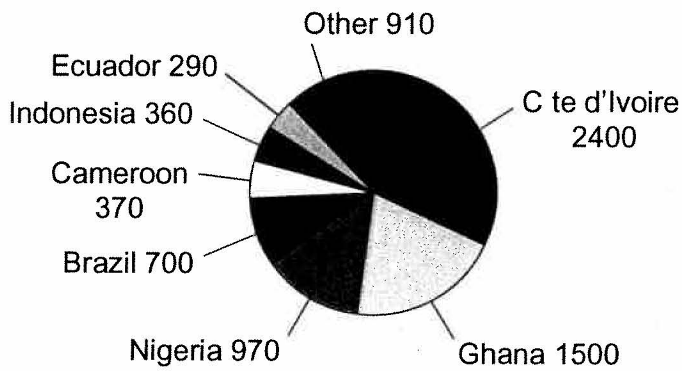
Cocoa *Theobroma cacao*

Production	
Area Under Cultivation	7.5 million ha
Global Production	3.4 million MT
Average Productivity	459 kg/ha
Producer Price	$656 per MT
Producer Production Value	$2,232 million
International Trade	
Share of World Production	115%
Exports	4.0 million MT
Average Price	$1,094 per MT
Value	$4,344 million
Principal Producing Countries/Blocs (by weight)	Côte d'Ivoire, Indonesia, Ghana, Nigeria, Brazil, Cameroon
Principal Exporting Countries/Blocs	Côte d'Ivoire, Ghana, Indonesia, Netherlands, Nigeria
Principal Importing Countries/Blocs	Netherlands, United States, Germany, France, United Kingdom
Major Environmental Impacts	Conversion of primary forest habitat Soil erosion Some use of chemicals
Potential to Improve	Poor Current cocoa prices discourage BMP adoption Difficult to overcome the constraints of replanting the same area Full sun cocoa requires more chemical inputs and produces more effluents

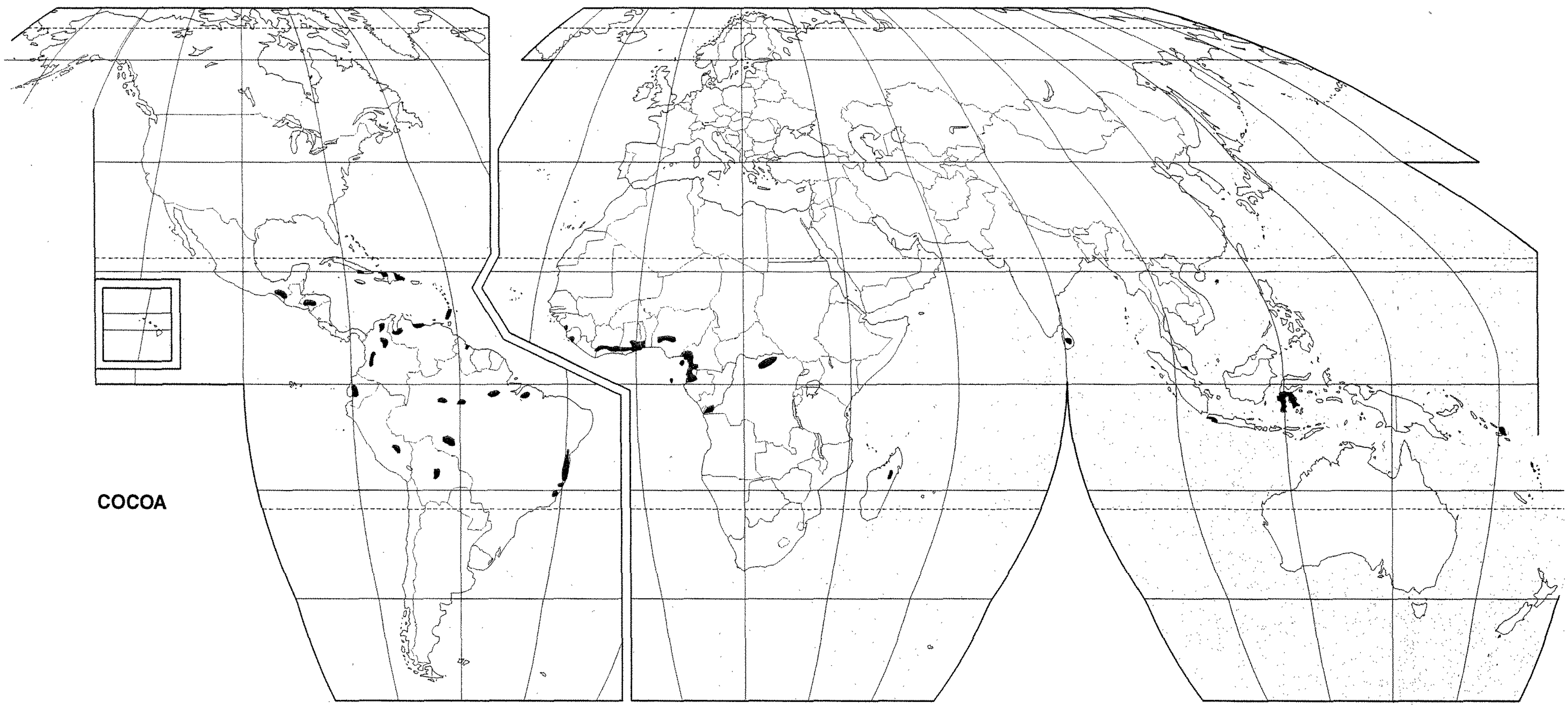
Source: FAO 2002. All data for 2000.

Cacao

Area in Production (Mha)



COCOA



Main areas of production

Chapter 5

Cocoa

Overview

Chocolatl—the Aztec word for the drink and the source of our word chocolate—originated along with chocolate itself in the Western Amazon. By 1500 cocoa was the most valuable cash crop in Mesoamerica (Henderson 2001). Cocoa cultivation began in the Americas an estimated 3,000 years ago (Smith et al. 1992). It had already been planted throughout the American tropics by Amerindians at the time of European conquest. The inhabitants, however, consumed the product as a bitter, spicy beverage prepared with hot peppers. Sweetened, solid chocolate was not invented until after cocoa was taken to Europe.

Cocoa was so valuable in ancient Mesoamerica that the beans served as a form of currency, one that literally grew on trees, throughout the markets of the region. The coastal lands, where cocoa grew best, were highly valued by Indians and Spaniards alike. Along the Mosquito Coast of Honduras, cocoa seeds were used as money to buy things in village markets as late as the 1980s. In the state of Bahia and other cocoa producing areas of Brazil, *cacao*, the Portuguese term for cocoa, is still slang for money.

From the beginning of its trade, cocoa was very popular in Europe. Initially, however, it was because of its purported medicinal qualities, for which Amerindian peoples had also used it. It was said to make women conceive, help with childbirth, facilitate digestion, and cure consumption. It was supposed to cure the plague, cough, fluxes, jaundice, inflammation, and kidney stones; it was also supposed to clean the teeth, sweeten breath, provoke urine, expel poison, preserve from all infectious disease, and help emaciated patients gain weight (Henderson 2001). (At least one of those medicinal properties proved to be correct!)

