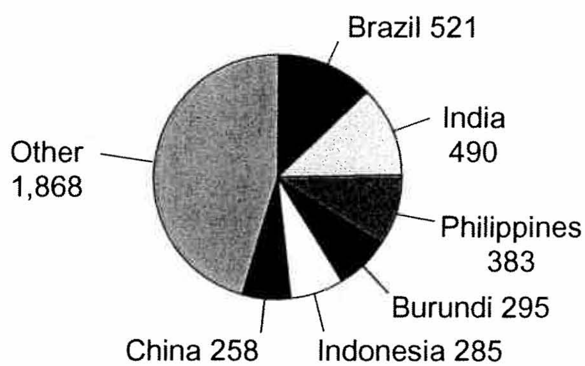
Bananas *Musa acuminata* and *M. paradisiaca*

Production	
Area Under Cultivation	4.1 million ha
Global Production	67.5 million MT
Average Productivity	16,463 kg/ha
Producer Price	$116 per MT
Producer Production Value	$7,822 million
International Trade	
Share of World Production	21%
Exports	14.2 million MT
Average Price	$303 per MT
Value	$4,306 million
Principal Producing Countries/Blocs (by weight)	India, Ecuador, Brazil, China, Philippines, Indonesia
Principal Exporting Countries/Blocs	Ecuador, Costa Rica, Colombia, Philippines, Guatemala, Honduras, Panama
Principal Importing Countries/Blocs	United States, Germany, Japan, United Kingdom, Italy, China, Russia
Major Environmental Impacts	Conversion of primary forests Soil erosion and degradation Agrochemical use Solid wastes Water use
Potential to Improve	Good Organic, eco-label, and fair trade certifications exist BMPs have been identified and are cost effective to implement Large companies involved in reducing production impacts

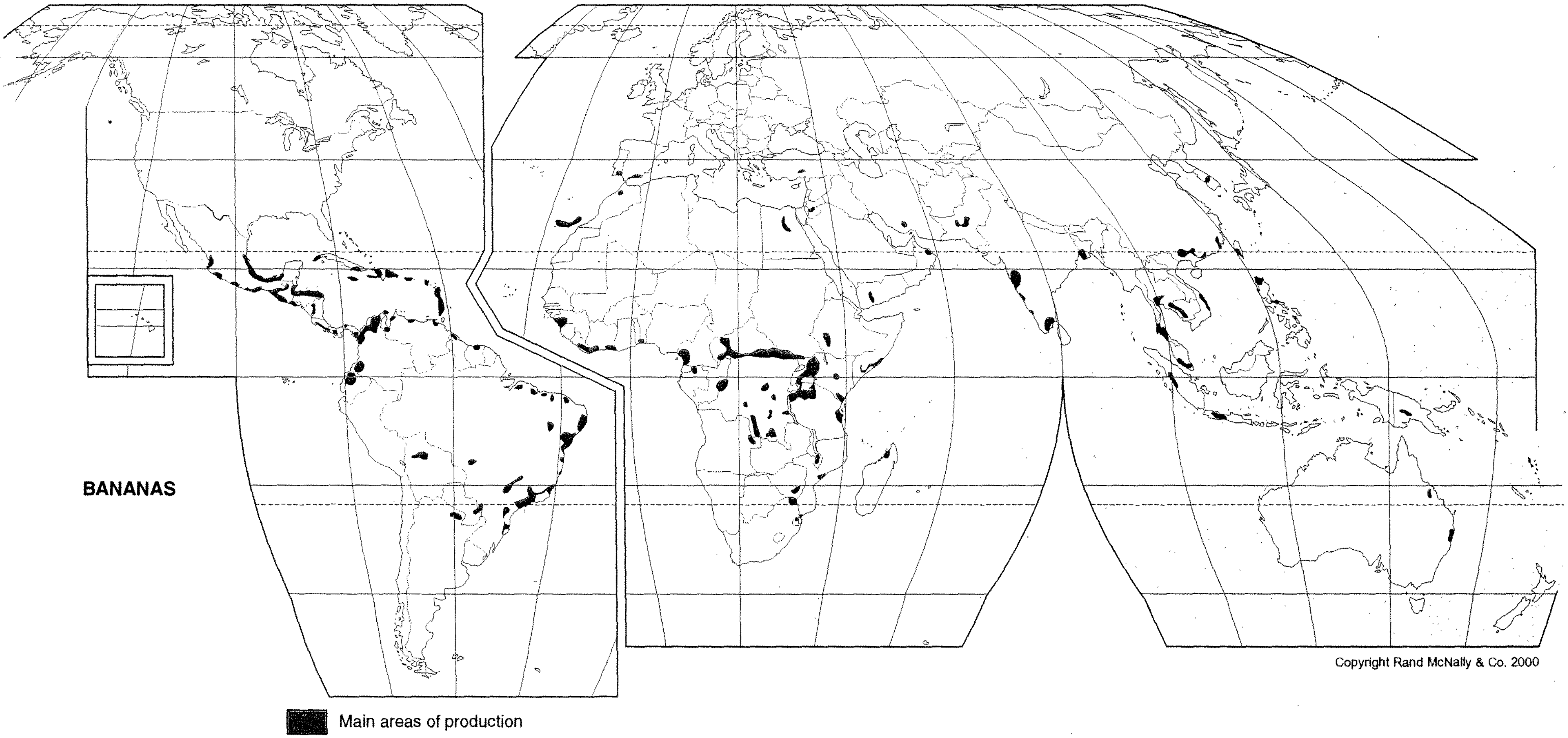
Source: FAO 2002. All data for 2000.

Banana

Area in Production (Mha)



BANANAS



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Chapter 10

Bananas

Overview

Bananas were among the first fresh tropical fruits to be mass-marketed worldwide, competing with local fruits. A major advantage of bananas in the marketplace is that they can be produced year-round; bananas are not seasonal like many other fruits. Historically, bananas were primarily a subsistence food crop. By the end of the nineteenth century, they started being produced for export and showing up as expensive foods in international markets. Davies (1990) reported that in 1905 bananas had become the most popular fruit in the United Kingdom, ahead of oranges, apples, or tomatoes. Market penetration has continued throughout the past century so that today bananas are considered a staple rather than a luxury food item. With the breakup of the former USSR and its allies, bananas were imported and became widely available in those formerly closed markets for the first time ever. This made bananas the symbol of open international commerce.

Bananas are and have always been a basic foodstuff in tropical countries. To this day the two largest banana producers do not export any bananas, and globally nearly 80 percent of all bananas are consumed in their country of origin. Most bananas are produced in backyards or small plantings and are sold into local or regional markets in the producing country. The environmental impacts of this type of production are minimal. Most bananas produced for export are grown in large, monocrop plantations. It is in these production systems that most of the environmental problems arise.

