. The singular reliance our societies have on fossil fuel is the root cause of many crises, as an alternative is not widely used when supply is decreased. As more and more fuel sources are discarded as unsuitable to replace the current use of fossil fuels in its entirety, it becomes obvious that a shift in thought is necessary. The answer to our current energy crisis will not be found in any one source, but in a combination of different sources, which are location specific, and sustainable only when used locally. The basic principles of Earth processes and mechanisms inform the futility of searching for one single source of the future's energy. The Earth is a diverse system with intricate history and infrastructure that varies considerably by location. While these systems are relied upon in order to produce sustainable yields of energy, it is these same systems that are simultaneously ignored in the search for a universal 'new oil'.

1.2. Holistic analyses of alternative fuels

Biodiesel changes the carbon cycle in a different way as the carbon used in it comes directly from plants grown as part of the current carbon cycle. These plants absorbed carbon dioxide and incorporated that carbon into the flesh of their bodies, which in the combustion of biodiesel is again released into the atmosphere as carbon dioxide.

This could be classified as a ‘closed loop’ system in that there is no net loss or gain of carbon to the current cycle.

On a small enough scale, and when consumed locally, this would be considered sustainable, as it is unlikely that using the oil from one African palm tree in your back yard and burning it as fuel would change the global distribution of carbon. Concerns arise, however when biodiesel production reaches a global level where in turn, global impacts become possible. For example, forested areas or grasslands are carbon sinks, or absorb carbon from the atmosphere at a faster rate than they release it. When land that was a forest is converted to agricultural land to create biodiesel feedstock crops, this is no longer the case. At best, the area would become carbon neutral, in that it would absorb the same amount of carbon as is released in the burning of the fuel.

Beyond the land use changes, the processing, transportation, and distribution of the fuel adds variables to the carbon equation. In order to determine if, in fact African palm based biodiesel creates more energy than is used in its production, careful analysis of both the plant as an agricultural crop, it’s processing into biodiesel, and the subsequent transport is necessary.

2. Biodiesel

The process of creating biodiesel from vegetable oil is fairly straight forward. In the presence of a catalyst, an alcohol is used to replace the glycerin molecules on the fatty acids in the vegetable oil. The common catalysts used for this reaction are either potassium hydroxide (KOH) or sodium hydroxide (NaOH). This reaction is done under heat and by mixing. Figure 1 shows the generalized reaction for vegetable oil.

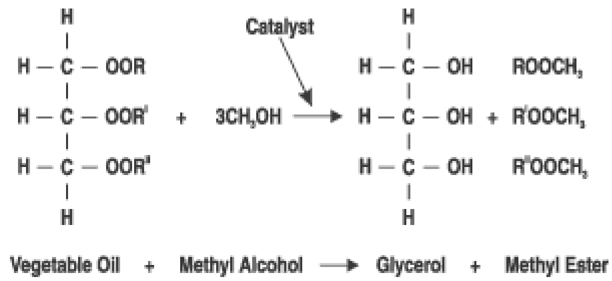

Figure 1: Transesterification Reaction (Van Gerpen 2005: 28)

The products of this reaction are the methyl esters, which is the biodiesel, and glycerol. Glycerol is usually sold industrially for use in the production of such products as soaps (Van Gerpen 2005).

2.1. Environmental claims and validity

When biofuels were first proposed as the answer to the current oil crisis, little thought was given to the validity of the environmental benefits being claimed. Often, using the world 'bio' in the label of a product is an excellent marketing tool to lure in green-minded consumers who have little scientific background or curiosity. Due to lack of regulation and research in this somewhat new market of biofuels, products are often attached to claims about their environmental impacts or lack thereof that are not supported with scientific research. More and more research has been done recently to attempt to quantify such claims and to produce useful comparisons.

For example, since the primary goal in creating biofuels is often to deal with global climate change and the contribution of greenhouse gases (GHG), it is useful to compare the total GHG emissions from petroleum to the total GHG emissions from biofuels. For both biofuels and petroleum, these estimates include emissions from transport and production as well as from the eventual burning of the oil as fuel. Often if a fuel has lower emissions when burnt than fossil fuels, this is conclusive enough to substantiate its environmental superiority. However, when the agricultural practices and processing of biofuel feedstocks are taken into consideration, the pendulum begins to swing the other way, suggesting is some cases that these new 'clean' fuels may actually be worse for the environment than petroleum.

One study done by a group of scientist from Austria, Germany, Britain, and the United States studied one specific piece of this puzzle; the additional GHG emissions produced from the application of nitrogen based fertilizers. One of the byproducts of fixed nitrogen application in agriculture is nitrous oxide or N_2O, which is an almost 300 times more potent GHG than an equal mass of CO2 (when comparing average global warming potentials) (Crutzen et al. 2007). When taken into consideration in calculations of overall emission reduction from petroleum standards, this study found that the production of many biofuels, including biodiesel from rapeseed among many bioethanol fuels, "can contribute as much, or more, to global warming by N_2O emissions than cooling by fossil fuel savings (Crutzen et al. 2007: 11192)". Although this study leaves many other factors out that would each require research, it contributes to clarifying the validity of 'green' fuels as truly being more environmentally beneficial than petroleum.

2.2. Addressing Global Biofuel Sustainability

2.2.1. European Union Standards

Because biodiesel is relatively new as a large-scale fuel source, no current framework for analyzing the sustainability of such fuels exists. The European Union has begun to address the sustainability of biofuels and is currently in the process of writing guidelines for determining the sustainability of such fuels. It is considering factors such as greenhouse gas balance, direct and indirect environmental impacts, and direct and indirect social and economic impacts (Gilberston 2007).

The task of certifying certain biofuels as ‘sustainable’ and others not is perhaps so large it may be impossible. The complications that arise are endless: agricultural practices vary considerably between countries growing the same crop, international trade of biodiesel adds differing quantities of fossil, or other fuel, to the equation as it is used in transporting the fuel varying distances, greenhouse gas balances are only short term analyses, and long term analysis taking into consideration changes to global climate conditions are not yet available, quantifying environmental and social impacts is a near impossible task without personal bias entering the equation, and the sustainability of a certain crop depends heavily on the scale and quality of its production.

2.2.2. Global Palm Incentives

The Global Subsidies Initiative (GSI), is a group of researchers that focus on the efficacy and appropriation of global subsidies with regards to development, and are funded by the governments of Denmark, The Netherlands, and New Zealand, among other private foundations. According to their recent report focusing on Australia, the Australian government spent $95 million Australian dollars in 2006-07 on “supporting biofuel production and consumption”, a number they claim will grow rapidly in the future when newer programs begin to come online (Quirke, Steenblik and Warner 2008). The number for the United States is reported to be $6 billion US and for the European Union it was $4.2 billion US. The GSI is critical of the effectiveness of such spending, categorizing it as indirect, and claims that subsidies are less efficient in reducing GHG emissions than other more direct ways of changing energy policies.

Whether or not these types of incentives have the largest impact on policy, recent changes in these policies by several countries including Australia, Britain, France, Germany, the Netherlands, Switzerland, as well as parts of Canada have attracted attention (Rosenthal 2008). As concerns rise about the environmental validity of biofuels, these forward looking countries are beginning to rethink the best option for renewable energy (Rosenthal 2008). At the same time, however, other countries, including the United States, are continuing with plans involving imported fuel feedstocks. Part of the problem in creating effective incentives that have the desired positive environmental impacts, and another reason a holistic analysis is necessary, is that incentives and policy are unspecific regarding feedstock sources, origins, and production practices.

3. Palm oil as Biodiesel feedstock

3.1. Energy Analysis

In order to determine if using palm oil as a source for biodiesel is the most energetically efficient use for it, the energy cost to produce the biodiesel must be compared to the amount of energy that is available for use in the finished product; the biodiesel. The energy content or gross heat of combustion of palm ethyl (refined palm biodiesel) is 39,070 kJ/kg (Van Gerpen 2005).

Following is a break-down of all foreseeable energy costs associated with the production, processing, and transportation of African palm based biodiesel from Ecuador to be used in the United States. The majority of the categories are followed by a series of questions that would necessarily need to be researched and answered in order to calculate the quantitative energy cost of this fuel. When possible, simple estimates of details and calculations have been included.

<u>Agricultural Costs</u>

Fertilizers applied

- What types of fertilizers are applied?
    - $(NH_2)_2CO$ (urea), KCl, $MgSO_4$, (2x/year)
    - Triple Superphosphate and $CaCO_3$ (1x/year)
- How much of each type of fertilizer is used for each application?
- What is the energy cost of producing, transporting, and applying each type?
- Are other resources necessary such as safety training and education or healthcare because of their uses? What are the energy costs of these services?

Pest/Herb/Insect/Fungicides applied:

- What specific chemicals are used?
- How often and what quantities are applied?
- What are associated energy costs of production, transportation, application, and management?

Labor Costs:

Fossil Fuel Powered Mechanized Labor:
- What percentage of the labor is mechanized?
- What is the energy cost of these machines?

Human Labor:
- How much human labor is involved?
  - 100-150 bunches per day per man can be produced (Duke 1996).
  - Therefore, one man could produce approximately 100-150 gallons of biodiesel per day (see Appendix for calculation)

Transport Costs:

Within Ecuador (truck):
- How far does each truck go with how much oil?
- What kind of fuel is used in the truck?
- What is the efficiency of the truck transportation?

From Ecuador to US (ship):
- How much energy is used to transport the fuel from Ecuador to the United States?

Within the United States for use (truck):
- How far does each truck go with how much oil?
- What kind of fuel is used in the truck?
- What is the efficiency of the truck's engine?

Processing Costs:

From fruit to raw oil:
- What is the energy cost for pressing the oil from the fruit?

From raw oil to refined biodiesel (additions of alcohol, etc)[2]
- What inputs are necessary?
  - An alcohol and a catalyst, and perhaps others.
- What percent waste is created?

3.2. Performance as a fuel

Although the properties of a vegetable oil are essential in determining the feasibility of oil for use as a biodiesel, this is not the focus of this report and will therefore not be discussed extensively. One property that is of some relevance however is the cloud point, which is defined as “the temperature at which the onset of crystallization is observed visually as cloudiness in the fuel” (Van Gerpen 2005: 21). Reported values for palm biodiesel range from 8-13 degrees Celsius (Van Gerpen 2005: 283). If this point is too high, it implies that this fuel could not be used in colder regions of the world where temperatures drop below this point, as the fuel would begin to solidify at these temperatures.

The reason this value is important to this report is because the Ecuadorian company La Fabril, has started to market a new “Cold-Flo Biodiesel” that they claim to be tested to -3 degrees Celsius and is guaranteed down to 0 degrees Celsius. This adds allure to the use of palm based biodiesel in more diverse and colder environments, as the low cloud point was formerly one of its biggest downfalls for potential biodiesel use (Business Wire 2006).