Two varieties of the species, *Theobroma cacao*, are commonly cultivated: criollo and forastero. Cocoa liquor, butter, powder, and cake—the primary ingredients of chocolate—are all derived from the plant's bitter purple seed. Up to a few dozen seeds (about two centimeters long and half that in diameter) are found within each cocoa fruit pod. The leathery pods contain white fleshy pulp in which the seeds are embedded. In some areas, fresh juice from the pulp is consumed locally, but some pulp must be left on each seed in order for it to ferment properly and maintain the value of the seed for making chocolate.

Cocoa was introduced into European markets after the conquest of Mexico and Central America. Almost immediately, it was prepared with sugar and, by 1800, with milk. Due to increased demand, small-scale production spread in the Americas and to the Philippines by 1600. The crop was introduced into present-day Indonesia and India before 1800 (Wood 1991). By 1800 global production was 135,000 metric tons, and

Ecuador was the largest producer, followed by Central America and several Caribbean Islands (Hardner et al. 1999).

Cocoa became a plantation crop in the nineteenth century. Advances in cultivation technology and the increasing development of trade with colonies led to the establishment of plantations in Southeast Asia, Oceania, and present day Sri Lanka. The Portuguese, after losing control of Brazil, spread the crop to West Africa. By the latter half of the nineteenth century production began in earnest as the crop spread to British West and East Africa, Australia, Fiji, and Samoa (Wood 1991).

By the beginning of the twentieth century, today's three primary regions of cocoa production were established—tropical America, West Africa, and to a lesser extent Southeast Asia and Oceania (although Asian production did not become important until much later). At that time, tropical America was responsible for about 80 percent of global production. During the last century, cocoa demand and trade grew dramatically in the United States and Europe, stimulating production throughout the world (Hardner et al. 1999).

The historical spread of cocoa around the world provides an interesting parallel for many agricultural crops. Colonial powers, in conjunction with commercial interests, were in a constant search for new sources of trade and revenue. New crops were introduced throughout the world on the hit-or-miss chance that they would literally take root and provide the basis for local economies. What this meant is that by 1900 cocoa, like many other crops, had been introduced throughout the world and was well known by small farmers. These farmers were simply waiting in the wings until market conditions turned in their favor either to produce cocoa or another crop. As a consequence, any positive market signal encouraged a rapid increase in production.

In the latter part of the twentieth century, the independence of many colonies and the increase of the cocoa market in the post-World War II period resulted in the shift of cocoa production from plantations to small farms of less than 10 hectares. These farmers already knew how to grow cocoa and could substitute family labor for capital and capital inputs (Hardner et al. 1999). Furthermore, the increase in disease associated with the expansion and intensification of production also tended to favor small-scale production, as small-scale producers could use family labor to reduce the impact of diseases rather than use expensive chemical inputs. Today, most cocoa is still produced on small farms, but production efficiency varies tremendously. For example, small farms in Asia produce five times the yields of their West African counterparts. However, West African producers produce very high quality cocoa.

Producing Countries

The Food and Agriculture Organization of the UN (FAO 2002) reports that nearly 7.5 million hectares of land were planted to cocoa in 2000. Côte d'Ivoire has the most extensive plantations with some 2.4 million hectares, followed by Ghana with nearly 1.5

million hectares. The other major producers by area of production are Nigeria (966,000 ha), Brazil (697,420 ha), Cameroon (370,000 ha), Indonesia (360,000 ha) and Ecuador (287,300 ha). According to the FAO, these countries account for 87.8 percent of all land planted to cocoa, and 86 percent of the 3.44 million metric tons of cocoa produced annually. Côte d'Ivoire leads all producers with 1.4 million metric tons in 2000; Indonesia follows with 465,700 metric tons, and Ghana is next with 436,600 metric tons. Together these top three produce 67 percent of global production. Seven other countries contribute most of the remaining 33 percent of production.

During the 1990s world cocoa production increased 1 to 2 percent per year, reaching 3.4 million metric tons in 2000. Consumption has increased at double the pace of production, which has largely eliminated the vast cocoa stocks that had accumulated throughout the 1990s. Increased demand has caused price increases as well, as the amount traded in 2000 exceeded total production. In 2002 global market prices were increasing steadily.

The production increases of the 1990s were not evenly distributed around the world. In general, production increased in Africa, stabilized in Asia and Oceania, and declined in the Americas and the Caribbean. There are exceptions, however. Indonesia's production, for example, increased more than tenfold from 1986 to 2000 (33,000 MT to 465,700 MT), boosted by a 300 percent jump in local prices following the winter 1997 currency devaluation (Ruf and Yodding 2001). This encouraged the use of fertilizer and new plantings as well, even though the new plantings would not begin to produce for five to eight years. Yet Malaysian production dropped by more than two-thirds in the same period as many producers found it advantageous to tear out their cocoa plantings in order to establish oil palm plantations (Hardner et al. 1999).

In the same period, Brazilian net exports as a percentage of total production declined due to disease, high production costs, and increasing local consumption. Brazil illustrates how farmers in one country have reacted to declining prices. In Brazil there are approximately 25,000 producers, each with an average of 25 hectares in production. In addition there are approximately 400,000 permanent rural workers employed by the cocoa industry. Brazil produced about 500,000 metric tons of cocoa from 1986 to 1993, but by 2000 the country produced only 192,949 metric tons. During peak production, the country averaged 700 kilograms per hectare. By 1993 average production had decreased to around 450 kilograms per hectare and was continuing to decline because owners refused to invest money, either in the form of labor or chemical inputs, in a crop that was losing money (May et al. 1993). In Brazil the main limiting factor is neither land nor marketing manipulation, but the cost of labor. The spread of diseases (and the labor implications of combating them) is also an issue.

In many countries, cocoa production has reached its limits. But the factors that limit production can vary tremendously. Some countries have little remaining land that is good for cocoa production. There are few forested areas into which the industry can expand profitably. This is true, for example, in Côte d'Ivoire. Some 2 million hectares in the country (16 percent of its surface area) are already used for cocoa cultivation, and today little forest remains for future expansion of the crop.

Another limiting factor is the productivity of certain cocoa varieties and associated cropping systems. High-yielding, more intensive production strategies can diminish the pressure to convert natural habitat. While most cocoa production averages below 1 metric ton per hectare, the new high-yielding varieties can elevate the yields to as much as 4.5 metric tons per hectare. This strategy can be combined with intercropping or multiple cropping and yields of 2 metric tons per hectare per year can still be expected. Even the lower yielding of the two strategies more than doubles traditional yields and can decrease habitat conversion (Panfilo Tabora, personal communication).

In Ghana the factors that limit production are different. Ghana has some 2.4 million hectares of land under cocoa cultivation. This is about 10 percent of the country's total area. At this time, Ghana has converted virtually all forests appropriate for cocoa production. There is little room to expand. However, there is another factor that also significantly limits production. In Ghana a government-controlled marketing board still controls producer prices and taxes farmers based on production. Thus, the incentives are all wrong to encourage more sustainable production (Hardner et al. 1999).

