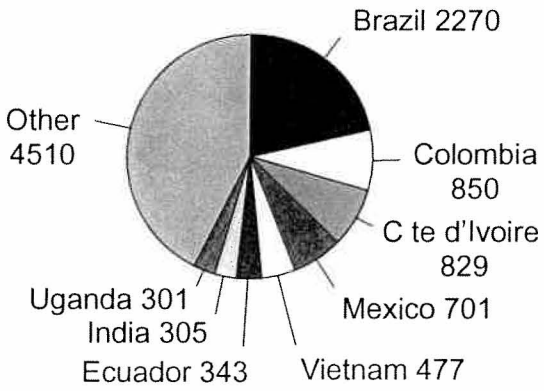
**Coffee** *Coffea arabica, C. canephora,* and other species

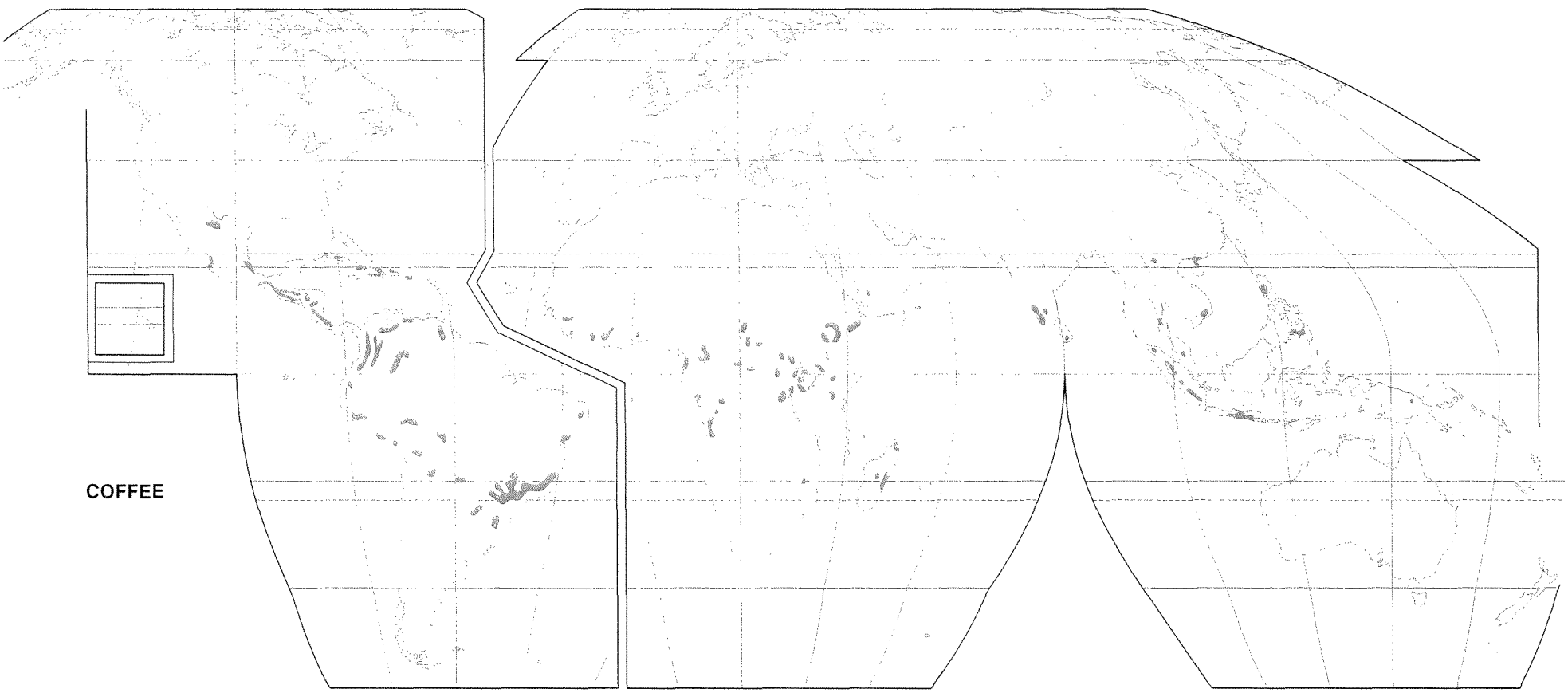
| | |
|---|---|
| *Production* | |
| Area Under Cultivation | 10.6 million ha |
| Global Production | 7.4 million MT |
| Average Productivity | 698 kg/ha |
| Producer Price | $1,130 per MT |
| Producer Production Value | $8,362 million |
| *International Trade* | |
| Share of World Production | 76% |
| Exports | 5.6 million MT |
| Average Price | $1,510 per MT |
| Value | $8,441 Million |
| *Principal Producing Countries/Blocs (by weight)* | Brazil, Vietnam, Colombia, Indonesia, Mexico, Côte d'Ivoire, Guatemala |
| *Principal Exporting Countries/Blocs* | Brazil, Vietnam, Colombia, Indonesia, Côte d'Ivoire, Guatemala, Mexico |
| *Principal Importing Countries/Blocs* | United States, Germany, Japan, Italy, France |
| *Major Environmental Impacts* | Conversion of primary forest habitat<br>Soil erosion and degradation<br>Agrochemical use and runoff<br>Effluents from processing |
| *Potential to Improve* | Good<br>Better practices known for both sun and shade grown coffee<br>Organic, shade-grown, and Fair Trade certifications exist<br>Low prices driving harmful practices |