3.3. Ecuadorian Evaluation of Biodiesel from Palm

In order to understand the discussion in Ecuador about palm biodiesel and its potential on the global market, materials from La Asociación Nacional de Cultivadores de Palma Africana (ANCUPA, the national association of palm oil growers of Ecuador) were examined. I translated the following paragraphs and included them as representative of the Ecuadorian industry perspective regarding biodiesel[3].

> Biodiesel is the new market for African palm oil. It could become the primary substitute for petroleum. It is 100% biodegradable and non-toxic.

> There are magnificent expectations and potential for this product on a global level. (3)
>
> African palm is a crop without comparison in its ability to intercept solar energy and transform it to vegetable oil. The African palm ecosystem, when compared to other natural ecosystems of the humid tropics, has a net rate of biomass production equal to or even better than the tropical forest. Even though African palms are only planted in 2% of the oil crop lands, they contributed 22% of the global oil in 1990. (15-16)
>
> (Loaiza Granda 2006)

> A round table conference about biofuels held in Cuenca and Santo Domingo de Los Colorados was put on by the Ministry of Energy and Mines. Rommel Vargas, president of ANCUPA discussed the growth in African palm crops in Ecuador and emphasized the extraordinary global market for African palm oil providing real bio-combustible alternatives for the country. (5)
>
> African palm provides the possibility to include the South American *pueblos* in the global change in production of biodiesel. In an effort to emphasize the potential of South America to contribute to the global energy demands: Europe would have to dedicate 70% of its usable lands to produce even 10% of its energy and Brazil can use 0.5% of its land to produce 50% of its needs. It is also cheaper to produce cane sugar than corn in the US, which implied the need for international trade. (20)
>
> Increased demand worldwide of African palm oil is due to biodiesel, and the decreased demand for trans-fat foods. (23)
>
> (Roman O. 2006)

4. Agricultural Aspects of Palm in Ecuador

4.1. Land use change from tropical forest to plantation

4.1.1. Tropical land use changes in nutrient cycles

It has been demonstrated in studies of tropical ecosystems in Africa that "human-induced long-term land-use and land-cover changes clearly perturbed the soil ecosystem and led to an exponential depletion of up to 85% of the original organic C and N from the surface solids, thereby reducing the soil quality and the potentials of these native tropical and subtropical highland ecosystems to serve as C sinks" (Solomon 2007). These same studies compared the proportional loss of SOC and N concentrations between natural forest to agriculture versus native grasslands to arable cropping and found that the forests were more heavily effected in these areas (Solomon 2007). It was found that along with decreased ability to be carbon sinks, these anthropogenic perturbations also "considerably altered the inherent structural composition of the remaining SOC" (soil organic carbon) (Solomon 2007: 528). The beginning of these changes appeared as early as four years after the human-interventions and intensified with the duration of cultivation until a "new quasi-equilibrium was approached after 20 years" (Solomon 2007: 528). This was not the end of the changes however, as changes have been noted long after this equilibrium was reached (Solomon 2007). The generalized implications of anthropogenic perturbation of the soil and the connection to soil degradation apply in the case of African palm in Ecuador, as the soils there are similar to those researched in this study.

4.1.2. Degradation of soil accelerated via deforestation

Though the climate in the areas of cultivation in Ecuador seem to be compatible for the cultivation of African palm trees, when grown as a monoculture problems arise. These areas were all once native tropical forests. When this native vegetation was removed, along with it went most of the nutrients available for plant growth. This is due to the rapid rates of decomposition and subsequent absorption of nutrients necessary for life. At any given moment in a tropical forest, the majority of the nutrients are stored in the plant and animal bodies themselves rather than in the soil because that is where they are used; an extremely efficient system.

The case in Ecuador is typical of most forest to agriculture shifts done in tropical areas; the trees are harvested for their timber and for profit and a new monoculture is planted. It seems logical to plant something in these areas after they have been clear-cut to prevent further erosion and to avoid leaving the area unproductive. In addition to the large amount of nutrients stripped from the system with the biomass, the properties of the soils in these areas accelerated the loss of nutrients after the vegetative cover is removed. The soils where the African palm is planted in Ecuador are, for the most part, Entisols and Inceptisols (Mejia Vallejo 1986). These are very young soils, meaning they have not had time to develop many of the structures necessary for maintaining nutrients, such as defined horizons and strong aggregates. These soils function similarly to Oxisols, or old tropical, weathered soils often found in the tropics. In both Oxisols and the younger Entisols and Inceptisols, without their native vegetation, they are extremely poor at maintaining nutrients, natural or added, as they are quickly leached out of the poorly aggregated soil, intensified by the large quantity of rainfall in these areas.

It should also be noted that the lack of defined seasons in the tropics dictates the amount of litter on the ground at any given time. In a temperate location, a season comes when the soil is covered with litter, high in nutrients and is allowed to sit above the ground as it decomposes and adds to the nutrient base of the soil. In tropical areas, this seasonality is not as pronounced, and the amount of litter being added to the ground is more constant year-round, creating a different dynamic of soil development. When the vegetation and the litter is removed from these areas, the soil is exposed to the sunlight and other elements for the first time, exacerbating the effects of the elements due to their inexperience with dealing with these elements.

4.1.3. Results of canopy changes on topsoil erosion

Monocultures change many aspects of the natural ecosystem. The canopy of the forest naturally in these areas is very protective of the soil allowing very few raindrops to land directly on the soil without first having been deflected and slowed down by the leaf litter above. This is a natural and necessary defense against rains splash which results in raindrop erosion of the soil. When a monoculture is planted, the canopy becomes less diversified and therefore less efficient at protecting the underlying soil from this type of erosion. It is likely that this mechanism contributes to decreased yields.

4.2. Management of Land

4.2.1. General Location

Ecuador is a very young country in geologic terms. The Andes Mountains, the main geologic feature of the country, were formed by the collision of the South American plate and the Nazca plate, along with the melting of the Nazca plate deep under the surface. This chord-like chain of mountains forms a division between distinct ecological regions in the country. On the east of the Andes, is the Amazon Rainforest, and to the west is the lowland coast area, as seen on the map below (Figure 2).

(http://www.biologie.uni-hamburg.de/b-nline/world/maps/ecuador.htm)

Figure 2: Map of Ecuador

The majority of African palm plantations are located in western Ecuador in the area between the Pacific Ocean and the Andes, locally referred to as “La Costa” or the coast. This area is a coastal plain and historically was a combination of marshland, mangroves, estuaries and native forests. Since the 1500s, much of these ecosystems have been replaced with export oriented plantation crops including banana, cacao, coffee, and sugar cane in addition to African palm. The slopes of the Andes level off to flat plains around the location of Santo Domingo, which also indicates the beginning of the large-scale plantations.

The climate in this area of Ecuador is tropical, with relatively stable temperatures oscillating between 23 and 26 degrees centigrade (73.4 - 78.8 degrees Fahrenheit) (Ministerio de Turismo 2008). There is little seasonality, but a rainy season does exist between December and May (Ministerio de Turismo 2008). The smaller mountain range called La Cordillera Costañera insulates an area inland from it to the Andes creating a more intensified tropical temperature scheme and more intense rainfall. The palm plantations are located in this region. The average annual rainfall for this area is approximately 1250 millimeters, and up to 2500 millimeters in some areas (49.2 inches-98.4 inches) (World Trade Press 2008).

4.2.2. The Plantations

The general layout of the plantations is similar to those of other tree plantations with diagonal rows of trees planted at a distance of approximately 9 meters apart as shown in Figure 3 (Naranjo 2002).

According to University of Georgia the optimal plant density for Elaeis guineensis is 58 trees per acre or 143.26 trees per hectare, very close to actual density reported for Ecuador of approximately 143 trees per hectare (Naranjo 2002).

Despite extensive rainfall, recent studies have been conducted to investigate the effects of irrigation on fertilizer retention potential in palm plantations of these areas. The results of these studies were scheduled to be discussed in regional conferences in Ecuador in July 2007. In the study area for one report, “rainfall exceeds requirements from January to April, but a water deficit occurs from May to December (Mite 1999)”. The study was conducted between 1993 and 1998 and showed an increase in bunch weight of the palm fruits in the irrigated fields. This contributed to a cumulative yield of 26 to 33 MT/ha higher than rain-fed fields (Mite 1999). This was stated to be due to higher retention of fertilizers when irrigated and ultimately necessitates the irrigation of all palm plantations for production of higher yields (Mite 1999).

One positive aspect is the lack of mechanization observed in these types of plantations, due to the emphasis on manual labor to harvest the palm fruits. This minimizes the soil compaction that can become a major issue for soil management in other crop systems that rely heavily on mechanized harvesting (Loaiza Granda 2006).

(photo taken at by author July 2007)

Figure 3: ANCUPA Research Plantation

4.2.3. Extent and Expansion of Plantations

Historically the main areas of palm cultivation have been the western central areas surrounding Santo Domingo (ANCUPA 2005). The recent increase of over 150,000 hectares planted in African palm throughout the country in the past twelve years has been largely in the northwest of the country. The northwest quarter of the country, including areas of Esmeraldas and Pichincha provinces, now accounts for over 80% of the total area planted in African palm in Ecuador (ANCUPA 2005).

In the 1986 a document entitled “Climate, soils and nutrition of African Palm in Ecuador” was published which was accompanied by a soil use map, deeming the San Lorenzo county of Esmeraldas as a suitable soil type for African palm growth (Batallas nd). Subsequently, in 1998 the implementation of this project began with the final goal of planning between 30 and 40,000 hectares of African palm in San Lorenzo (Batallas nd).

As of 1999, the progress was visible in an area of 15,000 hectares in the San Lorenzo area (Naranjo 2002). The stated reasons for having chosen this particular area for expansion were to promote economic and social development of the region and because the land was less expensive (Naranjo 2002). Those expanding claim to have conducted “estudios tecnicos de impacto ambiental” (technical studies of environmental impact), and this is often given as the response to concerns by environmental groups about the expansion (Naranjo 2002). This expansion was necessitated by the decreased yields of palm in other areas of the country, as seen in Table 1. (Naranjo 2002)

The increase in area dedicated to palm has forced many small farmers to sell their land to the larger plantations and become laborers or to change their original crop to African palm in order to maintain their property. The farmers who maintain their land are then involved in what is known as ‘contract agriculture’ and are given packets including the necessities for growing African palm: seeds, chemicals, fertilizers, etc. They are then left to produce enough palm to pay back these loaned services. Many times, the areas into which these plantations are expanding are populated by largely marginalized populations such as indigenous tribes and Afro-Ecuadorians. Many political, social and cultural factors govern the expansions and will be discussed in detail in Chapter 2.