Producing Countries

According to the Food and Agriculture Organization of the United Nations, 122 countries produce bananas. As of the year 2000, there were 4.1 million hectares devoted to banana production worldwide. Brazil (521,285 hectares), India (490,000 hectares), the Philippines (383,387 hectares), Burundi (295,000 hectares), Indonesia (285,000 hectares), and China (258,260 hectares) lead all producers in area of land devoted to banana production. While these six countries account for some 54 percent of the global area devoted to bananas, only the Philippines exports a significant amount. In each of these countries, bananas are grown, first and foremost, as a food crop for domestic consumption (FAO 2002).

Global production is estimated at more than 67.5 million metric tons, with average global yields estimated at 16,463 kilograms per hectare per year. In general, those countries that use bananas primarily as a domestic food crop have lower yields than those that focus on exports. This is perhaps accounted for by the fact that those who plant bananas for food often plant them with other food crops as well. Yields are also highly sensitive to growing conditions, and export plantations occupy prime agricultural space in many countries.

Roughly half of the world's bananas are eaten as a cooked vegetable, utilizing green rather than fully ripened fruit. Markets for this form of consumption are essentially local ones, close to the point of production. Bananas are most important as a basic food in tropical Africa. In particular, bananas are a food staple throughout East Africa, where they are also used to make local beer.

The figures for the total world banana crop are not reliable. Production and consumption figures are self-reported by major producers. Only at the point of export or import is there a way to verify production. It is likely that most bananas produced in the world are consumed on the farm or in nearby communities and consequently do not make it into the statistics.

From 1992 to 2000 global exports increased from 10.7 million metric tons to 14.2 million metric tons. During the 1990s the main exporting countries were Ecuador, Costa Rica, Colombia, the Philippines, Guatemala, Honduras, and Panama. These seven exporters accounted for 77 percent of all internationally traded bananas. At the beginning of the 1960s Central and South America accounted for 66 percent of exports. The Philippines, an insignificant exporter in 1950, reached 12 percent of global exports thirty years later. African, Caribbean, and other Asian producers lost export share over the same period, from 34 percent to 20 percent by the mid-1990s (LEAD International 1996). Much of the remaining market share of these producers was achieved through guaranteed access to the markets of former colonizing countries. This advantage is likely to be eliminated by the recent banana ruling by the World Trade Organization (WTO). This will cause economic problems for those smaller countries, shown in Table 10.1, that depend on bananas as one of their major export crops.

Table 10.1
Banana's Ranking of Total Exports by Value for Selected Countries, 1990–91

Leading Export	Second Largest Export	Third Largest Export
Cook Islands	Costa Rica	Honduras
Dominica	Ecuador	Réunion
Guadeloupe	Guatemala	
Martinique	Somalia	
Panama		
Saint Lucia		
St. Vincent/Grenadines		

Source: UNCTAD 1994.

Costa Rica is the second largest exporter of bananas in the world and, as such, it can illustrate the internal structures necessary to export large volumes of bananas. One of the first issues is the concentration and intensification of production. In Costa Rica, bananas are produced for export on only 187 farms, with just over 48,080 hectares planted to bananas. About half of the farms are owned by export companies and about half by independent producers. Even so, some 5 to 10 percent of the country's population is estimated to be employed on banana plantations (Committee on Commodity Problems 1999).

Consuming Countries

For the past thirty years, India and Brazil have been the leading producers and consumers of bananas (FAO 2002). Bananas are widely traded in both countries. While bananas are clearly important commercial as well as subsistence food crops in both countries, neither is a major exporter nor importer of bananas.

Globally, banana imports totaled some 14.2 million metric tons in 2000. The European Union accounted for 4.8 million metric tons of these imports in 2000, followed by the United States with 4.0 million metric tons, and Japan with 1.1 million metric tons. The main European consumers of bananas are Germany (1.1 million metric tons), the United Kingdom (0.7 million metric tons), Italy (0.6 million metric tons), Russia (0.5 million metric tons), and France (0.3 million metric tons) (FAO 2002).

The international banana trade is dominated by three main companies—United Brands, Castle & Cooke, and Del Monte. By 1980 these three multinationals controlled 65 percent of the world market. These companies are vertically integrated, including some banana production, and controlling shipping, cold storage, ripening and warehousing in the consumer countries.

Production Systems

Bananas require warm climates, good soils, and ample moisture. They can be cultivated individually, on hillsides, or in plantations. Plantations, however, require greater uniformity of terrain. The taller varieties can cause soil erosion. Prolonged cropping inevitably causes soil degradation. Large areas that were once used to grow bananas tend to have been abandoned because the soils accumulate diseases or pests. Soil degradation resulted in these areas partly because the way they were originally cleared reduced soil fertility. Finally, prior to the use of chemical fertilizers (or where chemical fertilizers were considered too expensive), producers simply moved on to clear new areas. After some years or even decades of fallow, some lands have been brought back into banana cultivation once again. This happened in the Limón region of Costa Rica in 1970s and also with some farms in Honduras (Panfilo Tabora, personal communication).

Bananas grow rapidly. Fruit can be harvested the first year after planting root stock. Careful management can maintain a plantation for many years. In India, for example, some fields have been producing for more than 100 years. After the first year, crops are obtained from the offshoots of the original plantings. Both the number of offshoots and their production decline over time. Bananas can be picked green and will ripen after harvest. Bananas for export must be picked earlier than those for local consumption and will have more immature fruits.

Bananas are grown throughout the tropics. They are even less tolerant of frost than citrus, so they cannot be grown on the margins of temperate climates except when they are raised under some form of protection such as a greenhouse (as in Israel and Morocco). For much of the world, bananas are subsistence crops. They are high in carbohydrates and low in fat and proteins with a wide range of vitamins present in small amounts. In most areas of the wet tropics, bananas are interplanted with other food crops (e.g. rice, sorghum, chili peppers, sugarcane, cassava, and sweet potato) and tree crops (e.g. coffee, citrus, cocoa, and coconuts).

In plantations created for export production, bananas are not intercropped. The process of cultivating bananas for export includes the following operations. In most instances, virgin forests are cleared and all stumps are removed. The land is then plowed and contours or terraces are constructed as necessary depending on the slope of the land. A drainage system is established to drain water in the rainy season and to bring it in during the dry season. The appropriate varieties (depending on local soils, pests, and growing conditions) are selected, and cuttings are planted with the appropriate spacing. As the plantation begins to grow, weeding or weed controls are undertaken. As the plants grow, unwanted suckers are removed and pruning takes place to ensure a steady supply of bananas. Removal of suckers eliminates competition between stalks, which affects fruit size. Fertilization and applications of a range of pesticides are undertaken, often prophylactically to control diseases and pests. Plantations are irrigated as necessary.

In large-scale commercial operations, bananas are grown as a monocrop. They are planted on generally flat ground and on a grid. Because bananas are so susceptible to water fluctuations, deep trenches are usually cut through the fields to deliver water during the dry season and to drain it away from the roots during the wet season. Roads are laid out throughout the plantation as are overhead cables, which allow the product to be harvested, hung, and transported with minimal chance of bruising the fruit. Increasingly, other types of trees are planted as windbreaks to reduce potential wind damage.