Source: FAO 2002. All data for 2000.

## Coffee

## Area in Production (Mha)





# Chapter 3

# Coffee

## Overview

The coffee plant was originally found and cultivated by the Oromo people in the Kafa province of Ethiopia, from which it received its name. Around 1000 A.D., Arab traders took coffee seeds home and started the first coffee plantations. The first known coffee shop was opened in Constantinople in 1475, and the idea quickly spread to other parts of Europe. England's King Charles II raged against coffeehouses as centers of sedition because they were the meeting place of writers and businessmen. Lloyd's insurance company was started in the back room of a coffeehouse in 1689. In fact, coffee shops became centers of political and religious debate throughout the continent, and many were subsequently closed. The owners were often tortured.

Coffee first arrived in Europe from Turkey via overland trade routes. It is not known exactly when coffee first arrived, but it had probably been there some time before coffeehouses became common in the sixteenth and seventeenth centuries. It is possible that coffee was brought in along the same trade routes that were used to transport gold, valuable gums, and ivory from Africa and silk and spices from Asia. In any case, coffeehouses were already established in northern Europe with the sixteenth-century arrival of cocoa, which then spread quickly as another coffeehouse drink.

Over the centuries coffee has gone from a luxury to necessity. Globally, coffee consumption is increasing but not nearly as rapidly as production, so prices are decreasing. In 2002 real coffee prices reached historic lows. Many producers are abandoning coffee plantations; others are destroying them. All of this is happening when markets in developed countries are fixated more than ever on high-quality coffee. While many consumers are willing to pay more for their coffee, they are actually drinking less of it. Furthermore, increased supply has not been followed by a commensurate decrease in price in most developed countries.

## Producing Countries

Coffee is produced in about eighty tropical or sub-tropical countries. Some 10.6 million hectares are currently in coffee production. Average annual production is about 7.4 million metric tons of green, or unroasted, coffee. The value-added coffee industry is worth about U.S.$60 billion worldwide, making coffee the second most valuable legally traded commodity in the world after petroleum (McEwan and Allgood 2001). It is a primary export of many developing countries, and as many as 25 million people depend on coffee for their livelihood.

The main coffee producing countries by area planted, as opposed to total production, are Brazil (2.27 million ha), Colombia (850,000 ha), Côte d'Ivoire (829,000 ha), Mexico (701,326 ha), and Vietnam (477,000 ha). Each of the following countries has between 200,000 and 350,000 hectares planted to coffee: Cameroon, Ecuador, Ethiopia, Guatemala, Honduras, India, Peru, Uganda, and Venezuela. Combined, the top eleven countries account for nearly 74 percent of all land devoted to coffee and 74 percent of global production as well (FAO 2002). Even so, coffee production is less concentrated than many other commodities.

Coffee can still be important from an overall point of land use even if the country is not a major exporter. For example, Côte d'Ivoire and Puerto Rico both have 25 to 49 percent of all their agricultural land planted to coffee. Colombia, Costa Rica, Ecuador, El Salvador, Guatemala, Guinea, Panama, and Papua New Guinea each have 10 to 24 percent of all their agricultural land planted to coffee.