According to the Ministry of the Environment in 2002, 8,000 hectares of tropical forest had already been converted to palm plantations in the area of Esmeraldas and it was projected that in the next few years around 30,000 hectares would additionally be cleared for palm crops (Naranjo 2002). Other sources show that this projection of further expansion via deforestation during the next years was correct. On August 8, 2002, Ecuador's president at the time Gustavo Noboa, made an Executive Decree (number 2961) which modified the areas of the "Ancestral Forest" lands, advancing the agricultural frontier approximately 40,000 hectares (Batallas n.d.).

A group of environmental NGOs that met in Ecuador in July of 2007 maintain that the Ecuadorian government "authorized agricultural activities" in an area of 50,000 hectares north of the city of Esmeraldas, which includes more than 30,000 hectares of tropical forest (Bravo 2007:111). This area was assigned to be used for "sustainable agricultural development" (Bravo 2007:111). According to their report, these areas include ancestral lands, secondary tropical forests, and primary tropical forests. It is also stated that this decision put at risk 2,000 hectares of ancestral land of African-descendents and 800 hectares of Awa ancestral lands, both of which cannot be appropriated according to the Political Constitution of Ecuador (Bravo 2007).

4.2.4. Dissimilar to Agribusiness in the United States

Palm plantations are usually considered a part of the large scale agriculture industry because of the use of the word ‘plantation’ and the many connotations associated with agriculture that is bound for export. In July of 2007, various palm plantations in the area of Santo Domingo and La Concordia were observed to be grown in conjunction with companion crops between rows. These crops were of various types, and on the research property studies were underway to investigate the differences in the soil building potential of different types of legumes (Figure 4).

(photo taken at by author July 2007)

Figure 4: Companion Legumes at ANCUPA

Additionally, the lack of mechanized equipment that was observed is consistent with the literature indicating that most of the harvesting is done using human labor (Loaiza Granda 2006). For the first few years the fruits are harvested using a steel chisel with a wooden handle about 90 cm long, after the trees reach a sufficient height, an axe or a curved knife attached to a wooden pole is used (Duke 1996). One man can harvest

100-150 bunches per day (Duke 1996). There are significant advantages to this model of agriculture over the typical practices implemented in such crops as corn and wheat in the United States for example.

In Ecuador, 58.3% of all plantations are between 1 and 100 hectares in size. These relatively small plantations employ over 5000 workers, accounting for 95.5% of all those employed as palm farmers (ANCUPA 2005). This indicates a different agricultural structure than the norm of agribusiness. The African palm industry is not highly mechanized and the varieties of chemicals used all have detrimental effects for the laborers involved in all stages of the production process (Loaiza Granda 2006).

4.2.5. Chemical Uses

Information about the specific quantities and varieties of chemical additions to the African palm plantations in Ecuador is difficult due to the variability in the size and management of the numerous plantations.

4.2.6. Methods for plantation turnover

a. Injected herbicide method

The industry has a common practice of injecting the older trees with herbicide when they reach a height of 20-30 ft and are then too tall to be harvested. New trees are then planted between the decomposing trunks (Rieger 2006, Naranjo 2002). It can be assumed that when injected with this herbicide there may be some negative impacts on the soil fertility for the newly transplanted trees. Since these plants need full sun to grow, the shade created by these rotting trunks may be detrimental, although probably has minimal effects. The major concerns for this practice are the degradability of herbicide in ecosystem and water shed, and the difficulty for decomposition posed by the addition of the herbicide and the position of the trunk left standing vertically. Dead trees are left standing in nature at times and remain vertical until microorganisms and weathering have broken them down sufficiently for the trunk to cave and fall to the ground. In a monoculture a highly unlikely situation is created when entire plantations are left to rot vertically at the same time, as was observed in July 2007. The mass stored in the tree, that until it died was actively supplying the palm fruit with nutrients, is significant and the time it takes to reincorporate itself into the system may be extensive, even under tropical conditions. It should also be noted that the practice of leaving these trunks to decompose in the plantations, although it may be slow, does eventually replenish that same plantation with those stored nutrients. This cannot be said definitively of the following bulldozing method.

b. Bulldozing method

Also common, when machinery is available, is to bulldoze the dead trees. It is unclear whether they are then left to decompose on the ground or if they are removed. It would be beneficial to the system if they were left to decompose, facilitating a much more rapid decomposition as the microbes would have further to travel to do their job (Rieger 2006). If the trees are removed and sold for other uses, the soil is further depleted, although this may be economically advantageous for the plantation owners.

Bulldozing creates additional problems of soil compaction and increased energy costs associated with fossil fuel use.

(photo taken at by author July 2007)

Figure 5: Older intentionally killed palms too tall to harvest

5. Yield

5.1. Data and Analysis

Palm fruit and oil yields have been highly variable in literature based on variations in cultivation practices such as plantation size, density, mechanization, chemical additions, and climate among others. For Ecuador, Table 1 illustrates the calculated yields for the years between 1995 and 2006. Sufficient information was not yet available to calculate 2007 yields.

Table 1: Calculated Yields 1995-2007

Year	Area Harvested (Ha)	Palm fruit produced (metric tons)	Calculated Yield (metric tons/Ha)	Yield reported by SICA* (metric tons/ha)
1995	51,996.73	926,028.56	**17.81**	----
1996	56,957.34	901,682.77	**15.83**	10.31
1997	65,248.41	1,016,541.32	**15.58**	11.03
1998	72,210.03	992,474.19	**13.74**	11.96
1999	84,440.41	1,336,232.48	**15.82**	12.70
2000	96,853.80	1,110,975.38	**11.47**	11.78
2001	112,725.23	1,026,982.29	**9.11**	----
2002	128,860.39	1,190,631.68	**9.24**	----
2003	153,623.39	1,309,660.77	**8.53**	----
2004	176,193.42	1,395,760.14	**7.92**	----
2005	190,137.87	1,596,690.78	**8.40**	----
2006	197,786.02	1,708,556.60	**8.64**	----
2007	202,514.56	----	----	----

* Servicio de Información y Censo Agropecuario of El Ministerio de Agricultura Ganadería, Acuacultura y Pesca del Ecuador (information and farm census service of the ministry of agriculture and environment of Ecuador)

The ‘Calculated Yields’ were determined based on the numbers directly provided in July 2007 by ANCUPA. The yields provided in the right column from SICA are from a document published in 2002, which explains the lack of up to date data (Naranjo 2002).

As can be seen by the decrease in yields from 1995 to 2006, a significant change necessarily occurred between these years in the palm industry. Those within the sector attribute the decrease in yields to the negative effects of El Niño in 2001 combined with poorly managed, eroded soils (Naranjo 2002). While El Niño may explain the decrease from 2000 to 2001, it does not provide justification for the significant drop in production of palm fruit (over 225,000 metric tons) from 1999 to 2000, despite the addition of over 12,400 new hectares harvested. The inability for these yields to have recuperated to pre-El Niño levels after six years also indicates other influencing factors.

The areas experiencing the lower yields are those in which palm has been grown for the longest: Santo Domingo, Quinindé, and Quevedo (Naranjo 2002). The sector considers this reason to find new land for the crop, with little published discussion regarding the causes for the decreased yields.

The sector also indicates that “bad nutrient management” has necessitated the expansion of the industry into previously unaffected areas of the country, such as the northern province of Esmeraldas (Naranjo 2002). The expansion into the Esmeraldas province began on a large scale in 1999, and when looking at the total hectares that were harvested in 2002 and 2003 (3-4 years after the land was initially planted, which is the maturity time frame for African palms) it becomes obvious that this land is accounted for in the calculated yields from 2002 onward. For example, in 2002, when the first harvest from the Esmeraldas area would have been accounted for, there was an additional 24,763 hectares, but very marginal gains in yield (0.13 MT/ha increase). This trend holds true for the next two years as large quantities of land are added and yields are decreasing.

This decreasing yield trend seems to correlate with the addition of the newer fields in the Esmeraldas province, and there seems to be a variety of possible explanations. A combination of agricultural factors may have influenced the changes in yields including lower production from new fields, decreasing production in older fields, and production depending on age of trees. In addition, economic and cultural factors specific to this region of Ecuador may have influenced the decreased yields as well. The actual causes for the decreased yields could be any combination of these factors, but for the sake of initial analysis, simple models isolating each phenomenon were created. For the sake of simplicity in the modeling the ‘new’ and the ‘old’ plantations are separated.

Also, for consistency, the maturation time of African palm from planting to harvest is assumed to be four years throughout these models.

5.2. Models for decreased yields

5.2.1. Economic model

Ecuador changed its currency from the *sucre* to the US dollar in 2000 to attempt to stabilize astronomical inflation rates. This would lead to decreased additional harvested lands and/or lower yields in 2004 and 2005 as those would be the first years the plantations planted in 2000 would be harvested. In 2002, the Executive Decree to allocate more land to agriculture could have been a response to the economic situation caused by the dollarization.

Two possibilities of the how this economic turmoil affected palm plantations follow.

1. The effect of dollarization on agricultural production: This assumes that the economic hardship decreased the ability farmers and plantation owners had to acquire new land on which to expand. This means less palm was planted in 2000-2002 (assuming two years of economic impact), and the harvests in 2004-2006 would have been effectively decreased (four year maturation time).

Referring to Table 1 this model would explain the decrease in the area added to the harvest in 2005-2007, although if the model were completely accurate it would have shown a decrease in added harvest in 2004 as well.

2. The effect of dollarization on availability of additives (fertilizers, pesticides, etc): It is possible that due to the economic crisis, farmers had less ability to purchase fertilizers and other chemical additives in the years of 2000 and 2001. For this assumption, the *yields* from all fields that were harvested from 2000 on would show decreased yields due to less availability of agricultural additives.

Again, referring to Table 1, the yields after 2000 decrease:

Average yield from 1995-1999 (5 years) = **15.7** metric tons/ ha

Average yield from 2000-2006 (7 years) = **9.04** metric tons/ ha

This model seems to produce yields that generally agree with the actual figures in Table 1.

5.2.2. Soil depletion in aged fields

This model addresses the older fields alone and the possibility that they reached a point at which they could no longer produce at the same level due to soil depletion. It is possible that this point occurred before newer plantations were established enough to compensate for their losses (around 2000). This deceased capacity to produce could be due to many different mechanisms, such as the application of chemicals eventually degrading the soil after many years of good production or a natural drop-off due to the nature of the palm plants. The soil in these older fields may have been capable of producing far more palm fruit ten years ago, and perhaps can no longer sustain this level of production as nutrients in the system have become less available.

For this model, it is assumed that the 51,996.73 ha harvested in 1995 were all the same age and begin to drop off in production (from 15 MT/ha at a rate of one hectare per year) beginning in 1996. The changes in yields from that point are then dependent on old field depletion. The harvests from the 'new' or 'added' fields are assumed to produce at 15 metric tons/ ha for this model. Table 2 shows the hypothesized yield calculations found using this model. Sample calculations can be found in the Appendix.