In large plantations, bananas are susceptible to a number of diseases and pests (e.g. black sigatoka and nematodes) that require the use of several chemicals for control. Many of the chemicals used, however, are aimed not at diseases and pests but at preventing external blemishes, which affect prices on international markets. In Costa Rica pesticide use on banana plantations has reached levels of up to 44 kilograms per hectare per year. In 1987 banana cultivation used 35 percent of all insecticides in Costa Rica and represented 35 percent of total producer costs (Astorga 1998).

Outside of export-oriented plantations, however, the use of pesticides is not a serious problem. When interplanted with other crops, bananas are relatively impervious to pests and other diseases.

In some of the smaller countries where bananas are produced for national and even international markets, they are replanted every three to eight years. Replanting is usually necessary because of declining yields as a result of poor root development, which is related to compacted soil structure, poor drainage, reduced fertility, and increasing populations of soil nematodes. In addition, replanting helps to time harvests for the seasons of greatest demand and highest prices. This practice is most common on farms of 1 to 50 hectares (Stover and Simmonds 1987).

Processing

Bananas produced for local markets are not processed. Stalks which contain a dozen or more bunches (called hands) are cut from the banana plants and transported as stalks to the point of sale, either local markets, corner stores, or even supermarkets. At that point, the hands or bunches of bananas are removed from the central stalk and sold individually. Most bananas sold in the world are never boxed or packaged in any way.

By contrast there is a fair amount of processing and packaging for export bananas. In almost all instances the processing is done on farm. In plantations bananas are brought to central processing plants along overhead, mechanized monorail transportation systems. A convoy of ten to fifty banana stalks (attached individually to overhead hooks) is pulled by a machine operated by an individual and propelled by a single-stroke engine.

At the processing plants, the individual hands or bunches of bananas are cut from the central stalk and floated in a tank of running water. Tremendous amounts of water are used in flotation and rinsing operations. These operations are intended to remove pesticide residues on the peel as well as insects, spiders, or other foreign matter that might be in the bunches. The water used for this operation is more than 100 times that of the weight of the bananas.

The bananas are inspected, and any malformed or discolored bananas are removed. This is done manually, with oversight by representatives of the buyer in the case of independent operations. The rejection rate varies from approximately 7 to 35 percent. Grading is subjective; it depends on how saturated the international market is rather than the quality of the bananas per se. This is one of the ways that the large banana trading companies control volume and prices. Higher product rejection rates means lower profits for producers.

In any case, the stalks (rachises) and reject bananas represent, on average, the same weight as the bananas that are exported. This waste is a disposal problem. When piled up it rots; when put in streams the organic matter consumes all the oxygen as it decomposes.

Because of the unique issues related to banana ripening, distance and time to market are key issues for bananas. Frequent shipments are imperative. The introduction of the refrigerated container is a precondition, today, of reaching more distant markets in a timely way. However, such containers impose minimum shipments of 20 metric tons or more if they are to be most efficient and competitive.

With refrigeration and by picking the fruit before it matures, there is a window of about five weeks between harvest and consumption. Without refrigeration, however, the time for consumption of the fruit is a matter of days. More recently, faster boats can carry banana cargoes to Europe from Latin America in eleven to fourteen days. These boats allow bananas to be picked closer to maturity, with better yields for the farms and with better flavor for consumers.

Historically, banana companies exerted pressure on producers through shipping. Delays in shipping could be even more of a disaster than high fruit rejection rates. In the United States, and Europe to a lesser extent, control is exerted through the internal distribution system as well as through the large ripening facilities. Banana companies have also used their control of the market to insist on packaging requirements (compartmentalized boxes, pallets, etc.) that reduce labor use in developed countries and make the movement of bananas more efficient. Packaging in Costa Rica represents some 33 percent of the total production costs of producers up to the point of loading the fruit on boats for export.

Substitutes

Internationally, bananas compete with an increasing number of fruits. Not only has the global area devoted to production of all fruit doubled in the past forty years, productivity has increased as well. In addition, improved refrigeration and transportation systems allow fruit to be transported farther and longer than ever before. Even so, bananas appear to be holding their own. They are still the highest income generators in the fresh vegetable department of grocery stores in the United States. Furthermore, bananas are considered an excellent food for babies and a convenient and well-accepted food for children. No other fruit has been able to dislodge bananas from this position.

In those countries where bananas are grown primarily for local consumption, the only other perennial crop with comparable per-hectare yields is oranges. However, nothing comes close to the combined caloric and mineral content of bananas, at least in those areas that have sufficient water to grow them. Furthermore, unlike most other starchy food sources such as root crops, bananas do not require cooking. Even in areas where they are cooked, they require less cooking and preparation time than substitutes such as corn, cassava, millet, or peanuts.

Market Chain

The market chain for bananas consists of growers, packers, transporters, cold storage and ripening companies, and retail outlets. These areas tend to be dominated by different players, but there is some merging of the overall functions. For example, most of the large fruit companies no longer produce most of their own fruit, although they still have some plantations. The risk of growing bananas has been left to individuals with supply contracts (and contracted prices) from the large fruit companies. The more oversupply there is of bananas, the shorter the contract.

In general, overall production per grower is increasing while the total number of growers is decreasing. Most growers have their own packing sheds, where bananas are inspected and packed into boxes, shrink-wrapped onto pallets, and loaded into refrigerated containers. The large fruit companies provide inspectors to make sure that growers' rejection rates are in line with company policy. As mentioned above, increasingly rejection is driven by oversupply rather than product quality. The large fruit companies usually take possession when the containers are loaded onto their ships. These same companies ship and warehouse the fruit in the consuming country. Once taken out of special refrigeration warehouses and containers, bananas ripen fully in five days and should be sold immediately. This is when the retailers receive their shipments.

Over the past forty years the real price of bananas has decreased by 39 percent, but profits have not necessarily declined. Productivity increased over the same period and production costs declined (FAO 2002). Consequently, profits in many areas have actually increased, although at this time producer profit margins in countries that have higher land and labor costs are quite low. The data suggest that prices paid to producers of export bananas decreased by 10 percent between 1973 and 1983. Real income, however, increased over the period. Prices paid to producers increased by 9 percent in the 1990s, even though the producers' share of the value generated in the market chain declined. Profits, not relative prices, are more important to producers. It was the relative increase in profits through the 1970s, 1980s, and early 1990s that generated the investments that are now flooding the market with bananas (FAO 2002).

In the 1990s prices slumped and the portion of the retail price that goes to the producer decreased. At the same time, the percentage of the price received by the retailer also declined. During the period in question, the consolidating, shipping, and distribution share of the banana price increased in both relative and absolute terms. Table 10.2 compares the percentage of the final retail price captured as the product moves from producer to retail. These figures are averages and only show gross, not net profits. Even so the data show that the packing, shipping, handling, and warehousing segments of the market were the ones to increase their overall share of the retail price (Lopez 1986).