Consuming Countries

Worldwide demand for cocoa increased in the 1990s in response to lower prices and increasing incomes in consuming countries. Europe consumes about half of global production; per capita consumption rates there are nearly twice as high as in the Americas (2.4 kilograms per person per year versus 1.3). The United States is responsible for another quarter of all consumption, with annual increases of 3 percent, the highest in the world of major consuming countries (Hardner et al. 1999). Only Eastern Europe has experienced an absolute decline in cocoa consumption since 1988, as governments ceased purchasing cocoa and declining private incomes reduced purchasing power in those countries. Prior to that time the former USSR was the largest single buyer of cocoa in the world (Hardner et al. 1999). Singapore has increased consumption of cocoa more than 7 percent per year for the past twenty years, but this is most likely accounted for through processing, manufacturing, and re-exporting. The question is whether consumption trends in Singapore will be a harbinger of what is to come in China. If so, this will have significant impacts on global demand and production as well as overall impacts.

In 2000, world imports were dominated by the Netherlands, the United States, Germany, France, and the United Kingdom. These countries account for about half of global imports. However, the first industrialized stage of processing and grinding of the beans is dominated by the Netherlands, the United States, Germany, Brazil, the United Kingdom, and Russia, in that order. Consequently, many imports, at least into the nonproducer countries, also show up as exports (FAO 2002).

Production Systems

The flowers of cocoa are produced on the wood of the tree, either the trunk or main branches. The trees produce large numbers of flowers at certain times of the year depending on the variety and local conditions. Only 1 to 5 percent of the flowers are pollinated. The number of seedpods that develop per tree varies from five to twenty-five or more and appears to be directly related to the number of pollinators in the environment. The period between fertilization and pod maturation varies from 150 to 180 days depending on the variety (Laird et al. 1996). Cocoa grows best when rainfall is between 1,500 and 2,000 millimeters per year, but the range can extend somewhat either way under less than ideal conditions (See Table 5.1). The plant, however, cannot tolerate dry seasons with more than three months of less than 100 millimeters of rainfall per month, and cocoa is also sensitive to waterlogged soils. In short, the pattern of rainfall is more important than the total amount. Temperatures can vary from a maximum of 30 to 32 degrees Celsius to a general minimum of 18 to 21 degrees Celsius. While plants can sometimes tolerate lower temperatures, they will be killed at temperatures below 10 degrees Celsius. Cocoa does not grow well in persistent strong winds; the trees prefer a sheltered location with windbreaks or forest cover to minimize wind (Laird et al. 1996).

Cocoa can be grown in a wide range of soils. It does best in deep, fertile, clay loam soils. It responds well to surface application of nutrients since the plant has many lateral, surface roots. It is generally assumed that cocoa cannot be produced on previously cleared and cultivated soils. However, improved planting material and cultivation methods now make it possible to cultivate cocoa on such soils (Laird et al. 1996).

Planting material is one of the most important issues affecting cocoa production. Sorting out the genetic material in seeds has been a serious challenge. Fortunately, plant breeders have been relatively successful in tailoring the plant to local growing conditions. Plants can be selected or bred for tolerance to local diseases and pests, seasonality of rainfall, flooding, winds, and acid soils (Laird et al. 1996). The characteristics that plant breeders try to achieve include vigorous growth, early bearing, improved yields, good percentage of bean weight in the pod, and high fat content.

Table 5.1 Cocoa Cultivation Requirements

Rainfall	1,250–3,000 mm per year
Dry season	No more than three months
Water	Impaired by both waterlogging and extended drought
Temperature	18–32°C, with absolute minimum of 10°C
Wind	Does not tolerate strong or even steady wind (forest cover or windbreaks are essential)
Soil	Deep, fertile, well-aggregated clay loam that is well supplied with nutrients at surface (not economical on degraded soils)

Source: Laird et al. 1996.

Traditional cocoa plants produce in three years under ideal conditions, but starting with grafted plants rather than seedlings can produce plants that bear earlier. Cocoa trees produce flowers on wood that is two to three years old. Since grafts are made from branches that are two years old, grafted trees produce in the first year. Grafting cocoa seedlings in the field is a new approach to production. This approach uses direct seeding in the field and then uses the seedlings as rootstock for grafting. This approach has shown high productivity within twelve months after grafting and can reach 3 metric tons of beans per hectare in two years. While only recently adapted to cocoa, this technology is now practiced extensively in the Philippines and Malaysia. This system also tends to be undertaken in full sun, monocrop plantations (raising many of the same issues as full sun coffee).

There are different ways to produce cocoa in plantations. In Brazil cocoa was originally planted within existing forests. In-forest production is considered the most environmentally positive form of agriculture practiced in Brazil today. But Brazil was one of the first major cocoa producers to create large cocoa plantations. In Cameroon and Nigeria forests were selectively thinned to plant cocoa and other fruit trees. In a relatively short time, a forestlike appearance was regained. This agroforestry system is still the most common form of cocoa production worldwide (May, et al.1993). However, in the 1970s, some growers began to advocate the "clear-cut system" in which all non-cocoa vegetation was removed. This is analogous to full-sun coffee production and, as might be expected, such producers depend more on agrochemical inputs. But the scale of full-sun cocoa production is much smaller than that of coffee production. At this time, some 70 percent of world cocoa production is still grown by small farmers mostly in agroforestry systems. Some 5 to 6 million of them depend on cocoa for part or nearly all of their cash income.

Cocoa produced for the market is divided into two main categories: bulk or ordinary cocoa from the forastero-type beans and fine or flavor cocoa from the criollo beans. In 1850 fine or flavor cocoa constituted 80 percent of world production; by 1900 it had fallen to 40 to 45 percent, and today it is only about 2 percent of world production (Wood 1987, as cited in Wood 1991).

The economics of cocoa production make it far easier for most large producers to simply push their plantings further into natural forest frontier habitats rather than to replant cocoa in existing plantations and agroforestry plots. This is true for two reasons. As Table 5.2 shows it is cheaper to clear forests than to replant existing plantations. Also, for at least the first few years, newly cleared areas have 15 to 25 percent higher yields than replanted areas (Matlick, personal communication, as cited in Rice and Greenberg 2000).

The cost of labor and/or chemicals to maintain production indefinitely in the same areas or to begin production in previously used or degraded agricultural or pasture areas is deemed too expensive by most producers. Given traditional production levels, world prices were not seen as justifying the expense. The cheapest alternative is simply to clear new forests. However, if the value of forests were to increase significantly, most cocoa production would not be viable without a significant increase in the international price of the commodity.

Table 5.2 Labor Requirements for Planting Cocoa in Primary Forest versus Replanting in an Aged Cocoa Farm

Activity in Primary Forest	Labor (person-days/ha)	Activity for Replanting	Labor (person-days/ha)
Clearing primary forest	33	Clearing fallow	30
Sowing cocoa beans	10	Nursery	20
Complementary planting	10	Planting	55
Intercropping	14	Intercropping	20
Initial weeding	3	Initial weeding	16
Replacement of dead seedlings	4	Replacement of dead seedlings	11
Complete weeding	12	Complete weeding	16
Total	**86**	**Total**	**168**

Source: Ruf 1995, as cited in Hardner et al.1999.

