Large-scale banana production has been conducted in Central America since the beginning of the 20th century. The development and success of this industry has resulted in the complete alteration of tropical lowland environments from Mexico south to Panama. Hundreds of thousands of hectares of rich and diverse tropical ecosystems have been transformed into the monotonous and chemical drenched landscapes of banana plantations.

The banana industry is almost entirely controlled by three large fruit companies: Chiquita, Dole, and Del Monte. Many Central American countries depend on the revenue, employment and jobs that these corporations provide. This dependence has allowed these transnationals to become very powerful and influential in the social, political, and economic activities the region.

Most of the bananas produced in Central America are exported to industrialized countries. The high demand for low cost and blemish free fruit has greatly influenced the cultivation methods utilized by banana growers. Only a change in consumer demands for a more sustainably produced fruit will push the industry to end the continued devastation of the biophysical and social environments of Central America.

**Geographic Location**

Banana plantations have been developed primarily along the Caribbean Coast of Central America where the high temperature, rainfall, and rich alluvial soil are suitable for the large-scale production of this tropical fruit. Lowland regions of the Caribbean Coast, at elevations below 250 ft., generally exhibit high annual temperatures averaging around 24° C, with little diurnal variations in temperature (Hall, 1985). These lowlands are primarily composed of a mixture of volcanic and alluvial soil, providing the necessary nutrients for banana growth. An average of 80 to 120 inches of rain falls per year, with no pronounced dry season (West and Augelli, 1989). This high rainfall makes crop irrigation unnecessary, but necessitates the installation of drainage canals to prevent flooding.

During the 1930’s, Panama disease, a root fungus, severely damaged crops along the Caribbean Coast and forced plantations in this region to be abandoned. As a result, production shifted to the Pacific Coast. Unlike the Caribbean Coast, the Pacific Coast generally experiences a three-month dry season, from January to March, making irrigation necessary. In the 1940’s, Panama disease spread to the Pacific zone and production subsequently declined. During the 1960’s disease resistant varieties were found and introduced to the region and production once again shifted to the Caribbean Coast. Some plantations remained along the Pacific Coast, but the Caribbean became the dominant banana-producing zone in Central America.

**A Historical Overview of Banana Production**

Edible varieties of bananas are native to tropical regions of Asia. They were introduced to the Caribbean Islands early in the period of Spanish colonization. The fruit was first brought to the United States during the 1860’s aboard ships on route from Jamaica. An expanding US market led to the formation of the Boston Fruit Company which purchased the fruit from producers in the Caribbean Islands and marketed it in the United States (May and Plaza, 1958)
Bananas were first grown commercially in Central America during the 1870’s when Minor C. Keith, an American entrepreneur commissioned by the Costa Rican government to construct a transnational railroad, began planting bananas along his railroad and exporting them to the United States. Keith’s venture was highly successful and through subsequent railroad contracts, Keith was able to acquire large tracts of undeveloped land and expand banana production into Guatemala and Honduras. In 1889, Keith merged his business with The Boston Fruit Company and The United Fruit Company was formed (May and Plaza, 1958; Kepner, 1967; Vandermere and Perfecto, 1995). United Fruit rapidly expanded throughout Central America. At its formation in 1889, United Fruit held 84,957 hectares of land in Central America, with 24,505 hectares in production. By 1955, landholdings had grown to over 400,000 hectares with 53,200 hectares in production (May and Plaza, 1958). Although other major banana producers such as Standard Fruit Company existed, United Fruit held a monopoly over the industry until the 1950’s.

In the early 1950’s, the possibility of government sponsored agrarian reform programs to redistribute company lands in Central America motivated banana corporations to voluntarily reduce their land holdings. Transnationals divided their land into smaller parcels and leased them to growers. These independent growers formed contracts with the fruit companies agreeing to sell their fruit only to the transnationals, who would be in charge of transport, marketing, and distribution abroad. Banana corporations maintained strict control over the growers, fixing prices and volumes. These independent contracts became win-win situations for the fruit companies: They were able to maintain profits and control, yet eliminated all risks of production (Barry, 1987).