Table 2: Soil depletion in aged fields hypothesized yields

Year	Hypothesized yield
1995	**15.00**
1996	**14.01**
1997	**13.34**
1998	**12.78**
1999	**12.48**
2000	**12.28**
2001	**12.20**
2002	**12.15**
2003	**12.27**
2004	**12.33**
2005	**12.25**
2006	**12.09**
2007	**11.90**

The general trend created by this model follows that of the calculated yields in Table 1 and therefore, old field depletion may likely contribute to the decrease in yields.

5.2.3. Decreased productivity in newer fields

This model assumes that the 'newer' fields planted in the northwest of Ecuador are simply less productive soils and/or climates than those historically producing oil palm. It is possible that the newer plantations are of a different soil type, or of a less homogenous soil type than their older counterparts. It is also possible that the newer fields have not yet adapted to the transformation from a complex tropical forest ecosystem to the new monoculture system, and they were, between 2002 and present, in a transitional period which will eventually level off to a ‘sustainable’ yield. If this is true, their significantly smaller yields would not help the overall yield. This would cause a significant decrease in the overall yields by accounting for much of the additional land, and little additional palm fruit production.

Also, it is noteworthy that the structures of the new plantations are probably much different than those in the older regions as these are most likely small, poor, inexperienced (in large scale operations) farmers.

For this model it was assumed that the new fields are less productive than the old ones regardless of their age. Therefore, all fields planted after 1998, when the expansion project in the newer areas began, will produce at 8 MT/ha, and the older fields will continue to produce at 15 MT/ha. The trees planted in 1998 would not be harvested until 2002, so this model only applied from that year on. Table 3 shows the calculations obtained using this model, beginning with 2002. Sample calculations can be found in the Appendix.

Table 3: Decreased productivity in newer fields hypothesized yields

Year	Hypothesized yield (2002 and on)
1995	*17.81*
1996	*15.83*
1997	*15.58*
1998	*13.74*
1999	*15.82*
2000	*11.47*
2001	*9.11*
2002	**14.11**
2003	**12.67**
2004	**12.17**
2005	**12.23**
2006	**12.32**
2007	**12.34**

Although this model only explains effects after 2002, the general trend created thereafter is congruent with the trend seen during these years in Table 1.

5.2.4. Age dependent yields

This model assumes that fruit yield is a simple function of the age of a tree. It assumes that once a tree reaches four years old, it will produce at a slightly increasing, but largely constant level until it reaches a point at which it is no longer able to produce as efficiently. This may be due to the lifecycle of the trees, the capacity of the soils, and/or the height at which trees can be harvested.

This model assumes that until 1995 all trees produced at 16 MT/ha. At that point, fields reached their peak and began to taper off in production, decreasing in yield by 1 MT/ha each year, while the new trees being harvested increased their yields by 1 MT/ha each year starting at eight the first year they were harvested. Table 4 shows the yield calculations determined using this model. Sample calculations can be found in the Appendix.

Table 4: Age dependent hypothesized yields

Year	Hypothesized yield
1995	**16.00**
1996	**14.35**
1997	**12.82**
1998	**11.81**
1999	**10.88**
2000	**10.31**
2001	**9.92**
2002	**9.75**
2003	**9.63**
2004	**9.70**
2005	**9.95**
2006	**10.31**
2007	**10.72**

This model creates an interesting trend that eventually turns around to increase yields in 2005-2007. This is reflected somewhat in the calculated yields of Table 1 and perhaps the age of trees accounts for some of the decrease in yields.

6. International Trade with the United States

6.1. Biodiesel Refinery in Washington State

Imperium Renewables is the largest biodiesel producer in Washington, and it recently opened the largest biodiesel refinery in the United States, located at the Port of Grays Harbor in Washington. It will have the capacity for 100 million gallons of biodiesel per year. As of January 2007, Imperium was estimated to use 30% of raw palm oil from Malaysia. This was planned in an attempt to decrease the costs of the refined biodiesel by decreasing the cost of the raw vegetable oil, which accounts for around 75% of the end price of biodiesel at the pump (Timmerman 2007). The other 70% of oil will come from soybeans from Iowa, which costs 25 cents per gallon to transport by rail to Seattle (Timmerman 2007).

The information regarding their use of palm oil was from early last year, and the plant is now functioning, but some changes were made. When contacted regarding the current raw vegetable oil in use at their Grays Harbor plant, the response was that palm oil has never been used in this plant and that they are using virgin canola oil from the state of Washington and Canada (Millen 2008).

According to some sources, a demonstration in protest of Imperium's possible use of Malaysian palm oil was planned for Thursday, July 12, 2007 (Cook 2007) Whether or not this demonstration took place is unclear, but the debate and controversy regarding their use of palm oil could have been a significant factor in their choice of canola as their dominant vegetable oil source, although this is not confirmed.

6.2. Biodiesel Refineries in Florida

On the other side of the country, Earth First America is importing already processed palm oil-biodiesel from Ecuador. The first shipment of this kind to arrive at the Port of Tampa on November 8, 2005 contained 878 metric tons, or 267,790 gallons of biodiesel. Earth First America's partner company in the production of the biodiesel is La Fabril which is located in Manta, Ecuador. Also included in their partnership is the use of EFTI's Catalytic Activated Vacuum Distillation (CAVD) technology and equipment.

This technology is expected to increase the efficiency and therefore decrease the costs of the biodiesel refining process (Kotrba 2006).

Earth First has also organized an international consortium of biodiesel producing businesses for distribution in not only Latin America and the Caribbean, but also in the United States and the European Union (Business Wire 2005). Earth First has arranged with La Fabril for ongoing monthly shipments of biodiesel to have begun in January 2006. In 2006 they expected to import up to 45 million gallons, and in 2007 they hoped to increase that figure to over 100 million gallons (Web 2005).

Also in Florida, Biodiesel Energy Systems Incorporated, (BES) is a marketing company based in Tampa, and also has a contract with La Fabril (Jessen 2007). According to BES president Elio Muller, between October 2006 and February 2007, La Fabril had exported over 15 million gallons of palm-based biodiesel to the United States (Jessen 2007). After planned expansions to their facility, La Fabril intended to increase their biodiesel plant’s capacity to 100 million gallons per year (Jessen 2007). According to Carlos Gonzalez, general manager of operations at La Fabril, this increased capacity for biodiesel production would make it the largest producer of biodiesel in the Western hemisphere, and one of the top five in the world (Rohde 2006). BES prefers palm oil as a biodiesel feedstock because it is “easily available and affordable (Jessen 2007)”.

6.3. Federal Renewable Energy Policy in the United States

At first glance, The Energy Independence and Security Act of 2007 (House resolution 6), approved by President Bush, seems to indicate an advance in the sustainability and security of energy for the United States. It aims to "improve vehicle fuel economy and help reduce U.S. dependence on oil (United States Department of Energy). This document specifies the amount of 'renewable fuels' but not the origin or quality. One of its stated goals is to "reduce energy consumption by 7% and greenhouse gas emissions by 9% by 2030 (United States Department of Energy). Although this seems to be a step in the right direction, further research as well as careful consideration of the processes involved in the production of these fuels is essential if these goals are to be reached. In this, like many other areas, Europe has surpassed the United States in implementing effective policy for renewable fuel usage. In Europe, there are high taxes on petroleum products to decrease the difference in cost between petroleum-based fuel and biodiesel. In the US, increased biodiesel production is mainly driven by environmental and energy security concerns and resulting legislation and regulations are usually not enough to encourage widespread use (Van Gerpen 2005). More specific legislation is necessary in order to actually decrease the GHG emissions of the United States.

The unspecific stated goals of the above Energy Act are accompanied by equally unspecific incentives. Currently, a $1.00 tax credit per gallon of Agri-Biodiesel is provided (defined as diesel fuel made from virgin oils derived from agricultural *commodities* and animal fats) (Renewable Fuels Association). There is also a 50 cent tax credit per gallon for Biodiesel (defined as fuel made from agricultural *products* and animal fats) (Renewable Fuels Association). Both of these tax credits were part of Volumetric Ethanol Excise Tax Credit, which was created by the American Jobs Creation Act of 2004.

The implications of this policy are troublesome for the following reasons:

- No regulations exist to ensure sustainability of ‘renewable fuels’. (This allows for fossil fuel intensive crops and crops replacing rainforests to be deemed ‘renewable’.)
- No specifications are made as to the origin of biofuels, allowing foreign biodiesel to receive the same tax credit as domestically produced biodiesel.
- The incentives are based on dollars per gallon instead of a more useful term like ‘dollars per ton of CO2 reduced’, which would efficiently account for the true energy cost of biodiesel.

Incentives for renewable energy are not in and of themselves bad, they have the potential to successfully change our energy policy towards a more sustainable path. The correct incentives are imperative, however if measurable change in emissions are desired.

In order to implement a plan based on a ‘dollar per ton of CO2 reduced’, quantitative research in energy uses and land use changes would be necessary.

Additionally, it is interesting to mention the origin of these trades and incentives. Underlying all of the policy to combat global warming through the use of renewable fuels, is an emphasis on the local use of biofuels. The demand for biofuels is coming from the United States in this case, (and globally among other developed countries). The origin of the cheapest biodiesel feedstocks are in developing countries, like Ecuador, as is the case with most raw materials due to cheap labor among other factors. Differentiating between goals of decreasing human impact on the earth and decreasing ones personal impact is pertinent as the resulting actions differ greatly.

A person wishing to decrease his or her 'carbon footprint' or environmental impact would be more effective if he or she paid for the production of the fuels where the plants grow (in this case in Ecuador) and also be satisfied with its use within that area to create the smallest overall impact as possible. The somewhat self-centered human attitude however, often prompts the desire to personally see the biodiesel burning in ones car; craving proof that it was made and used properly. The personal ego-boost attached to knowing one is personally and physically contributing to making the world a better place is hard to detach, even if environmentally, and energetically, another option would make more sense. Simple energy analysis of the fuel needed to move the biodiesel to the wealthy countries from the poor producing ones reveals that the world would be an even better place had the money from the rich gone to keep the fuel where it was made. The current situation is becoming more and more complicated as humans have not yet figured out how to efficiently account for the true environmental impact of biofuels. Once this analysis is established, the environmental privilege required to consider and purchase biofuels (in the developed world) may be better transferred to the areas where the most efficient fuels can be produced (sometimes developing countries) rather than spending energy to localize the benefits for those with the monetary ability to purchase them.

7. Conclusions and Suggestions

Based on the available information, the energy analysis would indicate that the shipment of palm-based biodiesel to the United States is not an efficient use of the fuel. As it stands, its production agriculturally, although it is not highly mechanized and is occasionally grown alongside companion legumes, is overall problematic. The decreasing trend in yields definitively indicates unsustainable practices, as a stable yield would be desirable for both economic and environmental reasons. The available data is insufficient to be able to determine the exact reasons for decreased yields, but was pertinent in determining specific questions which, when investigated further, would explain the cause of the decrease.