Once established, cocoa plantations are relatively simple to maintain. Most production activities involve manual labor; these include cutting weeds and clearing undergrowth, thinning trees to open up the canopy (cocoa needs some sunlight), insect control, mulching, fertilizing, harvesting, and on-farm fermentation and drying (May et al. 1993). Unlike many commodities, processing of cocoa begins on farm. If this level of processing is not undertaken correctly, the value of the cocoa diminishes considerably.

There are many pests that attack cocoa. These include thrips, cocoa mirid species, ants, borers, and other pests as well as witches'-broom, and black pod rot; weeds are also a problem. Increasingly, farmers turn to pesticides to control these, at least when markets are good or credit is available and they can afford to do so. Even the use of pesticides, however, is not always effective. For some pests, like the weird growths known as witches'-broom, the most effective treatment is prompt pruning or the elimination of infected trees. Such labor-intensive pest management measures are expensive for larger planters. In Brazil, for example, some 50,000 trees had witches'-broom in Bahia in January 1991. Because it was considered too expensive to take care of those trees, by April of the same year 250,000 were infected (May et al. 1993). It is for this type of reason that most cocoa is still produced on smaller farms.

While there are some 1,500 insects that feed on cocoa, less than 2 percent of these have become economically significant. A wide range of pesticides is used for these pests. A lengthy list is included in Laird et al. (1996). Cocoa production uses almost all the main categories of chemicals manufactured for pest control—organochlorines, organophosphates, carbamates, and pyrethroids. In some cases, chemicals are used that are banned in the consuming countries. This creates a thriving black market. Of the thirty-two or so most common pesticides used in cocoa, at least nine are included in the Pesticide Action Network's "dirty dozen" (Laird et al. 1996). Pesticide use and misuse is a serious problem in many cocoa-producing areas. In addition to using banned pesticides, the lack of proper training or clothes and inadequate directions on the containers result in exposure and even death for workers. Improper use also causes needless damage to local flora and fauna.

As chemical weed control becomes cheaper and more cocoa is grown under full-sun conditions that encourage weed growth, more herbicides are used. These commonly include paraquat, dalapon, diuron, 2,4,5-T, 2,4-D, picloram, glyphosate (Roundup), and Simazine (Laird et al. 1996). Paraquat and glyphosate are the most common.

Fertilizer stimulates the growth and production of young trees and increases the yield of mature trees, but applications can cause eutrophication if excessive amounts are used. The concentrations of the main fertilizer nutrients—nitrogen, phosphorous, and potassium--are adjusted for specific conditions as well as the amount of shade (Laird et al. 1996). The rate of application also depends on the current value of the crop. As prices increase so do applications of fertilizer. The production of full sun cocoa requires the application of more fertilizers than shade grown cocoa.

Because some 50 percent of the cocoa bean is fat, this makes testing for agrochemical residues much easier than for many other crops. Organisms tend to store toxic substances in their fat. Thus, cocoa is particularly vulnerable to pesticide residues (From the organization Toxopeus, personal communication 1994, as cited in Laird et al. 1996).

There are new, highly productive strategies in cocoa growing, which include planting in densities of 4,000 plants per hectare using more compact varieties of grafted plants. These plants are productive for only six to eight years. Another production method is planting at high densities (e.g. about 2,000 plants per hectare) but in single rows intercropped with other crops such as cassava, sugarcane, and sweet potatoes. Intercropped cocoa has more resistance to the major disease problems. However, the plants are also short lived (about six years of production). In both systems, the cocoa is then pulled out and replanted or production moves to other areas. These strategies, while much more intensive in their use of chemical inputs, can actually be cheaper forms of production because they are more productive and utilize existing cleared areas which require less labor to establish. In addition, the expansion of production is not a major threat to natural habitats. Such strategies are being used on some farms in Malaysia and the Philippines (Panfilo Tabora, personal communication).

In general, large-scale producers pay more for better land, use more paid labor, and have higher fixed and working capital costs compared to small-scale producers (Rice and Greenberg 2000). These factors tend to make larger producers more price sensitive. If prices decline, they are more likely to destroy cocoa and plant another more profitable crop. It also makes such producers more interested in higher-yielding, shorter-lived varieties.

One advantage that smaller producers have traditionally had is that they have a more intimate knowledge of their plots and even the individual trees. This knowledge is critical for identifying and addressing production problems early, when they are most easily remedied. As a Malaysian researcher has said, "Cocoa is like horticulture, the planter must almost know each tree" (Rice and Greenberg 2000). In Sulawesi small producers achieve yields of up to 2,000 kilograms per hectare per year, more than plantations average but less than half of the yields of many research station field trials. This implies that farmers are not yet close to achieving in the field the known limits of production for cocoa. Even so, pest buildup and declining fertility cause yields on most farms to decline significantly within fifteen to twenty years of planting.

Processing

Cocoa processing begins in the fields. Cocoa is gathered in the fields by workers, mostly women, who are hired specifically for that purpose. Pods are brought together in piles and then broken with machetes to remove the husks. Pulp and beans are initially gathered and later transported by people, animals, or machines in wooden boxes or woven baskets to on-farm fermentation facilities. At these locations the beans are subjected to a five-day fermentation process. The fermentation can be undertaken in baskets, heaps, boxes, or trays. After fermentation the beans are dried. Increasingly, this takes place in artificial dryers heated by fuelwood (May et al. 1993).

Fermentation and drying eliminates astringency and bitterness, imparting the peculiar flavor and brown coloring desired; it also reduces moisture content to 6 to 7 percent (May et al. 1993). A well-controlled fermentation process with inoculation of yeast and other effective microorganisms produces beans with better flavor profiles and storage qualities. Moreover, the beans dry faster because the mucilage that impairs drying is removed by the fermentation process. The reduced moisture content allows the beans to be stored and transported without risk of mold or mildew. No chemical or artificial additives or treatments are employed in processing cocoa beans.

After drying, beans are shipped to commercial centers for direct export or further processing. Many of the main producing countries attempt to add value to their cocoa by further processing the beans. In Brazil, for example, some additional processing is carried out in nine factories. To be competitive on the world market, these factories have a processing capacity of more than 100 metric tons per day. However, because of declining production in the country, Brazil began to import cocoa to keep the factories operating. Even this strategy has not worked; by 1992–93, these factories reported 38 percent idle capacity (May et al. 1993).

During transit, shipping, and storage, cocoa beans are often treated with phosphine to kill pests. This can be done prior to loading as well as during transit. The beans are then fumigated regularly, at least once per year, as long as they are in storage. Methyl bromide is also used for fumigation. This is a severely toxic, cumulative poison. Residues can cause brain damage months after use (Laird et al. 1996).