The transfer of company lands to independent growers did not eliminate the plantation system or company expansion entirely. By 1980, of the 26,000 hectares in production, only 7,300 hectares were cultivated by contracted growers. Banana cultivation in plantations, greater than 5,000 hectares was and still is practiced (Nelson, 1987).

The banana industry in Central America is still controlled by U.S. based fruit companies. Chiquita Brands (formerly United Fruit), Dole (Standard Fruit), and Del Monte are the "big three" banana producers. Together, these companies control over 65% of the world banana exports (Thomson, 1987).

**Biophysical Transformations**

The natural ecosystem of the Caribbean lowlands is biologically rich and diverse. The warm and wet tropical climate of the region supports dense tropical moist forests. Many species of plants, mammals, birds, reptiles, and insects inhabit these forests. The Caribbean coast is traversed by numerous streams which support a variety of plant and animal life. Near the sea, marshes and mangrove swamps provide habitat for many species including mangroves, unique trees which have adapted to and thrive in the brackish water of the mangrove swamps. Sea turtles nest along several beaches of the Caribbean Coast, and the warm tropical ocean water supports magnificent coral reefs abundant with marine life.

The development of banana plantations requires the complete transformation of the Caribbean lowland environment. Marshes are drained to allow for cultivation of the fruit and construction of the plantation. The diverse tropical forests are completely removed right up to their river banks and replaced with banana trees. Streams are channelized and drainage canals are constructed to prevent flooding of the fields. Agrochemicals are applied to the land to insure high yields. The fertile Caribbean lowland ecosystem is completely removed and transformed into a homogenous and chemical laden landscape.
The greatest amount of primary forest deforestation for bananas occurred from 1870 to 1960 (Astorga, 1998). During this time banana plantations were “developed from virgin land, covered…with forest and dense tropical undergrowth” which contained the highest nutrient quality (Reynolds, 1927). The prevalence of Panama disease and rapid depletion of soil nutrients required production to be migratory, with new land cleared as yields declined. The following quote, from a United Fruit company engineer in charge of opening new regions for production, describes the characteristics of production during this time:

The Panama Disease used to kill everything. The only solution was to get a hold of new lands. It was not possible to maintain bananas once the disease struck. So when one farm died off another was planted, one would die another was planted, one would die another was planted, and once the division was played out you would have to leave the country and find another (Bourgois, 1989).

There were few government restrictions of the expansion into primary forest land and companies operated free of monitoring and regulations.

After 1960, the rate of virgin deforestation slowed with the introduction of two disease resistant varieties of bananas that allowed the development of regenerated secondary forests or fallowed areas that were former plantations along the Caribbean Coast. The vigorous growth and high yields of these new varieties enabled production to continue in one area for a longer period of time without a decline in production. Increased pesticide and fertilizer use permitted soil fertility to be maintained and decreased crop loss to pests and diseases.

The 1990’s have been characterized as a period of increased deforestation of primary and secondary forest for expanded cultivation along the Caribbean Coast. In the early 1990’s, the "big three" banana companies, in anticipation of future profits from the opening up of markets in Eastern Europe and the formation of the European Union, began expanding production (Vandermere and Perfecto, 1995; Astorga, 1998). The area under cultivation increased from 20,000 hectares in 1985 to 32,000 hectares in 1991 (Vandermere and Perfecto, 1995). By 1996, 52,000 hectares were being cultivated (Mora, 1998). Thirty five percent of the 32,000 hectares recently expanded into production were under forest cover at the time of purchase by banana companies (Vargas, 1998). Although there are regulations against the deforestation of primary forest land, the land buffering national parks, and the vegetation along river banks, these laws have repeatedly been violated (Mora, 1998).

The development of banana plantations has opened up new areas of previously undeveloped forest, resulting in increased deforestation. The first European settlers avoided settlement along the Caribbean lowlands because they found the swampy land, high rainfall, and the prevalence of tropical diseases such as malaria inhospitable. Only small groups of indigenous people were able to inhabit these locations. In these largely unoccupied and densely covered forest regions, banana companies carved out large plantations and company towns and built roads and railways to connect major commercial and production areas. The development of these regions allowed settlement in areas that were previously inaccessible.