Many of these questions regard the details of soil characteristics and include the following: determination of the difference between the soils of Esmeraldas and those of Santo Domingo, detailed examination of nutrient flow in and out of the system in the various soils to determine suitability of these tropical soils to palm cultivation, measurement of the effects of companion crops in maintaining sustainable yields, and the determination of the long term sustainability of fertilizer application under irrigation and tropical rainfall. All of these questions would be directly applied and integrated into more complex versions of the models presented in this report to explain more exactly and quantitatively the decreased yields.

In addition to yield sustainability, the energy content and balance is crucial in determining the sustainability of this fuel. Exact energy costs of each aspect of the process need to be determined including: agricultural energy costs (fertilizers, and other additives), labor costs (mechanized and human), energy used during transport (truck in

Ecuador and the US and ship between), and energy involved in processing (fruit to oil and oil to biodiesel).

Additionally, a study of the profits and the division of them among the various stakeholders would be very interesting, as many of the decisions made in these fields may prove to be influenced more by profits and the interest of involved parties than science or economics. It should be ascertained how the profits from the sale of the fuel in the United States are distributed among the many involved parties in Ecuador. This would require research about the pay to farmers, laborers, growers, and producers. With the inclusion of such findings, the values placed on varying aspects of the situation (profits, in-tact rainforest, cheap labor, cheap fuel, sustainability, etc) would facilitate a deeper understanding of the value system involved from both sides.

In spite of the difficulty in ascertaining exact values for the above mentioned questions, the necessity of further investigation of these areas is extremely apparent. The sustainability of future energy sources depends of this type of research and thoroughness prior to large scale implementation. Regardless of further findings, the current situation is an enlightening example in which the United States is forging ahead with renewable energy policy without knowing the facts about energy, the environment, or management dynamics.

It should be noted that all conclusions in this thesis are based on the current transport to and use within the United States. However, if the fuel were it to be used domestically, within Ecuador, the conclusions would be different, as its motivation and structure would change. In order to ensure the sustainability of the fuel, it would be advisable to use the fuel as closely as possible to its place of production. From the

United States perspective, the most productive decision would be to discontinue to importation of this fuel and invest in more domestically available fuels, eliminating transport costs. It would also be advantageous, in the long term, to discontinue to expansion of the plantations into new areas until further research is done into the causes of decreased yields. Instead, the resources currently used for expansion would be better utilized by investing in managing the already established plantations as sustainably as possible. In this regard, the use of palms that are genetically altered to produce higher yields over the long term may be recommended.

CHAPTER TWO: SOCIO-CULTURAL SUSTAINABILITY

1. Introduction

Current conflict is always informed by the historical context within which it occurs. In addition to the many environmental issues discussed in the previous section, in order to fully understand the effects of this fuel as an alternative to fossil fuels, the socio-cultural issues involved must be given equal weight. First the historical context for both the socio-cultural and natural environments of the region must be discussed, followed by detailed discussion of the effects of the palm plantations on specific cultures and social structures of Ecuador.

2. Historical Context of the Americas

At the time when the Americas were first contacted by European explorers, the population is estimated to have been between 40 and 70 million people. This initial population size is often overlooked in the analysis of Latin American development, often due to differing perceptions regarding how influential and widespread these populations were. The North American experience taught to many Americans and Europeans creates a false pretense with which to study the native peoples of Latin America. The organization and sophistication of the pre-Columbian societies in Latin America is a vital starting point for this analysis as it informs all activities and perceptions thereafter.

For several reasons, until somewhat recent archeological evidence was presented, the statements made by the conquistadors regarding the grandeur of the societies upon which they had stumbled were considered to be ego-building exaggerations. The population decrease that occurred immediately after conquest contributed greatly to this belief. Only the first Europeans were privileged enough to witness these societies in their entirety because by the time the second wave of explorers arrived, an estimated 90% of these populations were already decimated by the intentional spread of disease and warfare. The populations witnessed by the majority of Europeans arriving on the continent were extremely diminished from what they once were.

2.1. The European Perspective

Much of the resistance to the possibility of such sophisticated and numerous societies having existed in Latin America prior to the conquest is due to what is referred to as the Pristine Myth. This myth is informed by a mixture of misconceptions and truths, all with a hint of Euro-centrism, as those that initially created the myth were of European descent.

First was a sense of cultural superiority that the explorers felt due to the apparent modernity of the societies from which they came and the ill-informed idea of the primitive nature of the societies they encountered in the Americas. As already mentioned, a large contributing factor to the perpetuation of this myth was the rapidity of declining populations immediately after conquest, leaving little chance to witnesses these societies at work.

The European agricultural experiences of the explorers lead them to diffuse the impossibility of the tropical land to support such large societies. To their untrained eyes, the rainforests looked as if they had not been changed even slightly from their 'natural states'. Later to be understood and studied were the variety of extensive practices of agriculture used by indigenous peoples of Latin America. They include the intentional formation of grasslands to attract large game, swidden (or rotation) agriculture, agroforestry, complex arrangements of terraces, and probably the most famous: chinampas. The Europeans' unfamiliarity with these types of site specific agricultural practices informed their misconception of both the 'pristine nature' and the 'primitive noble savage' they thought they had encountered (Denevan 2001).

Additionally, problems with archeology in the tropics complicated the efforts to substantiate the claims of the first settlers that these significant populations were in fact, at one time established in these areas. New archeological discoveries and the development of new technologies in this field have only recently shed light on the validity of such misconceptions.

The logical outcome of such an idea about the environment of the Americas is a similar myth about the people who called it home. The 'myth of the noble savage' was associated with Latin America beginning with the writings of Amerigo Vespucci in after he spent 27 days with Brazilian Indians in 1502 (Hemming 2006). His descriptions of the Indians were as a 'blank slate' having no kingdoms, provinces, land ownership, heirs, and no one to obey (Hemming 2006). Upon the first contact with the Europeans, the Indians were seen as generous and innocent, and did "not recognize the immortality of the soul (Vespucci [1503] 1974:285, cited by Hemming 2006:7)."

It is now known that these myths contained little truth, but nevertheless these are the ideas that have informed policy in Latin America for over 500 years. The intent of such reports is now considered to have been less of an attempt to accurately describe the lives of the Indians, and more of a direct criticism of the European lifestyle of the time via comparison. By romanticizing the Indians' lifestyle, for Europeans, it implied that other societies were somehow corrupted via 'development' and the advents of 'modernity' (Hemming 2006).

2.2. Environmentalists' Perspective

The recent rise of environmental concern worldwide has brought attention to the lifestyles of lowland indigenous peoples. Promoting this attention is another related myth, that of the "ecologically noble savage". The origin of the phrase is attributed to Kent Redford in 1991, and since its introduction, it has inspired a debate among anthropologists and conservation biologists regarding the sustainability of native peoples prior to outside contact (Hames 2007). This myth is the idea that Indians have lived, and continue to live when allowed, in harmony with nature (Silvious et al. 2004). This implies that conservationist tendencies are innate in the thinking and activities of native peoples, which deprives them of the ability to make decisions as the rest of society does regarding their relationship to nature.

In the same way Amerigo Vespucci reported on the nobility of the Brazilian Indians, environmentalists use the 'sustainability' of current lowland indigenous populations to criticize the consumer oriented rest of the world. Implied in the statements made by Western environmentalists is the idea that the Indian's way of life must be adopted by the rest of the world in order to sustain our future generations. Ecologically speaking, the way of life of the hunters and gatherers, if adopted by the rest of the world, would not bring the planet back into harmony with its human inhabitants.

2.3. Counterfeit Paradise

Ideas regarding the natural environment and agriculture of lowland South America have heavily influenced both past and present policy throughout the region. African palm growth in tropical areas is no exception. Of particular interest with regard to this report are the false perceptions that the lush forests of the Amazon and other regions were necessarily supported by extremely fertile soils. The Europeans were amazed at the possibilities of agricultural production that seemed to be implied by the variety and expanse of vegetation in tact upon their arrival. Implied as well, was the under-production of the Indians because they had not yet planted large agricultural fields in these still forested areas. The earlier discussion of soil mechanics and properties in tropical areas proves that not only are these lands not suitable for most types of agriculture, but that they were being used efficiently by the natives by leaving most of the native vegetation in tact to continue the nutrient cycling throughout the ecosystem.

2.4. Afro-Ecuadorians

The presence of the Afro-Ecuadorian population in Ecuador has been all but ignored by those within and outside of the country, although it is an integral part of this, and many other current issues in Ecuador.

The long told legend has also been documented in regard to the origin of Afro-Ecuadorian population in the northwest province of Ecuador, Esmeraldas. This area of Ecuador is home to the descendents of Africans and Afro-Hispanic people who were liberated themselves from enslavement in the mid 1500s (Cabello Balboa 1945 as cited in Whitten 2007). They arrived there after a shipwreck off the coast and intermarried with indigenous people of the area, later arising as the dominant force in the region. They successfully resisted all attempts by the Spanish military and the Catholic Church to conquer them.

3. Colonial Legacies

The legacies of colonialism are prevalent in contemporary business structures, agriculture, and societal organization throughout the Americas. The intent of the colonizers of Latin America[4] was different than that of those who colonized North America. The British settlers were looking for a new land in which to live and prosper whereas the Spanish and the Portuguese were looking for lands with rich resources they could extract and export back to their homelands. The ‘conquest’ in North America involved the movement and eventual murder of the native peoples with the intent to then acquire their lands as their own. In Latin America, the intent was to conquer the Indians to the point where they could be used for forced labor with the final goal of exporting goods to Spain and Portugal (Seed 2001). The Spaniards believed that the Indians should be able to remain on their lands, to a certain extent, as long as they work for them. This is partially inspired by the history the Spaniards themselves had of being conquered by various Arab groups throughout history, and the value they placed on maintaining the land of one's ancestors. These differences between North and Latin America are evident in Latin America as both the historical extractive economies and the inequalities created by the historical submissive role of certain ethnicities play integral roles in current issues.

3.1. Agricultural commodities for export

The extractive nature of the colonization of Latin America by the Iberian powers is relevant today as they are still viewed as extractive in nature rather than investment economies in and of themselves. For example, the historical crops that were exported from Central and South America were bananas, sugarcane, and cotton, among others. These are all agricultural products produced via a monoculture plantation infrastructure.

The societal implications associated with this type of production are significant and detrimental for the producing countries, and especially for the laborers harvesting and processing the goods to be exported. By using the most productive lands to grow export crops, it leaves the more marginal lands, if any, for the cultivation of food crops for local consumption.

The nature of monocultures and their heavy reliance on chemical applications to produce high yields creates dangerous situations for the laborers and the communities surrounding the growing areas. Water contamination due to runoff from pesticide and herbicide use is a major problem in many of these areas. Multiple factors in Latin American agricultural practices exacerbate this already serious problem with mono-cropping including the illiteracy of workers, poverty, lack of safety standards and enforcement of law, government subsidies for pesticides and promotion by multinational companies (Murray 1994).