Table 10.2
Cumulative Value of Bananas Exported from Central America to the Retail Market

	1973			1983		
	Actual $ per Case	In Real 1990 Prices	Percentage*	Actual $ per case	In Real 1990 Prices	Percentage*
Retail Price	6.60	16.75	100.0	15.42	19.39	100.0
Wholesale	4.50	11.42	68.2	11.00	13.83	71.3
CIF+	2.99	7.59	45.3	7.80	9.81	50.5
FOB#	1.61	4.09	24.4	4.35	5.47	28.2
Local Prices	1.18	2.99	17.9	2.61	3.28	16.9

Source: Lopez 1986.
Note: * Percentage of the cumulative value created as the product moves to retail level.
+ Cost, Insurance, and Freight fees for imported product.60

Freight on Board (all costs paid at the point of export).

Part of the explanation of the shifts in value in the market chain for bananas can be linked to the concentration of banana exports in the hands of fewer companies. In the United States, for instance, there was considerable demand for bananas by 1900. More than a hundred exporting firms existed in Latin America to satisfy that market. By 1930 however, one firm—the United Fruit Company—controlled over 90 percent of the industry. By 1950 United Fruit still controlled 80 percent of the banana retail business in the United States, and a few other large companies came to dominate the rest. By the year 2000 banana transport and warehousing was still dominated internationally by only a handful of companies.

One market trend that could affect the market chain is the increasing proliferation of certification labels for bananas. Organic and Fair Trade bananas require production and handling practices that do not readily lend themselves to the larger fruit companies that handle bananas. If demand changes significantly, however, larger companies may be more willing to handle a differentiated product. The Chiquita company is already working with the Rainforest Alliance to have their producers certified by that organization. However, Chiquita is not attempting at this time to gain any market advantage from this work by distinguishing the product in the marketplace

Another factor that will affect the source, if not the amount, of global exports is a recent ruling by the World Trade Organization (WTO) on a dispute regarding favored trade status for former colonies exporting bananas to Europe. Under these trade provisions, the European Union gave preferential access to, and paid higher prices for, bananas produced in the former colonies of European countries. This favored trade status was said to be a form of development assistance, even though very little of the additional price paid by European Union consumers ever gets to the growers. The WTO ruled that this was an illegal trade barrier(von Moltke 1997).

Market Trends

Between 1961 and 2000, global banana production increased by 214 percent while the amount of bananas traded internationally increased by 255 percent. Real prices for bananas decreased by 39 percent during the same period (FAO 2002).

Evidence shows that as per capita income increases, the rate of increase in per capita banana consumption slows. A moving average calculation of banana demand showed that in 1961 banana consumption was rising by 5 percent per year, by 1971 it was rising by only 4.4 percent, and by 1981 it was rising by 1.1 percent per year (FAO 1986). Increased demand for bananas was not keeping up with population growth. Increasing markets in the future will depend on the increase in purchasing power in the less-developed countries such as those in Eastern Europe, or on rural-to-urban shifts in which people are no longer able to produce their own bananas.

In the 1990s the Asian financial crisis and the collapse of the Russian economy had a negative impact on overall demand for bananas. The real problem was that the contraction in demand began precisely at a time when production was increasing. For example, Ecuador's production was 4.2 million metric tons of exportable bananas in 1998 and an estimated 5.4 million metric tons in 1999. Yet, Ecuador alone lost markets of 1.1 million metric tons as a result of these two crises (UNCTAD 1999). Increased production coupled with decreased demand promise continued hardship for producers

There are some other notable market trends with regard to bananas that are linked to various certification programs. For instance, there is now an increase in the production of certified organic bananas for international markets. While this market is tiny, there appears to be considerable consumer interest in it, particularly as consumer awareness increases with regard to the pesticides that are used in most banana plantations. The largest portion of current trade in organic bananas is in processed form, mostly for infants. Processing on site eliminates the need for a costly transport chain as well as problems of deteriorating quality. Costa Rica currently exports 500 metric tons per month of processed organic banana pulp to the German firm Hipp for baby food. Some 1,500 farmers, 70 percent of whom are from indigenous ethnic groups, are involved in the production (Euroban 1997).

Another program in Costa Rica initiated by the Fundación Ambio, developed by EARTH University and supported by the Rainforest Alliance promotes "ECO-O.K." bananas. These bananas are not organic, but banana production is undertaken with an overall reduction in the use of a wide range of inputs. Most of the ECO-O.K. production has been marketed to Germany, but Chiquita has reportedly come into compliance with the program without yet attempting to take advantage of it in the marketplace.

Fair Trade bananas have only recently been introduced into the European market. Fair Trade bananas not only require specific production methods that reduce the overall environmental impact, they also require that producers address labor and social issues. Like any other "certified" banana, these also require a separate verifiable chain of custody from producer to consumer. In the Netherlands, Fair Trade bananas command a 10 percent market premium (Euroban 1997).

A new certification called the Sustainable Banana Program has been initiated by EARTH University in Costa Rica together with Wholefoods, a supermarket chain the United States. This program, like most of the other certification programs in existence, incorporates activities that reduce the use of inputs including water, plastics, and agrochemicals and minimize environmental impacts. In addition, however, the program aims to provide or protect on-farm habitat for wildlife, thereby making banana cultivation more compatible with biodiversity (Panfilo Tabora, personal communication).

Environmental Impacts of Production

Major environmental problems arise from the production of bananas for export or from large-scale commercial production of bananas for local markets. These include habitat conversion, soil erosion and degradation, pollution from agrochemical use, solid waste, and water usage. Each is discussed separately below.

Habitat Conversion

During the expansion of the banana industry in Costa Rica from 1979 to 1992, 166,460 hectares of primary and secondary forests were cleared in the eastern province of Limón, the area of the country where bananas are produced for export. During the same period, the area planted to bananas expanded by 51,000 hectares, yet in 1996 export bananas in Costa Rica covered some 52,000 hectares. In short, virtually all the production in Costa Rica shifted to new lands between 1979 and 1992. The lands used previously were abandoned by banana producers.

The issue is not just the clearing of forests to produce basic food crops and foreign exchange. Commercial banana production has been a moving frontier that requires continual deforestation of tropical forests in countries such as Costa Rica. In many instances, these areas are supposedly protected by law. For example, by law in Costa Rica forest strips must be left along the banks of rivers. The banana companies, however, have clear-cut these areas.

In many instances, deforestation takes place at the hands of independent owners who produce bananas and sell them to larger exporting companies. The expansion often takes place gradually over time, and rarely on a large scale. Rather, thousands of producers cutting a hectare or ten in a year gradually eat away at the forest. Subsequent would-be banana producers leapfrog over previous ones, always farther into forests.