The unequal distribution of land in Central America has created numerous landless farmers forced to settle wherever land is available. The most fertile agricultural land is usually controlled by large export producers while many subsistence farmers are landless. For example, in Honduras, only four percent of the country’s landowners control 56% of the farmland while approximately half of the population is landless and forced to practice shifting agriculture on any available unoccupied land. (Barry, 1998; Norsworthy, 1993). When new land is opened up by
development, such as banana plantations, landless people are given access to new forest land to practice subsistence farming. This land is often of poor quality or on steep slopes. Productivity on the land deteriorates rapidly from erosion and leaching of nutrients and shifting cultivators are forced to migrate even deeper in the forest to farm.

The result of the increased deforestation directly and indirectly caused by the banana industry has impacted the physical and biological environments. About 75 percent of all diversity is held within the tropical forests (Ashton and Panayotou, 1992). The destruction of the rainforest habitat results in a loss of some of this plant and animal diversity. In the Sarapiqui Valley of Costa Rica, recent banana expansion has resulted in the near extinction of 18 known tree species (Mara 1998). It is important that further destruction of lowland tropical forests is prevented to protect the numerous species of plants and animals which inhabit them.

The removal of all vegetation exposes the soil to the intense and frequent rainstorms characteristic of the tropical lowlands. The high amount of rainfall percolating through the soil quickly leaches out nutrients. Water that is not absorbed by the soil becomes runoff and erodes the soil. As the soil becomes compacted by the intensive cropping, machinery, trampling of soil, removal of organic material, and pounding of rain, the soil’s ability to absorb water decreases and runoff and erosion increases. The removal of vegetation along streams destabilizes their banks and increases lateral erosion. The result is the rapid erosion of the once fertile floodplains and increased sedimentation in streams and water bodies.

Significant alterations to the natural hydrology of the Caribbean lowlands must be done in order to create an environment suitable for large scale banana production. Banana roots cannot be submerged in water, so the numerous marshes of the lowlands must be drained. The drainage of the land causes a lowering of the water table and impacts local water supplies. Streams, naturally prone to flooding because of the abundant rainfall in the region, are channelized. The straightening of the river increasing the velocity of water moving through the channel and subsequently increases the occurrence and severity of downstream flooding. Numerous drainage canals are constructed to drain off excess water from the fields. During periods of heavy rainfall these ditches increase the volume and velocity of water flowing through the channel, further aggravating downstream flooding.

**Agrochemical Use**

Maintaining high yields of cheap and blemish free fruit requires frequent and intense applications of agrochemicals. Fertilizers must be applied to meet the high nutrient requirements of the crop and to compensate for nutrient loss to weathering. Herbicides are used to keep the ground free of vegetation. Nematicides must be applied directly to the soil around the base of the trees to protect the roots from nematode damage. Aerial applications of fungicides are done up to 50 times a year to battle the destructive Black and Yellow Singatoka fungi. In the packing facility, workers apply fungicides and disinfectants such as formaldehyde to the fruit to protect it during shipment. The result of this intensive chemical use has been the contamination of lowland environments.

It is estimated that approximately 30 kg/ha/yr. of pesticides are applied to Central American banana plantations, ten times the amount used for agriculture in industrialized countries (Wheat, 1996). Many of the chemicals used on banana plantations have been heavily restricted or banned for use in the United States, from where most pesticides manufactured and exported from. Two pesticides frequently used by banana growers, Paraquat and Parathion, have been placed on
Pesticide Action Network’s “Dirty Dozen” list because of their toxicity and potential danger to humans and wildlife. (Barry, 1987; Astorga, 1998).

Excessive chemical use has contaminated the soil on plantation land. Many abandoned plantations have large amounts of copper in the soil. Copper concentration in uncontaminated soil is 20 to 50 PPM, while abandoned plantations have concentrations as high as 4000 PPM (Astorga, 1998). In many regions, such as the South Pacific lowlands of Costa Rica, the land has been so contaminated that future agricultural use is impossible.