The next stage of processing after drying is cleaning; the beans are cleaned and all foreign matter is removed. After cleaning, the beans are broken and the resulting fragments, or "nibs," are winnowed. In some cases the beans are processed with alkali to neutralize acidity (this produces what is known as alkalized or "Dutch process" cocoa). The nibs are then roasted and ground and the mass is conditioned at high temperature. At this point processing diverges into two separate product lines, one for cocoa butter and another for fine-pressed cake or chocolate. The former involves filtering, solidification or tempering, degumming, and deodorizing to meet consumer demands in the cosmetics industry. Chocolate is packed in small kibbled cake form, or ground as cocoa powder and marketed directly to end users (May et al. 1993).

For each metric ton of cocoa beans harvested, nearly 10 metric tons of pod husks and pulp are generated. Traditionally this crop residue is discarded, either in small piles in the fields as it is harvested or in larger piles on the margins of the fields where it is left to decompose. Leaving uncomposted pods in the field, however, has been found to spread diseases such as witches'-broom and black pod rot (May et al. 1993).

Substitutes

While there are no direct substitutes for chocolate (carob has never lived up to its billing), there are substitutes for cocoa butter in the personal care and cosmetics industries. These include coconut oil, palm and palm kernel oils, and babassu oil (from the babassu palm, *Orbignya phalerata*, of Brazil).

An interesting issue raised by cocoa is that its consumption is directly linked to sugar consumption. So when the consumption of chocolate increases, the consumption of sugar increases as well.

Market Chain

Globally, the cocoa industry employs millions of people in the production sector. There are hundreds of thousands of producers, thousands of buyers at the local level, and hundreds of traders and exporters. A few hundred processors dominate the market. A dozen or so manufacturers of chocolate products dominate the interface with consumers.

The profits taken at any point in the system vary considerably. While the main producing countries control about 80 percent of production, they have not been able to form an effective, cohesive bargaining block.

The control of the final market for cocoa is concentrated in the hands of a very few, very large multinational companies who dominate its processing as well as the manufacture and distribution of chocolate: Nestlé-Roundtree, Mars, Jacobs-Suchard, Hershey's, and Cadbury. The Hershey's corporation, for example, imported cocoa equivalent to Brazil's entire exports but obtained ten times the Brazilian suppliers' revenues from its value-added processing and manufacturing. Many of the export houses in cocoa-producing countries are subsidiaries or joint ventures of these same multinationals. These companies are armed with more complete information than any other players in the market chain regarding harvests, purchase terms, and financing. Furthermore, they reduce their risks via hedges in the New York and London commodity exchanges, and they manage their own inventory stocks to prevent, or at the very least buffer, production variations and possible producer price increases.

A 1993 study showed that the value of cocoa exported by the principal producing nations in 1989–1990 was $1.8 billion. By processing the cocoa into chocolate and adding sugar, nuts, and milk, the five dominant corporations obtained gross revenues of $36 billion in 1990. CABI Bioscience (2001) reported that the global trade in confectionery (chocolate has the lion's share of this) is estimated at $80 billion per year.

Market Trends

Between 1961 and 2000 global cocoa production increased by 183 percent while cocoa traded internationally increased 230 percent. During the same period, prices declined by 68 percent.

By 2000–2001 cocoa prices were at an all time low. This was due in large part to overplanting during the market peak in 1976–77 that stimulated widespread planting. This planting, in turn, resulted in huge surpluses beginning in the early 1990s; these annual surpluses created stockpiles that continued to drive down prices. Cocoa generally takes three to four years to produce after planting and seven years to mature. Production increases for the first twelve years or so and then begins to decline. This means that production from plantings in the 1970s would have peaked in the early 1990s. In 1991 the stockpiled surplus represented 70 percent of one year's production. By 1999 the ratio had dropped to 40 percent, but the surplus stock of cocoa was still more than 1 million metric tons. By 2002 the price of cocoa had increased dramatically in response to increased consumption and declining stocks.

The cocoa market peaked in 1976–77 at a price of about U.S.$3,600 per metric ton and bottomed in 1992–93 at a price of about $800 per metric ton. By 2002 the price was near $1,500. The cycle from planting to retiring trees is about twenty-five to thirty years, but trees can continue to produce at lower levels for some time thereafter. Globally, many producers will probably retire their current, older plantings and replant or convert to another crop within the next decade. Those countries with lower wage rates, particularly in Africa and Asia, will continue to be able to compete even with current low prices or low productivity so long as they have forested areas and are permitted to expand into them. It is not clear whether that will be the case with Brazil and other South American countries, or even with Asia, where the price of labor is increasing. If full-sun, highly productive cocoa is planted increasingly, especially in Asia, it will tend to reduce prices considerably and to marginalize shade-grown cocoa in other parts of the world.

European countries have had preferential cocoa tariffs for former colonies. These tariffs discriminated against cocoa products based on the country of origin of production and/or processing. Under the regulations of the World Trade Organization, that will probably no longer be allowed. This, too, will cause shifts in production to favor the lowest-cost producers.

Environmental Impacts of Production

The main environmental problems associated with cocoa production are habitat conversion, forest degradation, soil degradation, and pollution from processing by-products. Each of these is discussed below. In addition, producers use a wide range of pesticides and agrochemicals that have impacts both in the area of use as well as downstream through the impacts of effluent contaminants on freshwater and marine organisms.

Habitat Conversion and Deforestation

The production of cocoa results in deforestation. Best estimates indicate that cocoa production is probably responsible for the loss of some 8 million hectares of tropical forest (Hardner et al. 1999). The climatic and agricultural conditions most suited for traditional cocoa cultivation are precisely those that harbor extraordinary amounts of biodiversity. In fact, most of the land that has been historically cleared for cocoa production is in what would today be called biodiversity hot spots. These include areas in Brazil, Ecuador, Peru, Colombia, Ghana, Côte d'Ivoire, Cameroon, and Indonesia. In the West African countries of Ghana and Côte d'Ivoire, only small patches of original forest cover have been spared in the face of advancing cocoa production.

Average cocoa plantings remain productive for only twenty-five to thirty years, so expansion into new forests is the norm. If nothing is done to prevent it, cocoa cultivation can be expected to cause the deforestation of millions of hectares of tropical forests over the next twenty-five years. Simply maintaining current production levels could well mean the clearing or selective cutting of more than 6 million hectares of tropical forests as the cocoa frontier expands on one side and leaves degraded areas behind on the other. Another question, then, is what will be the next use of those areas currently devoted to cocoa production, and will the environmental impacts be more or less than those of cocoa production?

In Brazil cocoa cultivation is one of the main causes of the conversion of vast tracts (over 700,000 ha in the past century) of Atlantic coastal forests. If one looks at the relationship of deforestation to cocoa production, there is cause for concern. Three periods of deforestation related to cocoa production can be identified in Brazil: 1945–65, 1975–79, and 1982–86. During the first period, deforestation resulted from stagnant cocoa prices. During the second period, deforestation resulted from high prices. And, during the final period, deforestation resulted from declining cocoa prices. In short, deforestation resulted from upward or downward price shifts as well as overall market stagnation (May et al. 1993). On first glance, it appears that cocoa prices have little to do with deforestation. In fact, since cocoa is the only game in town, any change in price can cause deforestation. When prices were flat or were high people planted more to increase their income. When prices were low people increased planted areas or the density of existing plantations in an attempt to maintain their previous income.