Soil Erosion and Degradation

Due to their high nutritional needs, banana plantations are established on the most fertile lands. Because the production systems are intensive and lack methods to prolong the sustainability of the plantations, production tends to degrade soils after twenty to thirty years. The lack of ground cover and the elimination of buffer strips lead to the further degradation of soils in plantation areas. In addition, increasing populations of nematodes and other persistent pests eventually make the soil unsuitable for bananas as well as many other crops.

Over time, high levels of pesticide residues and heavy metals such as copper (from the breakdown of copper sulfate used as a pesticide) accumulate in the soils of plantations. Due to the heavy use of pesticides, the organisms that normally aerate the soil are eliminated over time. The soil compacts, the rain is not absorbed, and the runoff causes erosion. Even the addition of massive quantities of fertilizer cannot offset the nutrient losses from serious erosion. At some point, the purchase of fertilizer becomes simply too expensive and it becomes cheaper to move to a new area to plant to bananas.

Table 10.3
Estimated Nutrients Used per Hectare by Bananas

Nutrient	Amount Used (kg)
Nitrogen	58
Phosphorous	8
Potassium	44
Calcium	1,120
Magnesium	471

Source: Foro Emaús 1997

To insure an adequate supply of the nutrients listed in Table 10.3, commercial banana plantations apply chemical fertilizers. Fertilizers can be applied up to ten times per year and are most often applied on an entire plantation rather than as needed in specific locations. Chemical inputs and the labor required to apply them are two of the largest costs of banana producers aiming at the export market. In Costa Rica these costs can be as much as half the total cost of production. By contrast, in Costa Rica labor costs for producing organic bananas represent as much as 70 percent of the costs of production, as labor is substituted for chemicals. At EARTH University the commercial farm operators have found that the cost of producing low-input conventional bananas and organic bananas is about the same, but labor's proportion of the total costs is much higher for organic production.

The use of clean cultivation (i.e. eliminating all weeds and ground cover) also exacerbates soil degradation. Without any soil cover, soils in banana plantations are easily eroded. In addition, the finer clay particles can be carried down through the soil structure to a depth of 1 meter or so where they form a hard pan that tends to prevent drainage of rainwater and increase flooding.

Pesticide Use

Bananas produced for international trade are the most pesticide-intensive of the major tropical food crops. Grading occurs at the point of packing for export, and only completely blemish-free bunches are exported. The presence of even one blemish on a bunch causes major loss in value or outright rejection. The result is a pattern of "precautionary" pesticide applications at every stage of the production process, whether they are needed or not. The idea is to prevent possible pest outbreaks rather than to treat them when and if they arise, even though spraying these chemicals when the target pests are not present kills more beneficial predators than pests. Pesticides are viewed as the best way to maximize harvests as well as to lower the risk of loss in the value of the harvest.

Export banana production and large-scale domestic banana production in countries such as Brazil depend on chemical controls. Some 286 different pesticides (fungicides, herbicides, and nematicides) have been authorized for use on bananas in Costa Rica either on-farm or in the packing sheds prior to shipping. A few of these are listed in Table 10.4. Most of the chemicals are produced in the United States, Switzerland, or Germany.

Table 10.4 A Partial List of Pesticides Used in Banana Production in Costa Rica

Type of Pesticide and Chemical Class	Active Ingredient
Nematicides (organophosphates)	terbufos, cadusaphos, fenamphos, ethoprop
Nematicides (carbamates)	carbofuran, oxamyl
Insecticides (organophosphates)	chlorpyrifos
Herbicides (various)	paraquat, glyphosate
On-farm fungicides (various)	mancozeb, chlorothalonil, benomyl, tridemorph, propiconazole
Packing-house fungicides (various)	imazalil, thiabendazole, tridemorph, aluminium sulphate

Source: Astorga 1998.

The use and cost of these chemical inputs is increasing. Pesticide use in banana production can reach 40 kilograms per hectare per year. In 1991 Costa Rica imported U.S.$56 million of pesticides, in 1994 $84 million, and in 1996 $100 million. In general, pesticides represent 20 to 35 percent of the total costs of banana production. The cost of fighting the disease black sigatoka alone can be as high as U.S.$1,000 to $1,200 per hectare per year.

In Belize, banana companies tend to mix all agrochemicals together and then spray them from a plane on a regular basis (usually about once a week, but sometimes more often). This spray is referred to by locals as a "toxic cocktail". It affects not only the bananas, but also the workers in the fields and their families who live in and alongside the fields, the biodiversity next to the plantation, and the water systems that flush the banana plantations on a regular basis. This latter point is very important. Bananas are planted on ridges with deep trenches cut between the rows of plants. The roots cannot survive in standing water, but the plants need water continuously. This means that water is a constant in banana plantations, and it is always flowing in or out to achieve the right balance.

Table 10.5 Agrochemicals Used by the Banana Industry in Belize

Chemical Input	Half-Life	Quantity Used	Loss via Leaching
Nitrogen (fertilizer)		809 MT/year	60–85%
Phosphorous (fertilizer)		256 MT/year	minimal
Potassium (fertilizer)		1,413 MT/year	60–85%
Calcium (lime, soil neutralizer)		1,760 MT/year	60–85%
Paraquat (herbicide)	500 days		
Mancozeb (fungicide)	70 days	10 MT/month; 31.9 MT/yr accumulated	
Ethoprophos (pesticide)	25 days (9%=1yr)	1.87 MT/yr accumulated	

Source: Usher and Pulver 1994.

The use of chemicals in the banana export industry is particularly important because, in most parts of the world, banana plantations have been established on the fertile, flat lands of coastal areas. This means that all the chemicals will, more often than not, have a relatively immediate impact on coastal wetlands as well as the inshore coastal areas and even nearby coral reefs. For example, it is well documented that 60 to 85 percent of all fertilizer is lost via leaching and/or runoff (Usher and Pulver 1994). Nitrogen, potassium, and calcium are lost rapidly via leaching. In contrast, most phosphorous is attached to soil particles and is only leached if the soil sediment is washed off the plantations. Table 10.5 shows leaching losses for some applied nutrients as well as half-lives (the time required for half a substance introduced into an ecosystem to break down or be eliminated by natural forces) for some of the agrochemicals.

Solid Wastes

There are a number of residues and wastes that result from banana production and processing. These cause environmental problems. The volume of waste produced is at least equal to the volume of bananas produced. Twenty percent of the waste requires special treatment. Yet in Costa Rica the Ministry of Health found that 78 percent of plantations did not dispose of waste properly (Astorga 1998). A 1996 summary from Costa Rica, shown in Table 10.6, illustrates these issues.

Table 10.6 Residues from Costa Rican Banana Plantations

Type of Residue	MT/year
Polyethylene bags	4,406
Polyethylene packing material	2,171
Polypropylene twine	2,755
Fruit stems	225,000
Scrap bananas and rejects	278,000
Fertilizers	110,000
Nematicides	8,300

Source: LEAD International 1996.