3.2. Extreme social inequalities

Ecuador is one of the three South American countries with the highest remaining indigenous populations, often blamed for a seemingly perpetual state of internal conflict and economic turmoil. There exists a deep rooted belief that all things European or 'Western' are more advanced or modern, and therefore superior to those that originated in Latin America. This provides the basis for a hierarchical class system in Ecuador that consists of the people of mixed European descent on top and those with more indigenous ancestry on the bottom. Ecuadorians of African descent are placed somewhere along this spectrum although it is usually disputed exactly where. This is rooted in the colonial era when the European settlers openly treated the Indians and African-descendents as inferior human beings, if as humans at all. As the indigenous people of Latin America were spared their lives in order to labor for the benefit of the Europeans, this now results in a complex spectrum of ethnicities in countries like Ecuador.

The term *mestizaje* is used to describe the mixing of those of European descent with those of indigenous descent. Similarly, m*ulataje* refers to the mixing of those of African-descent with those of European descent, while *zambo* refers to the mixing of indigenous and African descendants. This complex mixing has created a hierarchical system based on physical appearance. Because this system is not based solely on blood lines, it is a relatively fluid system, providing certain individuals the ability to self-identify with various ethnicities as they please. (Whitten 2007)

Two current trends in Latin America have begun to provide an alternative mentality proving to be more constructive than those based on historical myths. The first is an idea called inter-culturality. This is a system that not only recognizes the differences between diverse ethnicities within Latin America; it gives specific validity and value to 'blackness' and indigenity through systems of land right allocation and changes in national constitutions. This idea differs substantially from 'multiculturalism' and 'cultural diversity' as these often adopt a separate but equal ideology (Whitten 2007).

The second trend in Latin American studies of indigenous peoples and how they relate to the rest of the world is a term called 'alternative modernity'. This is a term used to describe the way indigenous people live in the midst of another culture. According to Whitten, it implies that "one can live in the contemporary world but adhere to cultural values and social practices at odds with the dictums of dominant modernity, where racial stratification, profit seeking, and forced conformity define an ideal way of life (2007)". The lifestyle of individuals and communities living an 'alternative modernity' embrace and practice a different economic strategy or mode of production than the majority; it is an alternative rather than an inferior lifestyle. Indigenous groups who have developed mechanisms to generate income sufficient to maintain their lifestyles and their autonomy, by participating in the national economy in some way, exemplify this idea.

3.3. The past in the present

The above mentioned mechanisms put into place by the conquest of Latin America are still widespread today in countries like Ecuador. The less Indian one looks, acts, and claims to be, the less difficult it is to succeed in the modern world of market powers and extreme external debt. Those with power are still usually of the same elite background as those who ruled the colonies hundreds of years ago. Multinational companies have taken the place of foreign colonizers in dictating, via economic threat, the activities within supposedly sovereign nations like Ecuador. This, among other factors, is the basis for the belief that though Latin America is no longer colonized, it is neo-colonized by the economically powerful countries of the 'West'.

4. The Awa of Ecuador

One of the specific populations affected by the expansion of palm in Ecuador is the Awa. They are a group of around 10,000 Indians scattered across the Northwest of what is known today as Ecuador and various parts of what is now considered Colombia (Chernela 2001). The reason this population lived on both sides of the border is because they have lived there for thousands of years, much longer than the countries themselves have existed. The language spoken by the Awa is Awapit. As of 1987, around 3,000 Awa were living in one continuous area of Ecuador while the remaining 6-8,000 were located in scattered communities throughout both Ecuador and Colombia (Chernela 2001). According to a more recent article in the Ecuadorian newspaper *El Comercio* from July of 2007, there were reportedly 22 different Awa communities between both Ecuador and Colombia. In Ecuador, 3,500 Awa were reported to be living in an area of 115,000 hectares in the provinces of Carchi, Imbabura, and Esmeraldas (Montenegro 2007).

The map below shows the area within Ecuador that is now recognized as the Awa territory (Figure 6)

Figure 6: Map of Awa Territory

4.1. Historical Internal Organization

Traditionally, the Awa community was organized by family, each living in their own dwelling of four simple walls forming a rectangle built from wood (Montenegro 2007). Before each male child is born, their father chooses a space of about ten hectares for them to live on once they have married and are ready to start their own family (Montenegro 2007). The political organization of the Awa prior to the demarcation of their lands (after which they formed the Federation) was family and community oriented and is described below by an Awa spokesperson in a 1997 planning group:

> Before [the existence of the Federation] the Awa obeyed the oldest member of the family. Problems that arose were treated at the level of each family, and it was unusual for people of different families and different communities to sit down together to discuss their problems and to seek common solutions. As long as the problems that confronted people were related to Awa life and the environment in which we lived, this system of family organization functioned well.
>
> (Chernela, 2001; 182)

The transition of this type of governing to that which is now in place will be discussed in section **4.5.**

4.2. Agricultural Practices

Awa subsistence practices today are very similar to their long standing traditions in that they still rely on hunting, gathering, fishing, and plant cultivation, while they have more recently added income-generating activities like animal husbandry (Chernela 2001). The Awa practice a form of swidden (shifting) agriculture specifically suited for their humid tropical climate. They cultivate 1.25 to 5 acre parcels of land for two to three cycles and then allow them to lie fallow for at least seven years. Their practice is called slash and mulch, to be distinguished from slash and burn, which the excessive rainfall in their area prohibits. In this practice the Awa cut down the vegetation and allow it to decay on top of the ground. A thin humus layer is formed in the mulch after a few days which provides a hospitable environment for sprouting seeds such as corn. However, once the forest cover is removed, the excessive rainfall leaches the important nutrients from the soil, leaving it fairly infertile, which produces decreasing yields after one or two harvests. This is the reason for the rotation of their crops, so as not to completely degrade their soils, and still creates a productive agricultural system in an otherwise unfavorable agricultural environment. The same erosion and leaching mechanism is at play in the palm plantations in surrounding areas, which likely contributes greatly to decreasing yields.

Additionally, the diversity encompassed in the agricultural practices of the Awa significantly contributes to their long term sustainability as a society partially reliant on agriculture. They plant a variety of species in the same field, as well as implementing the use of variations within each species. This provides them with a crop that encompasses differing resistance qualities, nutrient requirements, climate tolerance, and rates of maturation, all contributing to their agricultural success. This strategy of intercropping has proven to be more productive than monocultures in the tropics due to the high risks of crop loss due to disease and pest problems. This type of agriculture is very common among native lowland South Americans for this reason. (Chernela 2001)

4.3. Land encroachment

In addition to the centuries of pressures by European settlers on their lands, the Awa began to face different kinds of pressures in the twentieth century. Lumber companies threatened them from the Eastern lowlands, and ranchers invaded from the Western Andes (Chernela 2001). This created conflicts between themselves and their neighbors as to where the boundaries of their territories lie and “[d]isputes and disagreements resulting from counterclaims for the same lands were common (Chernela 2001: 179)."

Railroad access and the construction of roads began in the 1950's, bringing an "influx of newcomers" to the Awa territory. This 'progress' was seen to be both beneficial and detrimental to the Awa people as it provided them with access to outside markets as well as allowed for "accelerated penetration into their territory" by outsiders (Chernela 2001: 179).

4.4. The demarcation of Awa territory

In the early 1980's, Ecuador's Ministry of Foreign Relations was concerned over the control of the area in northwest Ecuador that borders Colombia and initiated a closer examination of land issues in the region. Between 1983 and 1989 a coalition of government agencies, international indigenous advocacy organizations, and CONAIE (Confederación de las Nacionalidades Indigenas del Ecuador; the confederation of indigenous nationalities of Ecuador) worked towards demarcating the Awa territory. Their efforts were considerably slowed by counterclaims for the land, continued activity by lumber companies, and ranchers and settlers that refused to leave Awa lands.

Finally, after negotiation and the provision of compensation for those being asked to retreat from the Awa lands, two major accomplishments arose. The first was the issuance of citizenship cards to over 1,100 adult Awa by the Ecuadorian government. The second was the long awaited, national demarcation of their lands.

The combination of biological and ancestral importance of the land created questions as to whether the appropriate classification would be as a biological reserve or an ethnic Indian reserve. According to the 1981 Ecuadorian forestry law, if the Awa land was designated a “forest reserve” it would be protected by the national government. Were they to designate the land as “Indian reserve” they would be given less titled land, but a “forest reserve” would be officially property of the state. Due to problems with “forest reserve” designations for other Ecuadorian indigenous peoples, CONIAE influenced the Awa not to settle for a “forest reserve” designation. After extensive negotiations, a compromise was reached combining the two categories to create the “Awa Ethnic and Forest Reserve”. This land was home to around 1,800 Awa, covered approximately 120,000 hectares (296,400 acres), and was designated for the purpose of preserving both the cultural and biological diversity of the area they inhabited (Chernela 2001).

4.5. Organization changes after demarcation[5]

Once the official communal rights to their lands were granted to the Awa, they quickly agreed on the necessity of establishing a political organizing system with which they could preserve and maintain control of them. The Awa spokesperson quoted by Chernela said:

> …when…lumbering and mining firms began to threaten the Awa territory, people realized that another kind of organization was necessary that would unite all the Awa in order to defend our lands, our forests, and our culture.
> (Chernela 2001)

It was a delicate matter to create such an organizing power, but the Federación de Centros Awa (federation of Awa centers of Ecuador (FCA)) was at last formed and was structured both to allow for equal representation of its members as well as mechanisms for interaction with national and global parties. Throughout these changes the Awa "maintained their strong traditional egalitarian values (Chernela 2001: 180)."

The Awa acquire essentially everything they use from the forests and the rivers including their food, medicines, and building materials (Chernela 2001). This dictated much of the actions of the newly formed FCA. They were now officially responsible for the management and protection of an ecologically and biologically diverse area. Their territory encompasses distinct habitats such as tropical wet forests, high and low montane forests, and upper and lower páramo zones. Tropical wet forests and páramo are two of the most endangered ecosystems in the world (World Wildlife Fund 2006). As displayed in the earlier description of the Awa subsistence systems, it was not new information to the Awa that their territory was fragile and required careful care. The following policies were created due to the potential influence of outside forces upon their internal society, not because of inherent problems with their lifestyle, which they had always accounted for with their traditional family organization style.

According to the FCA, all negotiations with outside entities, including miners, lumberers, and ranchers, must be discussed at their group meetings. As a result of such discussions, offers by lumber companies have been refused by the Awa and the cutting of timber by outsider is prohibited. Strict limits are also placed on the Awa themselves with regard to the removal of wood and wood products from their land, allowing it only in cases of urgency and even then it is limited to two trees at a time (Chernela 2001).