Much of cocoa production in Brazil is centered in the state of Bahia. Production peaked there in the 1970s with about 400,000 hectares planted. As cocoa prices fell, agrochemical inputs were no longer financially feasible and marginal cocoa lands fell dormant. Witches'-broom has systematically destroyed cocoa trees throughout the region. Declining prices have left farmers with little money to pay laborers to fight witches'-broom. Debt has become so overwhelming in the cocoa sector that farms have been (and continue to be) sold and/or converted to other uses.

As a consequence, in Brazil today deforestation in cocoa producing areas is not accelerated by the expansion of cocoa production but rather by its contraction. The low international prices for cocoa are now causing many planters to go in and cut the more valuable shade trees that were left during the initial cocoa planting. Farmers use the funds from these trees to finance the conversion of their farms from cocoa to other agricultural and ranching activities. These alternative cropping systems (generally pasture or annual crops) eliminate virtually all biodiversity, and furthermore have proven to be more short-lived than cocoa-based production systems.

Hardner et al. (1999) predict that at least half of Brazil's cocoa farms will be converted to other uses in the near future. Most conversion will include cutting not only cocoa trees but also the intermixed natural forest remnants within the cocoa farms. Historically, at least, cocoa production slowed deforestation in Bahia, but how much forest will remain in the face of the failure of the cocoa market to rebound remains to be seen. Strategic intervention by conservationists to help save or make viable the Atlantic forest cocoa agroforestry production system could do a great deal for protecting the last pockets of biodiversity within the region. However, unless the land ownership patterns in Bahia revert to smaller units so producers can use their own labor to compete in global markets (which is not likely to happen), cocoa will not be a viable crop in that region.

In Indonesia the rapid expansion of cocoa production opened previously inaccessible tropical forests in such places as Sulawesi and Central Sumatra. New settlements in such areas led to further deforestation even when cocoa went into decline due to low international prices. Small farms expanded from less than 50,000 hectares in 1980 to more than 400,000 by 2000. Cultivation was preceded by the dramatic clearance of forests. In addition to increases in cultivation, the population was increasing in areas with expanding cocoa production. In southern Sulawesi for example, the population doubled in the 1980s and doubled twice in the 1990s. Whether cocoa production ultimately proves profitable or not, most of these immigrants and their children will remain and will put additional pressure on the environment and natural resources.

Forest Degradation

Much cocoa cultivation in the world today is undertaken in agroforestry systems in which some part of the natural forest is left in place. Even so, shade production has considerable impact on the ecosystems where it is established. Biomass and soil fertility declined because of cocoa production in Nigeria (Ekanade 1987). Specific impacts documented include losses of overall foliage cover (reduced by 6.9 percent), reduced height of native trees (a 58.6 percent reduction), reduction in tree girth (a 66.9 percent reduction), tree basal area (88.1 percent reduction), and volume of wood (95 percent reduction). Only tree density and accumulated litter showed a relative increase (by 78 percent and 2.6 percent, respectively) in cocoa plantations relative to natural forests.

Forest mammals, reptiles, and amphibians showed declines both in absolute numbers and species diversity similar to the deterioration of the vegetation matrix. What tends to happen is that some species disappear, and a small subset of species that do well in disturbed areas tend to dominate cocoa production forests.

In Brazil, even in the shade cocoa planting system where seedlings are planted within native forests, the floral substrata are removed, as are about 90 percent of the original tree species. The impact on sedentary biodiversity can be devastating.

While clearing the understory and much of the forest canopy to plant shade cocoa has significant environmental impacts, experience and research have both demonstrated that sustainable shade cocoa production provides habitat to important forest and migratory bird and mammal species. Sustainable shade cocoa production can play a strategic role in the preservation of forests, forest remnants, and forest corridors—those forested areas that connect larger blocks of intact forest (Knight 1998). Similarly, higher diversity within the cropping system has been found to lead to higher diversity in associated biota, as does lower use of pesticides. Overall, increased biodiversity leads to more effective pest control and pollination. And finally, increased biodiversity leads to more efficient nutrient recycling (Whinney 2001).

Soil Degradation

Cocoa cultivation often exposes soils when forest vegetation is removed prior to planting. Erosion occurs as plantations are established and even during their early years. Once plants mature and tree canopies are reestablished, erosion rates decline. However, studies show that foliage cover is not as complete even in traditional cocoa plantations as it is within natural forests, implying that erosion rates are likely to be higher in cocoa agroforestry plots than in natural forests. Because the leaves of cocoa do not decompose quickly, they can suppress other vegetation. This could make soils more susceptible to erosion.

In addition to erosion, soils in cocoa plantations experience a loss of fertility. Nutrients are exported from plantations in the form of seedpods, but more importantly, the loss of ground cover probably leads to increased leaching. The biotic and soil components of the Nigerian tropical forests where cocoa is being produced have deteriorated considerably (Ekanade 1987). This, in fact, suggests why cocoa plantations must be moved periodically to more fertile, virgin forest areas. However, instead of allowing the forests to regenerate in some form, most abandoned cocoa plantations are cleared and used for conventional agriculture. In this sense, cocoa production is merely the first step in the ultimate deforestation of an area even though the cycle may take twenty-five years or more to complete.

Wastes from Processing

For each metric ton of cocoa beans harvested, nearly 10 metric tons of waste (pods, pulp, etc.) are created. In the past, the waste was often kept in the plantation and used as organic fertilizer or mulch. This practice, however, favors the propagation of witches'-broom and black pod rot unless the materials are properly composted to eliminate diseases. Such waste can also be used as mosquito breeding grounds and can be responsible for the spread of diseases to humans as well.

Better Management Practices

Several different but complementary strategies could help reduce the environmental costs of cocoa production. These practices should center on increasing the ability of producers to replant the same areas indefinitely, reducing the use of agrochemical inputs and the creation of wastes, and turning wastes into by-products or substitutes for purchased inputs. Biodiversity can be promoted through interplanting, which can be sold to producers as a means of diversifying their sources of income. Working with producers to adopt better management practices will be most effective when complemented and supported by work with the larger industry, investors, and governments as part of a concerted effort to reduce the negative environmental impacts of the industry.

For cocoa, the identification of better management practices will require that producers and researchers work together to identify, analyze, document, and disseminate information about the most promising practices from around the world. In every instance, the approach should be to identify production techniques that pay for themselves and offset the cost of adopting the more expensive better management practices. It appears that cocoa yields can be improved by more than 40 percent simply by adopting improved practices that allow producers to achieve yields that are within the genetic parameters of the varieties that they cultivate (Ooi et al. 1990). Such practices can be as simple as regular, thorough pruning after harvest to increase yields and reduce pests.

Shape the Expansion and Maintain the Viability of Shade Cocoa

In the near future, unless full-sun cocoa can be produced on existing or degraded agricultural areas, it is likely that cocoa production will continue to expand into existing forests. In these instances, expansion should be encouraged in ways that will reduce its impact on biodiversity and ecosystem functions as well as ensure the financial viability of the industry over time. For example, land use planning and zoning should be undertaken in consideration of what is known about how cocoa can be best produced, over time, with better practices that have already been identified by growers.