In regions proximal to banana plantations, where monitoring has been conducted, residues from agrochemicals have been detected in the soil, ground, and surface water. During the mid 1980’s studies done in the Valle de Estrella region of Costa Rica found residues of fungicides in wells and rivers in concentrations two times that known to cause adverse impacts to fish (Astorga, 1998). In the Chinandega region of Nicaragua, it was found that the aquifer that supplies water to the region is heavily contaminated by 30 different pesticides, many used on banana plantations (Wheat 1996). The total extent of the environmental contamination can only be estimated because there is little funding is available to local governments to conduct monitoring and many contaminated areas may go undetected and untreated.

After heavy rains, drainage canals from banana plantations inundate nearby streams and water supplies with contaminated water and sediment, adversely impacting aquatic life. During one month in 1994, five massive fish kills were reported in the Cariari banana region of Costa Rica. Deposition of sediment carrying large quantities of nutrients from fertilizers used on plantations has caused increased algae growth in water bodies. These algae blooms cause a decrease in the dissolved oxygen content of the water, harming aquatic life. It is estimated that sediments from banana plantations are partially responsible for the destruction of approximately 90% of the coral reefs along the Caribbean Coast of Costa Rica (MacKerron, 1993).

Plastic bags coated with Chlorpyrifos, a neurotoxic pesticide, are used to cover the maturing fruit and protect it from insect damage. Disposal of these bags has been a problem for many growers. The most common method of disposal is in open air dumps. The bags are not contained in the disposal sites and they often blow out and litter the surrounding landscape. This is especially troublesome when they end up in streams or the ocean, where they cause problems for aquatic life. Sea turtles have been found suffocated by the bags after mistaking them for jellyfish.

Workers on banana plantations come in daily contact with pesticides and face the greatest risk from chemical contamination. In 1987, 6% of paid banana workers in Costa Rica reported a pesticide accident, the highest percentage of reported on the job accidents in the world (Wheat, 1987). The actual occurrence of injury related to chemical exposure may be greater because many incidents go unreported. Examples of injuries include head pains, dizziness, faintness, burns, eye inflammation, and respiratory problems (Barry, 1987). The most dramatic illustration of the impacts of pesticides to human health was the mass sterilization of over 10,000 Costa Rican banana workers during the 1970’s and 1980’s from the use of the nematicide DBCP. By 1987, ten years after being banned in the United States, DBCP was finally banned on Central American banana plantations (Barry, 1987).

A majority of the accidental poisonings that occur on plantations are partially due to lack of safety instruction and equipment. Independent growers are persuaded by chemical companies and transnationals to use pesticides to increase productivity, with little instruction on the dangers of these chemicals. High temperatures and humidity prevent many workers from wearing the necessary safety equipment such as respirators, rubber gloves and boots, and heavy coveralls. Many workers cannot read the handling instructions because they are either are illiterate or
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unable to read the English labels. Rural farm workers, uninformed on the dangers of pesticides, have been observed using chemically treated plastic bags as raincoats and empty pesticide containers for food and water storage (Barry, 1987). Many Central American countries have attempted to control, regulate, and monitor pesticide use on banana plantations but have been ineffective due to inadequate funding and lack of control over transnationals.

Economic, Political, and Social Transformations
The income, employment, and development generated by banana production is important to Central American economies. In regions where jobs are scarce and foreign debts are enormous, the economic benefits are needed. The revenue from bananas is so promising that many Central American governments have done almost anything to attract the fruit companies. The development and reliance on this industry has led to a transformation of the economic, political, and social landscape of the region.

The banana economy is almost entirely export oriented. Approximately 85% of the fruit grown Central America is exported to industrialized countries (Thomson, 1987). The United States is the largest banana consumer, importing an average of 3.7 million tons of the fruit each year (Baxter, 1998).