There are two main types of solid wastes on banana plantations. The first are the organic remains of the bananas. These wastes include the bananas that are not of sufficient quality to export or even sell on the local market, as well as the banana stalks; both are transported to the selection plants where the bananas are washed and boxed for sale. These wastes are created in such large quantities that they are simply thrown away rather than composted. They are often dumped at the edge of the plantation or in or nearby rivers, where their decomposition can consume the oxygen in the water and result in fish kills. The IUCN (the World Conservation Union, formerly known as the International Union for the Conservation of Nature) estimates for the organic waste generated by the banana industry in Costa Rica in 1995 supported the information reported in Table 10.6. The IUCN reported 283,217 metric tons of stalks and 225,525 metric tons of rejected bananas. These amounts were up from 1990 amounts that were, respectively, 152,798 and 121,672 metric tons.

The second important form of solid waste associated with bananas produced for export is plastic, including bags, rope, and pesticide containers. Each banana stalk is encased in a thin plastic bag treated with insecticide to keep insects and spiders off the fruit as it ripens. In addition, each stalk of fruit is attached to a pole by plastic twine so that its weight will not pull it over to touch the ground. Both these forms of plastic represent waste disposal problems.

Few programs exist to recycle these products. Because pesticide containers are contaminated, they must be handled separately. In 1995 the IUCN estimated that 4,510 metric tons of plastic bags and 4,832 metric tons of polyethylene rope were generated by Costa Rica's banana industry. These amounts were up from 1990 when the figures were 2,433 and 2,507 metric tons respectively.

Water Usage

The average water requirement for a mature banana crop is approximately 160 millimeters a month. In some countries this amount is exceeded seven months of the year as a result of rainfall. During the rainy season in some areas, more than a meter of water in excess of what bananas need must be drained from the fields. It is in this water that a lot of suspended solids and agrochemicals become part of the runoff.

In addition, a tremendous amount of water is used in the processing plants, where the bananas are floated prior to selecting and boxing them for export. Up to one hundred times the volume or weight of the bananas in water is used during the process of washing, selecting, and packaging bananas.

Better Management Practices

The banana industry is faced with severe problems managing its impacts on habitat, soil, and water. The risks associated with continuing the current practices are serious. Land is being converted from forests; soils are being degraded beyond sustainable use; pesticides are accumulating in the environment; and rivers, streams, and coastal wetlands are being polluted. The Conservation Agriculture Network's "Standards for Banana Production" (2001) are a good start in the development of certification standards that will result in better management practices on the ground. A number of key, immediately practicable better practices are described below. More documentation and analysis are required to induce other producers to adopt these or similar practices, or to discover their own ways of reducing impacts to more acceptable levels.

Manage Plantations for Continuous Cultivation

Recently, some banana plantation managers have been experimenting with replanting in areas that were previously abandoned. This is true of formerly abandoned banana farms in Panama (in the Changuinola area), Costa Rica (in the Limón area), and Honduras (in the Aguan watershed area). The adoption of the Valery banana variety that is resistant to the soilborne Panama wilt disease (a disease that ravaged banana production in plantations growing traditional varieties) has allowed these areas to be brought back into production, and this has reduced pressure on new areas (Panfilo Tabora, personal communication).

More importantly, this new variety allows producers to continue to cultivate the same areas after much shortened fallow periods of only three years or even less in some cases. Due to the increasing cost of land suitable for banana plantations, more and more experimentation is taking place to find ways to undertake continuous cultivation.

Reduce Use of Agrochemical Inputs

In some areas, the application of agrochemicals is becoming more targeted and use per hectare is declining. Closer monitoring of nutrient imbalances, infestation rates, and the movement of disease vectors is a key technique used to determine the type of chemical to use as well as the best time for application. Farms in Costa Rica using this technique have reduced their pesticide spraying, for example, from forty-seven to as low as thirty-five times per year (Panfilo Tabora, personal communication).

Many chemicals applied to banana plantations are lost rapidly due to leaching. Smaller, more targeted applications spread out over the course of the year, for example, increase the efficiency of fertilizer use. However, the overall efficiency is still lower than it needs to be if the fertilizers are applied by themselves. One of the best ways to increase the efficiency of fertilizer use is to incorporate applications in organic material (either what is already on the field or mixed with compost) so that they bind and are released more gradually. This reduces leaching and makes the nutrients available in a slow release form over a longer period of time. Cover crops planted below the bananas are an efficient way of accomplishing this goal. Not only do they provide organic matter, but some species can also fix nitrogen that would otherwise have to be added to the soil. Different cover crops work better in banana plantations located in different parts of the world.

Another strategy is to invest in a more intense, enriched fallowing of degraded areas or areas that are at the end of the current production cycle. Enrichment planting with legumes for three to five years can rebuild the soil and decrease nematode problems.

During the fallow, the cover crops are enriched with the nutrients that their deep roots bring up to the plants. The leaves become rich in potassium and phosphorus, which have been leached down in the soil over the years. The roots become rich in nitrogen, as a result of the nitrogen-fixing bacteria that live in root nodules on legumes. Fallowing also builds up organic matter in the form of litter on the surface, which acts as mulch and eventually increases soil organic matter as it decomposes and is incorporated back into the (Panfilo Tabora, personal communication).

There are also other techniques to deter the growth of specific diseases, including the use of resistant varieties as described in the previous section. In a three-year experiment on the commercial operation of an independent banana grower in Costa Rica, sprayings of beneficial microorganisms have increased yields, reduced foliar chemical spray frequency by 15 percent, and eliminated 75 percent of the nematicide applications. The microorganisms included lixiviates derived from compost and bokashi (fermented banana waste, described later in the section on reducing wastes) (Panfilo Tabora, personal communication). There are indications that this approach can be improved further. Experiments at EARTH's commercial banana farm have reduced foliar spray applications of pesticidesby 30 percent. This overall approach has now become standard practice on plantations. EARTH researchers found that when beneficial microorganisms were incorporated into the spraying applications, the number of healthy leaves increased. Such applications have been followed by a marked drop in pest infestation (Panfilo Tabora, personal communication). However, with increased areas coming under cultivation, the total use of chemicals and the cumulative impacts are increasing even though per-hectare applications may be declining in some regions, so more work needs to be done in this area.

At EARTH University's packing house, there is a very deliberate separation of the fungal sprays to treat the banana cluster base (crown) from the rest of the water treatments used in processing. The fungal spray drips are collected and diverted to a dedicated settling pond where the chemicals degrade; the settling pond is covered so the chemicals cannot be further diluted. EARTH University has also begun to experiment with a naturally derived fungicidal compound that would allow for the elimination of fungal sprays altogether. The natural compound is based on citrus seed extracts and has been used for some two years. By all counts, both at the production end and with the buyers, it has performed well. Natural chemicals have increasingly become the norm (Panfilo Tabora, personal communication).