Cocoa can also be grown in association with other taller, commercially valuable trees. Cocoa has been grown on vast plantations of coconut, rubber, and oil palm trees. In these systems, the highest price commodity gets the most attention and the others tend to be left to fend for themselves. In many of these systems, since cocoa is often not the principal focus of many large-scale producers, it is often neglected.

In other large-scale agriculture or aquaculture production systems, owners and managers have found that making line workers responsible for specific plots and giving financial rewards to them for increased net profits on their areas can increase profitability as much as fourfold. Such "win-win" incentive programs should be adopted in cocoa production as well. Without such innovations, large-scale producers can never hope to compete with small-scale producers who use unpaid family labor to support their production.

Small-scale growers, however, have a different perspective; cocoa is grown together with other crops with the same care. This strategy would be improved if a more integrated system could be constructed that provides both food and cash crops while utilizing family labor rather than expensive inputs.

The areas of greatest concern and the areas where strategies may be more successful, however, are those where there are still considerable forested areas suitable for the cultivation of cocoa and where the industry may try to expand. For instance, Cameroon has only 0.5 million hectares of forests converted to cocoa production, but an additional 2.5 million hectares of forest land suitable for cocoa. The maintenance of a relatively stable level of production somewhat masks the geographic shift in cultivation from the central and southern regions of the country to the southwest where productivity continues to grow. Unfortunately, the southeast is among the most biodiverse regions in the country. Efforts to stem this shift in production will need to begin immediately and must address the root causes for the shifts in cocoa production, namely, loss of productivity in converted lands in other parts of West Africa.

Increase the Efficiency of Agrochemical Use

While much of the cocoa production in the world at this time is *de facto* organic, as the price continues to increase, a number of producers will find it advantageous to purchase and use increasing quantities of agrochemicals. During periods of low prices, many cocoa producers reduce their applications of expensive fungicides and pesticides. Not only do such practices lead to large crop losses, but also low-level reduced spraying can lead to increased resistance over time. In short, reduced, efficient use of chemicals should not imply their sporadic use, which can be quite damaging.

There are several ways to reduce the use of agrochemicals. One is to certify producers as organic and pay them to use labor instead of chemical inputs to produce their crops. There are formal organic certification procedures, but total organic production globally is still less than 10,000 hectares. However, it would be important to measure the environmental toxicity of several copper and sulfur compounds as well as tobacco extracts that are currently allowed for use by organic producers even though they are highly toxic to other organisms.

There are other ways to reduce chemical inputs as well. Managed spraying systems, using a list of approved chemicals (and excluding ones that are banned in the consuming countries), and ranking the approved chemicals according to their overall toxicity are all ways to reduce the use of the most toxic substances.

Farmers tend to adopt technology packages selectively. Often the highest returns on capital investments are most attractive (Johnson et al. 1999). However, the perceived risks of innovation are often as important as their perceived profitability. The interactive impacts among several variables can also be used to advantage when trying to get producers to adopt better practices. Stepwise adoption of complementary better practices (e.g. the increase of organic matter and the reduction of chemical inputs) can be encouraged as a way to gradually reduce impacts and improve profitability.

There are also a number of biological controls in various stages of development that appear to reduce the need to use agrochemical inputs. For example, nonpathogenic fungi can be applied to cocoa to reduce the levels of infective spores of disease-causing fungi. In Ghana, certain fungus species have been found to inhibit the growth of black pod rot in the laboratory. In Brazil, a commercial formulation of this product has been marketed to control witches'-broom, and producers are very enthusiastic about it (Pesticide Action Network 2001). Another approach involves the introduction of a beneficial fungus into the tissues of the cocoa tree. The fungus does not harm the tree; it helps protect it by attacking pathogens and increasing resistance. CABI Bioscience is investigating several fungi to control witches'-broom in South America (Pesticide Action Network 2001).

Finally, the use of natural enemy species for biological control of insect pests is also being investigated in several countries. In Malaysia, the black ant is being used to control cocoa mirids, a common pest. To date, the main problems with biological controls have been that they kill only a very narrow range of pests, they perform poorly relative to their cost, and the product quality is inconsistent (Pesticide Action Network 2001).

For low-input, small-scale producers, improving shade management can reduce expensive inputs while balancing overall productivity. For example, shade can reduce weed growth as well as the occurrence of some fungi. Such systems also increase the long-term productivity of cocoa and can be used to restore abandoned or degraded land (Rice and Greenberg 2000).

Diversify Sources of Income

Researchers have shown that interplanting low-input cocoa plantings with fruit trees can buffer the impacts of low cocoa prices. The break-even cocoa price for such integrated producers is just over 50 percent of the price needed to break even in cocoa production without fruit trees (Rice and Greenberg 2000).

Similarly, shade trees selectively cut to manage shade can be sold for timber, fuel, or charcoal. The sale of shade trees in coffee plantations has shown that they can compensate for lost yields of 17 percent when prices are high, 33 percent when they are intermediate, and 100 percent when they are low (Rice and Greenberg 2000). Thus, the shade trees offer sources of income at precisely the times when producers need them most. There is no reason to assume similar earnings/loss effects would not apply equally to cocoa.

Managing carbon is another potential income source for cocoa farmers if Kyoto-like mechanisms are ever ratified. Forty-year-old cocoa agroforestry systems in Cameroon fix atmospheric carbon at levels of around 154 metric tons per hectare. Systems that are fifteen to twenty-five years old sequester 111 and 132 metric tons of carbon, respectively. While lower than sequestration rates for primary forests (307 MT/ha), they are far greater than rates for annual crops, even those with associated fallows (Rice and Greenberg 2000). Depending on the price assigned to carbon, sequestration could supply significant income for producers, and also an incentive for them to retain shade trees in their areas of production and to reduce chemical inputs. Provided the carbon can continue to be stored, shorter-term crop rotations tend to sequester more carbon per hectare per year.

Reduce Waste and/or Create By-Products

As described earlier, nearly ten times as much waste from pod husks and pulp are generated for each metric ton of cocoa beans. If properly composted, this material can provide large amounts of organic matter for fields without risking the spread of disease. Alternatively, the pods can be ground and used in cattle feed or the alkaloid theobromine can be extracted from them for sale as a by-product. The pulp that surrounds the seeds is increasingly sold for juice, but it is also made into alcohol, vinegar, wines, and liqueurs (May et al. 1993). Such waste can also be dried and used for fuel. Producers are now exploring the possibility of using this waste for fuel to dry the beans or turning it into charcoal briquettes for sale on the open market.

In recent years, the adoption of very simple and relatively inexpensive crushers, coupled with fermentation of the cocoa hulls by inoculating with effective microorganisms that speed up composting, have shown that there is a potential for returning pod hulls back to the field. The microorganisms used suppress the propagation of other harmful microorganisms and therefore do not contribute to the reestablishment of diseases such as witches'-broom. This could solve the disease problem currently associated with returning pod hulls to the field.