The export of this fruit has been important to many Central American economies. In 1955, bananas accounted for 41% of Costa Rican, 18% of Guatemalan, 50% of Honduran, and 74% of Panamanian exports. Today, bananas make up approximately 39% of exports from the entire region and are the top export crop of Honduras, Panama, and Costa Rica (Barry, 1987; Norsworthy and Barry, 1993).

Although the foreign exchange from banana exports is great, the potential economic earnings are often not fully realized by the exporting countries. Of world banana trade as a whole, "only 11.5% of the total value of bananas generated at the retail level accrues as retained value to the national economies which support them". The remaining 88.5% accrues to foreign enterprises such as transnationals, wholesalers, and retailers, owned and operated by citizens of importing countries (Thomson, 1987). If exporting countries could gain more control over the banana industry, it is possible that they could increase their export earnings.

Banana plantations employ 5 to 10 percent of the population of Honduras and Costa Rica (Astorga, 1998). In Costa Rica, each worker produces approximately $20,000 per year for the transnationals but is compensated the minimum wage of only $2,000 per year (Mora, 1998). Workers are often required to work 10 to 12 hour days, six to seven days a week, of physically demanding labor. Thirty percent of the workers are permanent, while the remaining 70% are on ninety day contracts. Many workers must move from plantation to plantation to find work. These migrant workers never acquire the vacation, gratuities, and social security that permanent employees do (Mora, 1998).

The multinational fruit companies have developed many regions of Central America. They have constructed fully functioning company towns in primarily rural or undeveloped regions. They have constructed hospitals, schools, roads, railways, and communication systems to support their plantations.

However, this development has not improved the living conditions for all who occupy them. While supervisors and executives live in large one and two family homes with access to luxuries such as air conditioning, country clubs, swimming pools, bowling alleys, and golf courses, a majority of the workers live in squalor. The typical company barrack is a 2.3 by 3.3 meter room occupied by
as many as four people (Bourgois, 1989). Bars, brothels, and soccer fields are the primary social activities for workers. Alcoholism, violence, disease, sexual abuse, drug addiction, prostitution, crime, racism, erosion of the family unit, and juvenile delinquency are common problems on the plantation (Bourgois, 1989; Mora, 1998).

Banana development has historically been characterized by rapid development and even more rapid economic decline. Disease, storms, wars, and market fluctuations are all factors which have resulted in a decline and abandonment of production. Several regions in Central America have been completely abandoned by the banana industry and faced severe economic depression. For example, the Costa Rican city of Quepos, was developed as a major Pacific port during the 1930's. Production ended in Quepos in 1956 when Panama disease became established. Abandoned company land was used for African oil palm and cocoa production. These new crops only employed 700 people, compared with the 5,600 employed on the banana plantations (May and Plaza, 1958). The region suffered a great economic depression and many residents left the area, making Quepos the only town in Costa Rica to register a decline in population during the second half of the twentieth century (Hall, 1985). This boom bust pattern has been experienced in banana regions all over Central America.

The Central American governments have done almost anything to attract the potential export revenues, employment, and development provided by the banana industry, allowing the fruit companies to gain great political power. Banana companies have used this to their advantage, receiving large tracts of land at little to no cost, low export taxes, and immunity from labor and environmental laws. The following letter, written in 1920 by H. V. Ralston of United Fruit to the company’s lawyer in Honduras, exemplifies the company’s economic control in Central America:

…obtain rigid contracts of such a nature that no one can compete against us, not even in the distant future, so that any enterprise that could establish and develop itself must be under our control... We must obtain concession, privileges, franchises, repeal of custom duties, freedom from all public liens, burdens, and all those taxes and obligations which restrict our profits and those of our associates. We must erect a privileged situation in order to impose our commercial philosophy and our economic defense. (Thomson, 1987)

One of the methods utilized by the fruit companies in Honduras to achieve their "privileged situation" has been bribery. In 1975, United Fruit Company gave Honduran President Lopez Arellano a one million dollar bribe to repeal an export tax on bananas. After this was discovered, Arellano was removed from office (Rudolph, 1984).