Through these and other strategies, EARTH University in Costa Rica has been able to reduce pesticide use by more than half. In Costa Rica it has also been observed that after some twenty to thirty years of continuous spraying of manganese (from the fungicide mancozeb), zinc, iron, and copper, these metals have accumulated to levels that are considered toxic to banana roots. This tends to stress or debilitate the roots and make them more susceptible to nematodes. Experiments at EARTH University's commercial farm suggest that applying organic matter to the soil can halve levels of these metals, and result in healthy and numerous roots (Panfilo Tabora, personal communication). A recent comparison of the chemicals used by the Chiquita company's Better Banana-certified farms in Costa Rica to a progressive but uncertified competitor suggest that the certification program is having positive impacts on the use of nearly all pesticides. This comparison is shown in Table 10.7. The study found that up to 2002, there was an overall trend to reduce the use of all chemicals with the exception of post-harvest fungicides, which showed an increase.

Table 10.7 Comparison of Pesticide Use in Certified and Uncertified Banana Production in Costa Rica
(kilograms of active ingredient per hectare)

Type of Agrochemical	Uncertified Company	Better Banana Certified Company
Fungicides	60.4	44.8
Nematicides	11.1	6.3
Herbicides	2.2	0.8
Insecticides	0.5	0.1
Post-harvest fungicides	0.1	0.2

Source: Rainforest Alliance 2000

Identify Appropriate Integrated Pest Management Programs to Reduce the Use of Pesticides

As explained below, there are several ways to reduce pesticide pollution by limiting the movement of these chemicals. However, the most effective way to reduce environmental contamination from harmful chemicals is to minimize the amount of the chemical that is applied. Currently, insecticide and nematicide applications are used as prophylactics, on a preventative basis. The introduction of a monitoring program would allow producers to apply chemicals only at those times when potential damage would justify the control measures.

An important aspect of any integrated pest management program is that the workers, as well as the owners, be educated about the problems of pesticide use and its alternatives. In fact, the education of people who use pesticides directly is one of the most effective ways to reduce total use. Through such programs, owners and workers both can begin to change their attitudes about the management and use of chemicals.

Chiquita reportedly has successfully employed IPM techniques that have reduced nematicide applications by half on 20,000 hectares of plantations (Rainforest Alliance 2000). However, the story is not totally in the numbers. Octavio Cuevas, a manager of 3,500 hectares of bananas in Colombia, is a good example. Two years ago, he believed that he needed chemicals to prevent insects from eating his plants and weeds from taking over the plantations. Now the farms he controls have nearly eliminated all classes of agrochemicals except fungicides. The ground is matted with vegetation that holds the soil and protects it from the elements. Butterfly larvae make latticework of banana leaves (without causing significant harm to yields), and frog larvae abound in the chemical-free canals. Weeds are controlled by hand, and experiments are underway to replace fertilizer with chicken manure. Meanwhile the banana production is setting records and the chemical bill is declining (Rainforest Alliance 2000).

Research needs to be undertaken on IPM specific to banana production. In this way, the most toxic chemicals could be targeted for reduced use or elimination altogether so that what is used is both more effective and less damaging. The successful use of bokashi and fermented organic matter at EARTH University (described earlier in the discussions on reducing agrochemical use and reducing wastes) suggests that it is increasingly possible and financially feasible to produce bananas with nontoxic forms of pest control.

Reduce Fertilizer Use

Most banana producers apply fertilizer regularly to their crops. They do this through calculations that are made in advance of actual needs. Little monitoring is undertaken to insure that the plants actually need or take up the fertilizer used. Setting up systems to gather information and monitor the use of and need for chemical fertilizers would reduce use over time. Such a system would require more labor, but it would likely reduce overall expenditures for fertilizers and might extend the life of the plantation.

The migration of fertilizer from banana plantations to other areas is a serious problem. There is no universal solution. However, progress can be made in addressing the problem by reducing the amount of fertilizer that is exposed on the surface of the land. Applying only the amount of fertilizer that the plants need reduces the excess amount in the environment that is available for leaching. There are now experiments with precision application in bananas that could help. Producers should also make sure that roots are healthy and numerous so as to reduce runoff. One strategy to stimulate root development is to apply humic acids, substances found in and extracted in liquid form from compost and well-decomposed organic matter. These can be purchased or made on the farm from composted wastes.

Another hidden environmental issue is the use of burned lime, also called quicklime (calcium oxide). In some areas, burned lime is used to provide calcium for neutralizing soil acidity on banana plantations. For example, in Belize, some 900 kilograms of burned lime are applied per hectare per year on banana plantations. Dolomitic lime is available from local mines, but it takes longer to break down in the soil. Burning the limestone converts it to a compound that breaks down very quickly, so it does a much faster job of neutralizing soil acidity than unburned limestone. If banana producers in places like Belize began to use some dolomitic lime when applying smaller amounts of burnt lime (which is absorbed more quickly), in three years they would be able to convert totally to dolomitic lime. This is important in a country like Belize because the fuelwood required to burn limestone results in deforestation. Another strategy to minimize or avoid the use of lime altogether is fallowing or green manuring. Acidity (low soil pH) is raised to near neutral in fallowed fields. If the fallows are well managed, they can also reduce contamination of and demand for natural resources at minimum cost (Panfilo Tabora, personal communication). There is, of course, the short-term opportunity cost while the land is taken out of production and devoted to production of green manure during the fallow, but this needs to be evaluated in light of the future reduction of input use, reduced downstream pollution/effluent liabilities, and improved long-term viability of the overall farming strategy.

An additional strategy for reducing fertilizer use is crop rotation in conjunction with fallowing. Crop rotation and fallowing can be profitable investments with returns that can rival net returns of bananas per hectare per year, based on savings in pesticides and fertilizers during the cropping years. Cover crops not only provide organic material to replenish the soil, they also reduce soil erosion by reducing exposure to sun and rain, which maintains populations of beneficial soil microorganisms and protects the structure of the soil.

Produce Packaging Materials on Site When Possible

There is a tremendous amount of packaging (boxes, liners, cover sheets, pallets, etc.) for exported bananas. Packaging represents about a third of all FOB costs (Free on Board, a standard shipping term implying that all costs have been paid and that the product is free and clear) of banana producers in Costa Rica. Wood pallets and corrugated boxes represent about 10 percent of the total weight of the cargo for banana shipments. This is an area where improved resource efficiency and the development of product substitutes could reduce substantially the direct and indirect impacts of the banana industry. Because these materials also represent a significant cost to the producers, there is a financial incentive to use them more efficiently.

Since most banana hauling boats are empty, or at least not full, on the return trip to plantation areas, pallets could be returned for multiple uses. Another way to improve performance in this area would be for banana producers to grow timber on areas of the farms that are being fallowed or that are marginal for bananas, but which might be optimal for timber production for making pallets. If leguminous species of trees were used, they could serve a double role by fixing nitrogen in the soil as well. Forested areas could be developed as havens for wildlife, even if they are not as diverse as natural habitat. In the future forested areas might also provide a separate stream of income from payments for carbon sequestration. In addition some of the pallets could be made from on-farm plastic wastes. This may also help to minimize the need for wood or fiber within the banana industry.