Encourage Full-Sun Cocoa on Degraded Lands

Another way to avoid forest degradation is to change the architecture and planting density through the use of full-sun cocoa. This will only work, however, if trees are planted on existing or degraded agricultural lands rather than newly cleared forests or existing shade cocoa systems. High density planting is more efficient. In effect, higher yields can be achieved on previously degraded areas without any further impacts on soil fertility or habitat loss.

While cocoa production has been promoted in many countries around the world, the technology being used is the low-density technology that achieves yields of, at best, only 1.5 metric tons per hectare. There are, however, new production technologies that allow those levels to be doubled, or even tripled, to as much as 4.5 metric tons per hectare per year. This strategy is not very expensive. Full-sun cocoa utilizes newer, more compact varieties whose vertical trunks are the primary fruit-bearing areas of the plant, rather than the horizontal branches. These shorter, grafted plants produce more quickly. Pruning allows producers to keep the plants short so that pesticide sprays are more effective. Productivity falls off sharply after about ten years, but if rotated with other crops this system can be used to prevent conversion of natural habitat.

These technologies have been developed and are used by some competitive, private companies. Their strategy is to increase production to the point that labor costs are not as significant a factor in their economic viability. However, labor costs on full-sun cocoa plantations have been reported to be 70 percent higher than on conventional systems (Chok 2001). This means that increased productivity is required to offset such costs.

Larger companies adopting this technology, however, may be swimming upstream. Smaller producers using the same techniques could easily undermine the larger companies because they do not rely on the use of paid labor. Unfortunately, the technology has not filtered down to the smaller producers yet. This is an important bottleneck that could be addressed through the provision of grafted stock and overall production packages to small-scale producers. One place where this is happening currently is in Vietnam, where the government has set up thousands of nurseries to provide grafted cocoa seedlings to coffee producers. Vietnam is the second largest coffee producer in the world, but its production has helped trigger the lowest real producer coffee prices ever. Many coffee producers want to shift production to another crop. It is not clear, however, whether such a dramatic increase in production of cocoa in those areas would not cause a similarly dramatic drop in cocoa prices.

Work with Governments to Control Cocoa Expansion

An important leverage point in cocoa production is political. It is virtually impossible to develop effective strategies for working directly with hundreds of thousands of small producers scattered throughout the world. Governments have the ability to encourage producers to adopt better practices through regulatory structures that influence production, or as a condition of concession permits or licenses to use specific areas for cocoa production.

Three countries account for 70 percent of all production. Another seven bring the figure to virtually all traded cocoa. One strategy could be to work with governments to increase the sustainability of existing or planned cocoa expansion. For example, the identification and analysis of better management practices for specific regions could help existing producers reduce environmental problems and increase profits. Such practices could also be the criteria that governments use to zone new areas for cultivation. Such improved practices could serve as the basis for government licenses, permits, or even agricultural credit for the ongoing production of cocoa. Finally, better management practices can be used to make convincing financial arguments for why governments should modify land subsidies or infrastructural support in order to encourage the industry to become more sustainable.

Work with Companies to "Green" Their Supply Chains

A second key leverage point is the marketing and supply system. A careful examination of the cocoa value chain indicates that there are a few areas where most of global production passes through the hands of only a few. These leverage points should be the key targets for affecting the sustainability of production at the local level. For example, cocoa producers traditionally sell their product to one of three buyers—middlemen who aggregate stocks for resale (e.g. Phibro, Sucres at Denrees, Jacobs-Suchard, S.W. Group, Tardivat, Cargil), cocoa butter producers (e.g. Gill and Duffis, Barry, W. R. Grace, Gerkens, Van Houten), or chocolate confectioners (e.g. Jacobs-Suchard, Mars, Nestlé-Roundtree, Cadbury, Hershey's). The last two categories represent very few players. In some areas buyers have near monopolies; in others a few buyers have oligopolistic control of markets. The category of middlemen has the largest number of players, but even there the total numbers are quite small by comparison to the number of producers, especially when dealing with specific regions.

One proposal would be to pressure large multinationals to make conservation investments in pristine forest areas as compensation for the forest destruction that occurs with the production of cocoa. These "forest offsets" would be similar in theory to carbon offsets. Since multinationals are few in number and heavily capitalized, such negotiations would be more simple, cost effective, and timely than efforts to modify the behavior of hundreds of thousands of small producers.

The problem with this approach is that it assumes that production impacts cannot be mitigated directly, e.g. that there are no better ways to produce cocoa. Rather, the goal is to make sure that every company involved protects a forest equal in size to the one that the product they buy will destroy for the establishment of farms. The theory is that there would be no net loss from cocoa production. This is fine when replanting occurs under existing cocoa and shade trees. If, however, cocoa production is indeed a moving frontier, then this option is not feasible. It does not even postpone the inevitable forest destruction for very long unless the set-asides are purchased and put into protected status.

A better approach would be to work with key companies in the supply chain to develop screens for more ecological production that they can use for their purchases. Once the ecologically based screens are created for buyers, they can also be used to reduce the risks of investors and insurers who are also important players with the industry. Such screens will send a signal to producers about what type of products, produced in what way, they want to purchase. While no one knows how to produce cocoa indefinitely on the same piece of land, better practices for the industry are known and those not well known can be made available to those producers who are able to be competitive. Grafting improved varieties, high-density planting, avoiding steep slopes and riparian areas, reducing the exposure of soil during planting, utilizing ground cover, intercropping, reducing input use, reducing waste or converting it to usable by-products, and regular replanting are some of the techniques that can be encouraged. If adopted they would reduce considerably the most common problems from current practices. By working in partnership with producers to encourage the adoption of these practices, buyers can help to maintain their sources of supply well into the future.

Outlook

People are not going to stop eating chocolate. If anything, demand will continue to increase. Unfortunately, traditional production has known environmental problems. Cocoa is not easily or cheaply replanted on the same area, for example. So long as this is the case, traditional cocoa production will continue to expand into natural forests. Every effort must be made to find alternatives. There are two major avenues for this work. The first is to identify and analyze ways to increase and extend production in areas of current use. Research suggests that this may be a promising strategy; because it appears to depend on family labor it may be extremely important for smaller producers.

The second strategy is the development of full-sun cocoa production. This system promises to increase production dramatically per hectare and to reduce the pressure on natural forest conversion from planting cocoa. There are some major drawbacks, however. The system also promises to be far more input-intensive than traditional cocoa production. In addition, while full-sun cocoa can be produced on agricultural land or even degraded lands, it may be far cheaper to undertake in natural forests, degraded forests, or agroforestry areas. In any of these areas, full-sun cocoa would result in a net biodiversity loss. Even so, it is important to examine carefully as an option and to identify the best practices for this type of cultivation that could not only reduce impacts and increase profits, but also improve overall rotation cycles. It is very important to monitor closely what happens in Vietnam with full-sun cocoa as this could very well set the precedent, good or bad, for future cocoa production.

Resources

Web Resources

www.ambio.kva.se
www.cabicommodities.org
www.acri-cocoa.org
www.icco.org
www.chocolateinfo.com
www.cocoatree.org
www.pan-uk.org/Internat/IPMinDC/pmn12.pdf

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