Fishing and hunting are also extremely regulated, and the sale of fish or game to outsiders it prohibited. The various Awa communities monitor animal population dynamics and hunt accordingly in order to sustain their populations. Such regulations have contributed to rising populations for many previously threatened animals.

The FCA has also established a clear boundary around the Awa territory referred to as the “green belt”. It is a ring of cash crops cultivated for added income and to discourage outsiders from squatting and invading their lands. This border also separates successful preservation from utter destruction of natural forests in northwestern Ecuador. In 1950, 80% of the coastal areas of Ecuador were still forested, now only 7% remains, almost half of which is inside the Awa territory (Chernela 2001). The Awa are proud of this result and realize the significance of their efforts, taking full responsibility for the preservation of their land. “The Awa have been described as an independent people who have zealously guarded their autonomy from outsiders and their lands from invasion. These attributes continue to characterize the Awa in spite of the many historic alterations to their lifestyle an increased interaction with outsiders (Chernela, 2001: 179).”

4.6. Changes in the Ecuadorian Constitution

In 1998, Ecuador officially amended their National Constitution to include specific rights to citizens of African and indigenous descent. The first parameter for the added statutes is that all those who self-identify as being of these ancestries form part of the Ecuadorian state, unique and indivisible (República de Ecuador 1998). Following are a few of the collective human rights guaranteed by the state that are pertinent to the farmers, campesinos, and oil palm producers in Ecuador.

-The right to maintain, develop, and strengthen their identity and traditions of spirituality, culture, language, social structure, politics, and economics.[6]

- Conserve the inalienable property of their communal lands, that are indivisible, expect for the faculty of the State to declare their public use. These lands will be exempt from property taxes.[7]

-Maintain the ancestral possession of their communal lands and to be awarded them freely, as the law states.[8]

-The right to participate in the use, revenues, administration and conservation of any natural resources found in their land[9].

-The right to conserve and promote their biodiversity and natural environment management practices.[10]

-The right to their systems, knowledge, and practices of traditional medicine, including the right to protect sacred areas for use of the plants, animals, minerals, and ecosystems vital to their practices.[11]

4.7. The Awa and current land conflict

4.7.1. March to Quito in July 2007

In protest to the treatment they were receiving from the State with regards to their territory, on July 6, 2007 approximately 2,000 Awa began a week long march to Quito with the objective of asking that El Ministerio del Ambiente and El Instituto Nacional de Desarrollo Agrario (INDA) (the Ecuadorian ministry of the environment and the national institute of agrarian development) respect their ancestral territories (El Comercio, 5 Julio 2007). They claimed that the government's previous dialogues, run-arounds, and documents had not served them at all and that the government had created the land trafficking conflict and therefore the Awa would stay in Quito until president Rafael Correa handed them clear and legal documents that assured them the tenancy of their territories (El Comercio, 5 Julio 2007). They stated that they rejected the resolution given to them by the Ministerio del Ambiente on January 12, 2007, for co-management of 99,336 hectares of their lands, in the area of Tululbí of San Lorenzo, Esmeraldas, with the Afro-Ecuadorian community (El Comercio, 11 Julio 2007). In an explanation as to why the community was upset, Olindo Natsacuaz, the president of the FCAE (Federación del Centros Awa del Ecuador) stated that they were tired of promises and had given the government plenty of time (El Comercio, 6 Julio 2007a). He also stated that they would not be returning to their territories until they had titles to their lands signed by INDA and the co-management resolution was withdrawn (El Comercio, 6 Julio 2007a).

In an interview during the march the next day, another spokesperson stated that the African palm plantation owners and those who clear-cut the forest have devastated the Esmeraldas province and that they will not allow the same to occur in their territories (El Comercio, 6 Julio 2007b). Throughout the march, the Awa carried wooden spears, that according to their customs signify that their action is in defense of their territory and they will utilize them if they are threatened (El Comercio, 8 Julio 2007). Figure 7 shows the picture taken by Édison Serrano of *El Comercio* of the Awa during this march by.

(photo by Édison Serrano of *El Comercio*)

Figure 7: Awa March to Quito July 2007

On July 10th, 2007, the group finally reached the capital, Quito and was housed in the Casa de la Cultura (cultural house). They had an appointment to meet with the vice-president, Lenin Moreno, that afternoon in the Presidential Palace. At that time they would ask for the title to their land (El Comercio, 10 Julio 2007).

That evening, Mr. Moreno told the Awa that he had signed a compromise. The compromise consisted of the government respecting the ancestral land rights of the Awa, and the Awa promising to conserve Mother Earth. The Awas who were present were pleased with this announcement and would remain in Quito until the following Friday. Gustavo Larrea, the Ministro de Gobierno recognized the Awa as stewards of the land by stating that they protect the forest that are the lungs of Esmeraldas and Carchi. The three parts to the compromise were the following:

1. Suspend the effects of the agreement signed on January 12, 2007 by the Ministerio del Ambiente, reinstating the original designation of the Awa lands of 1998

2. Guarantee that within five days the government would complete the compromises in the first part.

3. Formation of a commission of six representatives of the national government and the FCAE to be designated by mutual agreement. This commission would address previous documents with regard to the Awa land.

The vice-president also indicated that he would later that day meet with a commission of the Afro-Ecuadorian community to which the government had granted co-management of the land.

(El Comercio, 11 Julio 2007)

4.7.2. The Awa as Ecologically Noble Savages

In light of the statement noted earlier by the Ministro de Gobierno regarding the Awa community's reputation as good stewards of their land, the 'ecologically noble savage' again is applicable. Although it is often the case that the Awa protect their lands and maintain their forests in tact, it is done for their communal good, not in order to be the "lungs" of Esmeraldas and Carchi as the Minister stated, or because it is their duty to the rest of the country.

Additionally, the idea of the 'ecologically noble savage' relies on 'looking Indian' enough to be capable of tending to the land. The Awa dress in a Western style, not in their traditional attire, as a part of a broader strategy to dissemble or attempt to appear 'normal' to outsiders to avoid hostility and interference (Conklin 1997). This allows them to maintain their appearance of sameness to outsiders, facilitating the preservation of important Awa traditions like their language and shamanic practices. According to Jeffrey Ehrenreich, the Awa "assert their cultural conformity in order to control their political autonomy. Dressing as such, they can hide in the background of a hostile and openly racist social milieu… thus reducing the degree to which they are targeted by the aggression of outsiders based on easily perceived differences (Ehrenreich as cited in Conklin 2007: 717)". A study done by Catherine Lutz and Jane Collins about the perception that readers of National Geographic had of cultural authenticity showed that appearance and local costumes "suggest something about the social stability and timelessness of the people depicted (1993:92)". Outsiders judge the authenticity of indigenous peoples largely based on dress, which implies that if the traditional dress is missing from a community they are somehow culturally degraded, or less authentic. When outsiders view indigenous lowlanders as 'ecologically noble savages' it often implies that the more Indian one looks, the more dedicated to their preservation practices they must be. In the case of the Awa, their choice to blend in to preserve their culture is directly counter to this outsider's perception of the situation. Conklin discusses at length the role these perceptions have had in the land rights struggles of the Brazilian Indians, showing the link, from an outsiders perspective, between good stewardship and the appearance as Indian (2007). Although this has not been specifically discussed in the Awa situation, the larger context and similar cases presented here are indicative of the images and discussions occurring surrounding their land rights and dress.

4.7.3. Consequences for the Awa

The effects that palm plantations have caused for the Awa are serious. According to a report by a group of environmental and human rights NGOs who went and spoke with members of the Awa communities affected state that the Awa now have to walk much further to get clean water (Bravo 2007). They have "high levels of agro-toxins in their environment with resulting serious health problems (Bravo 2007)."

The Mandato de la Nacionalidad Awa (Awa nationality mandate) states the following:

> We are under strong external pressure from palmiculturas, among other industries. These industries continually disrespect our territory and have destroyed almost all of the original vegetation in the areas, which has severe negative effects: water contamination, disappearance of species of flora and fauna important for the survival of life for the communities (hunting, fishing, collection of fruits, fibers and medicines). We manage our territory and its natural resources in a sustainable way.
>
> (CONAICE 2007)

It is unclear whether or not the Awa have been directly or indirectly employed by the palm industry. It is known, however that the rural *campesinos* are involved in 'contract agriculture'. This is the practice of the large producers providing packets that contain seeds, toxins, fertilizers, etc. This can create a new dependence for the farmers that are unfamiliar with the business side of agriculture. Men, women, and kids work in this way without benefits and without any protection or training for agrochemicals (Acción Ecológica 2007).

4.8. Afro-Ecuadorians in Esmeraldas

The Afro-Ecuadorian population of Esmeraldas is very diverse and cannot be assumed to be one cohesive community, as is more appropriate for indigenous lowland populations. The complex history and cultural mixing that has occurred in the region has given rise to many different groups of Afro-Ecuadorians. All, however, face the same prejudices and difficulties within the Ecuadorian culture. According to Whitten, the "blacks, zambos, mulato, indigenous, and other Esmeraldeños of color are…becoming negreado (darkened, blackened) through political-economic moves of the powerful, just as their diversity is increasingly recognized through processes of interculturality (2007)". He also highlights the disagreement among Ecuadorians as to when, and for what reasons the self-assertion of black movements in Ecuador have emerged. He goes on to show that these movements have existed along side those of self-depreciation for centuries, and that they are not emergent as an afterthought to the indigenous movements in the region.

4.8.1. Current situation and organization

The structures of Afro-Ecuadorian communities are noteworthy, in that they differ from the organization of lowland indigenous groups, such as the Awa. For example, it is common for Afro-Ecuadorians to request individual titles for their lands rather than communal rights. This differentiates their treatment by the state from that of the indigenous groups and creates a distinct political dynamic between their communities and the national government.

The situation with African palm plantations in the area has exacerbated the already existing land rights issues and marginalization well known to the Afro-Ecuadorians. According to a report published in 2007, citing Rettet den Regenwald from Germany, many Afro-Ecuadorian communities have been displaced to poor neighborhoods in large urban areas due to the loss of their land through sale or force (Ernsting et al. 2007). They made statements indicating that the palm oil industry has broken up their communities, separating those who sold their land and those who did not, and has created a desperate situation for many (Ernsting et al. 2007).

4.8.2. Afro-Ecuadorians and the Awa

Due to the geographical location of both the Awa territory and the Afro-Ecuadorian communities, the development of the area has become an issue important to both communities. Without outside pressures, these two communities have existed with relatively peaceful interactions and communications. Globalization has brought outside interests and investments to the area, initiating conflicts over land rights and titles.

Although the timeframe for the land acquisition is unclear, at least one mechanism is known. Palm growers buy the Afro-Ecuadorians' land, due partially to lack of community organization to resist, and because they have individual titles to their land. Some of the Afro-Ecuadorians then, under pressure from the companies, claim a larger area than they own title to; land that is communal Awa land and would be otherwise off limits to the palm growers. This is an example of the common 'divide and conquer' strategy used often in acquiring access to indigenous lands in Latin America, and has been described as land trafficking by Batallas (nd). This disturbs an otherwise peaceful past between the Awa and the Afro-Ecuadorian communities (Acción Ecológica 2007).