Reduce Wastes

EARTH University in Costa Rica is using banana stalks to make paper and is selling rejected bananas for baby food or animal rations. Because of the volume they represent, most producers will give rejected bananas to anyone who will haul them away.

EARTH University has also reduced its use of plastic by more than two-thirds and has implemented programs to recycle all the plastic that it uses (Panfilo Tabora, personal communication). In several countries, companies have been established to recycle this plastic. These plastic materials are now recycled into furniture, pallets, or other packaging materials that diminish the demand for wood and therefore help maintain natural habitat.

EARTH University has also found ways to hasten the decomposition rates of banana waste and harvest debris. The EARTH banana plantations produce some 20 metric tons of leaves and stalks per hectare per year. By spraying them with microorganisms that hasten their decomposition, EARTH not only eliminates the waste but creates a useful soil amendment (Panfilo Tabora, personal communication).

Recently EARTH University and some other farmers have begun to experiment with using reject bananas and stalks to make an inexpensive "bokashi," a fermented organic soil amendment that is nutritive and also supports the microbial biodiversity in the soil. This technology has now been adopted in Costa Rica, Ecuador, and Colombia. Waste bananas are ground into large pieces and then fermented together with a variety of mixed materials such as cattle or chicken manure and lime; microorganisms are added to enhance fermentation. In some places, fertilizers are added before the product is applied to the banana plantations. As described earlier in the section on reducing pesticide use, this technique offers the added benefit of bringing nematodes to lower levels than can be achieved when using even the most toxic agrochemical nematicides.

Water is another waste product from production and processing bananas. EARTH University's packing house, as well as one owned and operated by the Dole corporation in Costa Rica, have already set up a system in which 50 percent of the water is recycled (Panfilo Tabora, personal communication). The released water is coursed through a sedimentation and settling waterway that improves water quality to preprocessing levels.

Better Banana-certified operations have reduced total water use by as much as 20 percent (Rainforest Alliance 2000). Not only is the water use declining, but also, by monitoring water quality and water use at strategically located sampling stations, farmers have a much better idea about their performance with regard to the impacts of the agrochemicals they use.

Use Sediment Ponds to Control Runoff

An area that needs significant improvement in banana production is reducing the movement of sediment. Not only does this reduce the fertility of the soil being cultivated, but also eroded soil carries with it chemicals that pollute and/or clog the receiving bodies of water.

Rivers, creeks, inshore coastal areas, and even reefs are all affected by the surface runoff from banana plantations. This runoff contains soil sediments, organic matter, chemical nutrients, and pesticides. Most banana plantations are designed to assist the water to leave quickly and, consequently, to empty directly into freshwater ecosystems. In Florida, sugar and citrus producers are required to use sediment ponds rather than to empty their "flush" directly into the Everglades. In Colombia, shrimp aquaculture producers are required to pay a tax if their effluent is of poorer quality than their intake water. This has spurred the use of settlement ponds and canals and even the construction of biological filters, or biofilters, in wetlands and mangroves to treat waste. Banana producers should consider similar measures.

In Belize six of the seven main pesticides and one of the main fertilizer nutrients, phosphorus, move predominantly with sediments. Reducing sediment movement will prevent or greatly reduce the movement of most of the pesticides and phosphate, the most common form of phosphorus. Research should be undertaken to determine if the use of settlement ponds could reduce or even prevent pesticide- and phosphate-laden sediment from reaching natural waters and coastal areas.

Enforce Preservation of Riparian Buffer Zones

Most countries have laws that protect riparian areas in areas of banana production. Maintaining native vegetation in riparian areas reduces soil erosion and filters pesticides and fertilizers from runoff. While the laws vary (e.g. in the distance that must be protected), few if any existing laws are actually enforced. One of the best ways to reduce the overall impact of banana plantations, and to maintain a firewall between them and neighboring rivers or coastal wetlands, is to insist on the enforcement of riparian laws. Where riparian areas have been cleared, they should be replanted at the owner's expense.

Some banana producers are beginning to see riparian areas as nutrient banks. Companies throughout Latin America, at least, are planting trees in riparian areas. These areas are used to trap nutrients that would otherwise have been washed off cultivated soils into freshwater and marine systems. The riparian areas can be managed as nutrient banks that are cropped or thinned periodically of commercially valuable trees or other plant species. The harvest yields organic matter that can be used in its own right or applied in one form or another back onto banana plantations. The strategy of nutrient capture makes the riparian area a potential site of ecologically sustainable economic activity in addition to providing flood protection.

Viable riparian areas create wildlife habitat that serves as home to many species. They can also act as corridors between other wildlife areas (Rainforest Alliance 2000). Finally, because they tend to trap nutrients and chemicals, such areas protect fragile freshwater systems. If managed properly for carbon sequestration, producers could probably receive payments from companies that want to offset the levels of carbon that they produce. EARTH University currently receives payments for carbon sequestration from the port of Rotterdam in the Netherlands.

Another strategy is to ensure that canals and waterways work more efficiently to trap and remove chemicals. This can be accomplished by making sure that they are covered with vegetation. EARTH University plants flemingia (*Flemingia macrophylla*), a legume, on its commercial farm to cover waterways and canals. Coupled with the maintenance of riparian areas, this system of water management minimizes the presence of pesticides in the water by eliminating direct discharge of pesticides into local waters (Panfilo Tabora, personal communication).

Outlook

Subsistence production of bananas does not pose significant risks to the environment except in places like Rwanda and Burundi, where population pressure is high and banana cultivation for local consumption is spreading up hillsides and causing soil erosion and degradation. Even so, bananas tend to be interplanted with a number of other crops and are a better alternative than many other food production systems.

Bananas that are exported, either internationally or for national markets, pose more serious risks to the environment. However, some aspects of banana production and sale give hope that the impacts can and will be addressed. Banana production is increasingly in the hands of private individuals whose future is linked to sustained production and who do not have significant areas of ideal land on which to expand production. In addition, because bananas tend to be eaten fresh rather than as ingredients in manufactured products, there is a more direct connection between producers and consumers. Both of these factors are likely to push banana producers to reduce the overall environmental impacts of their production processes and to increase the overall quality of their product. The increasingly precise tests for product residues will tend to discourage the prophylactic use of chemicals.

Resources

Web Resources

bananalink.org.uk
www.fao.org/docrep/meeting/X2332e.htm
www.fao.org/es/ESC/esce/escr/bananas/costarice.htm
www.fao.org/unfao/bodies/ccp/bntf/99/default.htm
www.lead.org/lead/training/international/costarice/96/default.htm
www.laslett.com/banana/conf/paper2.htm

Contacts Within the WWF Network

No one within the WWF network has been identified as working on this commodity. Please contact Jason Clay at WWF-US (jason.clay@wwfus.org) for suggestions of contacts outside the network.

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