One of the most well known examples of the power of fruit companies was their involvement in Guatemala during the 1950’s. During this time Guatemala’s democratically elected president, Jacoba Arbenz, initiated and agrarian reform program to redistribute unused United Fruit company land to landless peasants. In response, United Fruit began pressuring the Eisenhower administration to overthrow the Arbenz government. The company produced propaganda such as Why the Kremlin Loves Bananas, a film likening Guatemala's reform programs to the evils of communism. United Fruit’s campaign was a success, and in 1954, the CIA led a coup in Guatemala which overthrew the Arbenz government and replaced him with a president who returned all of United Fruit's landholdings. Fear of losing corporate land in other countries from agrarian reform prompted the fruit companies to begin the transfer of land to independent growers (Barry, 1987).

The potential earnings of the banana industry continues to influence political decisions. For example, in 1985, Costa Rica issued the Banana Promotion Plan, which attracted increased production by providing tax benefits, deregulation of labor and environmental laws, permission to
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use new agricultural lands, and favorable exchange policies (Mora, 1998). The result has been expansion of production in the Sarapiqui Valley.

Through political concessions, transnationals have been able to obtain large land grants. Approximately 85% of the best agricultural land is used to grow export crops such as bananas, coffee, and sugar (Barry, 1987). This uneven distribution of land has resulted in an inability for Central American countries to produce enough food to meet domestic needs. For example, between 1960 and 1985, Honduras experience a 31% decline in per capita production of basic grains (Norsworthy, 1993). To compensate for this loss, they increased cereal grain imports by ninety percent (Norsworthy, 1993). The inability of countries to meet their own food needs has increased their economic dependency on developed countries not only to purchase their exports but also to import their food.

Alternative Growing Methods
The revenue and employment provided by the banana industry is extremely important to Central American economies. However, the environmental, political, and social impacts created by the industry often outweigh the benefits. The demand for perfect, low cost fruit by industrialized countries has contributed to many of the unsustainable production methods such as increased deforestation and widespread agrochemical use. Consumers in the developed world can push growers to utilize better growing methods by only purchasing certified or organic bananas.

The Rainforest Alliance and the Costa Rican based Ambio Foundation have implemented and "Eco-ok" certification program which attempts to push growers to implement growing techniques that are better for humans and the environment. Chiquita is the first major banana producer to endorse the certification program. Although not all Chiquita plantations in Central America have been "eco-ok" certified, the company has spent one million dollars to improve and certify all of its Costa Rican facilities. In accordance with Ambio and Rainforest Alliance guidelines, Chiquita has installed solid waste traps in packaging facilities to reduce river contamination, rebuilt warehouses to contain chemicals, started monitoring water quality, reforested waterways, and began composting organic waste. Although agrochemicals are still applied, pesticide application has been automated, showers have been installed so workers can wash off after contact with chemicals, and safety training programs have been implemented. Chiquita planned to have all 240 of its plantations certified by 2000 (Baxter, 1998).

Large scale organic production is difficult, if not impossible. However, numerous small growers are able to grow bananas organically. Small growers have a difficult time competing with the large fruit companies and have found it difficult to produce near large plantations because chemical contaminated runoff and aerial drift can enter their plantation and prevent them from becoming organically certified. Despite the difficulties, there is an expanding market for organic bananas in the US.

Conclusion
The construction of banana plantations along the lowland ecosystems of Central America has resulted in numerous ecological and social transformations. Forests have been cleared, rivers altered, landscapes poisoned, politicians bought, and governments overthrown. Despite the known problems associated with the banana industry, Central American people and governments often welcome the fruit companies for the economic benefits they can provide. The continued destruction of the natural environment must end but not at the expense of the revenue and
employment provided by the industry. Instead production methods must be implemented which reduce agrochemical use, evenly utilize agricultural resources, reduce the dependence upon industrialized countries and transnationals, and truly improve the quality of life of the workers that produce the crop. Although the implementation of more environmentally and socially sustainable growing methods cannot reverse the transformations that have already occurred, they may help to prevent future alterations to lowland tropical ecosystems.

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