5. Conclusion

The socio-cultural implications of this project are concerning. Placed into the context of a country still operating under colonizing marginalization and only beginning to address its diversity with ideas of inter-culturality, the situation becomes one of many that exacerbate the already existing wealth gap in Ecuador. The transformation of small farmers' land to large plantations, and especially monocultures has a long history of disaster for both the environment and those who depend on that environment.

In addition to this land transfer, the specific land rights presented here with regard to the Awa and the Afro-Ecuadorian populations are especially disconcerting. The threat to the lifestyle of the Awa in particular, would indicate that the expansion of these palm plantations into their territory need be discouraged. As the frontier of monocultures creeps closer to their land, their hunting, gathering, fishing, and planting way of life becomes increasingly difficult to maintain.

The international connection made by the exportation of the biodiesel to the United States creates associations for the Awa from the outside that are detrimental to their survival. As 'ecologically noble savages' they are viewed as serving the same purpose as the biodiesel agenda, when the reality is that their way of life is simply that, the way they live, regardless of the pressures placed on them from without. The actions taken by the Awa and described in this report serve to establish them as a people who will not accept exploitation and who will not become the passive people they are often depicted as to the rest of the world. They are a people who have survived this long by fighting for their community, and will continue to do so in whatever world is formed around them.

CHAPTER THREE: ARTISTIC REPRESENTATION

1. Introduction

The inclusion of an artistic element in this project has motivation on many levels. On a personal level the process of creating art in reflection to the issues that arose during this research was therapeutic and beneficial to my own understanding of both the issue and how I relate to it. I found this process to be particularly beneficial for me in the exploration of the connection between Ecuador and the United States with regard to this issue, as is reflected in the content of the pieces.

On a larger scale, the intersection between art and science motivated these works. The international element of the project also allowed for the opportunity for me to share the Ecuadorian art influences I personally have had, both in class at PUCE and while living there, with the art community in Corvallis.

2. Photographs and Artist Statements of pieces

2.1. El intercambio

Monotype ink on paper

Artist Statement

When one observes the hands and feet of another, language and culture become irrelevant. We all have the same hands; some are worked to the bone with dirt under the nails, others are neatly manicured for another kind of work. Our hands make us human and when we see the human in others, the rest takes care of itself.

Explanation of Images

This piece reflects this process in me, as I learned about a culture not my own. The piece is a triptych and is meant to be viewed in the orientation pictured in Figure 8. The piece on the left, entitled "El Ecuador" depicts an Awa woman's foot while seated in her home and a fisherman's hand while checking his day's catch; everyday life for them (Figure 9). The print on the right, entitled "EEUU" depicts a hand filling a gas tank and another driving a car; the biodiesel in use (Figure 10). The piece in the middle, entitled "El intercambio" (the exchange) reflects the ironic juxtaposition created in search for a sustainable solution in a globalized world, combining the other two pieces (Figure 11).

Figure 8: Image of entire "El Intercambio" piece

Figure 9: Image of “El Ecuador”

Figure 10: Image of “EEUU”

Figure 11: Image of “El Intercambio”

2.2. Portrait of Awa Woman

Charcoal on paper

Explanation of Image

This is a portrait of an unnamed Awa woman looking out the window of her house that was published in *El Comercio* while I was visiting Ecuador in July 2007. I was intrigued by the image as soon as I saw it and replicated it in charcoal as closely as possible.

Figure 12: Image of “Portrait of Awa Woman”

2.3. El proceso de la investigación

Color photocopies of travel sketchbook/journal

Artist Statement

This is a piece about the journal I kept on my trip to Ecuador in July 2007. It is a representation of the various pages that were highlights of my experience as a foreigner doing research in a country with which I am fascinated and forever intrigued by. The journal reflects a growing process that began before I arrived there the second time and that I hope will continue forever. The original journal was too precious to allow out of my hands, but this piece serves to give others an insight into the process I experienced in assimilating the multiple 'me's' created in the process of studying abroad.

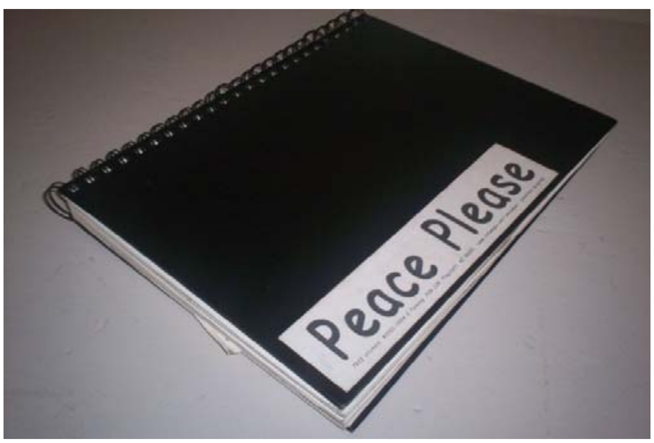

Figure 13: Image of Travel Sketchbook and Journal

Figure 14: Image of "El proceso de la investigación"

3. Conclusion

The artistic perspective of this project was the most meaningful for my personal growth and understanding. Art creates an accessibility that science often fails to obtain, and the inclusion of art in this project served to engage its audience on a different level than the rest of the research. In future endeavors of this kind, art could play a significant role.

Conclusion

After careful examination of this case study in energy alternatives, it becomes even more obvious that no easy answer to the energy quest at hand is available. All energy sources produce pollution and change part of the Earth in some way. This necessitates careful investigation into each fuel source and accurate accounting for its effects. One way that would be helpful for energy policy, is to measure the sustainability of each fuel not based on monetary values, but rather on the basis of reduction of overall greenhouse gases, including all aspects of production in the equation. If the global community fails to engage in these types of analyses, it will soon face similar problems due to the impacts of renewable energy as it is currently facing with those from fossil fuels. In all cases it is impossible to divisively separate the environmental and socio-cultural effects of fuel production, as has been shown in this case.

Notes

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[1] Sustainability is used in this report in two ways: One is in this general sense in that it is something that can continue to be produced without causing permanent harm to the environment or leaving the next generation with our problems. The second way it is used is with regard to yields. In this sense a sustainable yield is defined as a stable yield that the land is able to support year after year, without significant additions necessary. There is ambiguity involved in the definition of this word, and for the purpose of this report it will be used to generally to indicate a practice that has as little environmental and other impact as possible, although via a complete understanding of Earth systems, this is never entirely possible.

[2] In light of addressing the energy involved in the processing of the raw oil into biodiesel, it is useful to consider if it would be more efficient to use the palm oil directly as a fuel via thermo-chemical processing? Canola oil is known to work in this regard, and the chemical differences between palm and canola oil seem to be marginal enough for at least a blend to be successful.

In a collaborative project between the University of Colorado at Boulder Biodiesel student group and the community of Gaviotas in Eastern Colombia, a tractor was successfully converted to be able to run on straight palm oil (Belser and Hedlund 2004). The climactic conditions in this area of Colombia seem to somewhat comparable to those in some areas in Ecuador, perhaps indicating a use for straight palm oil as a domestic fuel for Ecuador.

[3] All translations from Spanish are mine unless otherwise stated.

[4] Latin America is defined as Mexico and to the South, including Central and South America. North America then refers to only the United States and Canada.

[5] This is the process of having ones land officially measured and the borders recorded. It is the first step to obtaining official title to ones land.

[6] Original text: “Mantener, desarrollar y fortalecer su identidad y tradiciones en lo espiritual, cultural, lingüístico, social, político y económico (Capitulo 5, Sección primera Art. 84.1)”.

[7] Original text:” Conservar la propiedad imprescriptible de las tierras comunitarias, que serán inalienables, inembargables e indivisibles, salvo la facultad del Estado para declarar su utilidad pública. Estas tierras estarán exentas del pago del impuesto predial (Capitulo 5, Sección primera Art. 84.2)”.

[8]Original text: “Mantener la posesión ancestral de las tierras comunitarias y a obtener su adjudicación gratuita, conforme a la ley (Capitulo 5, Sección primera Art. 84.3)”.

[9] Original text: “Participar en el uso, usufructo, administración y conservación de los recursos naturales renovables que se hallen en sus tierras (Capitulo 5, Sección primera Art. 84.4)”.

[10]Original text: "Conservar y promover sus prácticas de manejo de la biodiversidad y de su entorno natural (Capitulo 5, Sección primera Art. 84.4)".

[11]Original text: "A sus sistemas, conocimientos y prácticas de medicina tradicional, incluido el derecho a la protección de los lugares rituales y sagrados, plantas, animales, minerales y ecosistemas de interés vital desde el punto de vista de aquella (Capitulo 5, Sección primera Art. 84.4)".

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APPENDIX

APPENDIX

Human labor cost calculation:

(100 -150 bunches/man/day) (4kg oil/bunch) = 400-600 kg oil /man/day

Density of palm oil is approx 0.91 cm^3 which will be assumed to be 1 for this calculation. Therefore, it becomes 400-600 L, which converted to gallons is approximately 100-150 gallons palm oil/day/man.

Since biodiesel conversion rates are around 90%, this will be ignored and the final number, as stated in the text was 100-150 gallons palm biodiesl per man per day. This is a high end estimate of the labor required to produce palm biodiesel. The lowest yields provided by the Palm Plantations of Australia website were used (Duke 1996, and "Oil palm trees").

Yield Calculations:

<u>Old field depletion model example calculations:</u>

1995 = 51,996.73 ha producing at 15 MT/ha = 15 MT/ha

1996 = 56,957.34 ha total

51,996.73 ha producing at 14 MT/ha, 4,661 ha producing at 15 MT/ha =

[51,996.73 ha x 14 MT/ha] + [4,661 ha x 15MT/ha] / 56,957.34 ha = **14.01 MT/ha**

<u>Decreased productivity in newer fields example calculations:</u>

2003: 153,623.39 ha total

112,725.23 ha producing at 15 MT/ha and 40,898 ha (16,135 ha +24,763 ha) producing at

8 MT/ha:

[112,725.23 ha x 15 MT/ha] + [40,898 ha x 8 MT/ha] / 153,623.39 ha = **13.13**

<u>Age dependent yields example calculation:</u>

2003 : Total = 153,623.39

[(51,996.73 ha x 8 MT/ha) + (4,661 ha x 15 MT/ha) +(8,291 ha x 4 MT/ha) + (6,962 ha *13 MT/ha] + (12,230 ha x 12 MT/ha) + (12,500 x 11 MT/ha) + (15,872 x 10 MT/ha) + (16,135 x 9 MT/ha) + (24,763 x 8 MT/ha) / 153,623.39= **9.63**