The main coffee producers by volume harvested are Brazil, Vietnam, Colombia, Indonesia, Mexico, Cote d'Ivoire, and Guatemala. These countries are also major coffee exporters. However, coffee is also one of the leading exports (see Table 3.1) in a number of countries that are not the largest producers or exporters. World exports are expected to rise by 11 percent to 81 million bags in 2002, while stockpiled reserves are expected to reach record levels of 27 million bags.

Globally, production averages 698 kilos per hectare. Martinique has the highest per-hectare production with more than four times the global average. Tonga achieves more than three times the global production average while Costa Rica, Zimbabwe, Thailand, and Malawi all produce at more than double the global average.

**Table 3.1 Coffee's Ranking of Total Exports by Value for Selected Countries, 2001**

| Leading Export | Second Largest Export | Third Largest Export |
|---|---|---|
| Burundi | Angola | Costa Rica |
| El Salvador | Colombia | Equatorial Guinea |
| Ethiopia | Kenya | Côte d'Ivoire |
| Guatemala | | Laos |
| Honduras | | Sierra Leone |
| Madagascar | | Yemen |
| Nicaragua | | Congo |
| Rwanda | | |
| Tanzania | | |
| Uganda | | |

Source: ITC 2002.

## Consuming Countries

Coffee began as a luxury item, but it has become a basic food item that is now considered a daily necessity for many consumers. Today more than 2 billion people around the world are estimated to drink coffee regularly. Europe's thirst for coffee is the most voracious, as it annually consumes 2 million metric tons or just over 40 percent of all coffee traded globally (*The Financial Times* 2002).

Traditionally, producing countries along with the United States and Europe consume the most coffee by far. The United States consumes 25 percent of internationally traded coffee. However, the amount of coffee bought in the United States has declined in both absolute and per capita terms. Consumption throughout the European Union has also declined, but it is rising in Japan and Russia. The main coffee importers, as shown in the Fast Facts chart, are the United States, Germany, Japan, Italy, and France.

More people throughout the world are drinking coffee. Some 40 percent of the world's population drinks at least one cup of coffee each year. In general consumers first turn to lower-quality robusta varieties, which are used to make instant and mass-market coffee. As markets mature, consumers switch to higher-valued arabica blends, but they do not necessarily drink more coffee.

The industry has its eyes on China as an indicator of future global market trends. The Chinese currently drink about a cup per person per year. If China follows Taiwan, this will increase to thirty-eight cups per year. If it approaches the United States, consumption could reach 463 cups. Sweden has the highest per-capita coffee consumption in the world with each person drinking on average 1,100 cups per year. How China progresses will have a tremendous impact on global demand and markets. It is likely, however, that initial impacts will be confined to the lower-grade beans used to make instant coffee.

The trade in coffee is relatively concentrated. In 1989 eight companies controlled more than half of the internationally traded coffee (See Table 3.2). No single company dominates the trade, however. Consolidation of the food industry is likely to affect coffee traders as well.

**Table 3.2 The World's Largest Coffee Traders, 1989**

| Enterprise | Volume (1,000 bags) | Market Share |
|---|---|---|
| Rothfos | 9,000 | 12.6% |
| ED & F. Man Holdings Limited | 5,000 | 7.0% |
| Volkart | 4,000 | 5.6% |
| Cargil | 4,000 | 5.6% |
| Aron | 4,000 | 5.6% |
| Rayner | 4,000 | 5.6% |
| Bozzo | 3,500 | 4.9% |
| Sueden | 3,500 | 4.9% |
| Total | 36,500 | 51.1% |

Source: The Economist Intelligence Unit 1991.

## Production Systems

Coffee is a woody shrub or small tree that can reach 10 meters in height, but under cultivation it is usually pruned to about 2.5 meters to facilitate harvesting. Coffee grows in tropical climates and performs best with good sunshine, moderate rainfall, average temperatures from 15 to 21 degrees Celsius (59 to 70 degrees Fahrenheit), no frost, and at altitudes between sea level and just over 1,800 meters (6,000 feet) (Manion et al. 1999).

Coffee matures (begins to flower and fruit) about three years after planting. One main and one secondary flowering season occur per year. Each mature tree produces approximately 2,000 "cherries" per year, or 4,000 beans. This is the equivalent of half a kilogram (1 pound) of roasted coffee (Manion et al. 1999).

Coffee is a relatively easy crop to grow, but it is susceptible to a number of diseases and insect pests. At least 350 different diseases attack coffee, while more than 1,000 species of insects may cause the plant problems.

Two of the most significant factors that affect coffee production in any country are the relative costs of land and labor. Because coffee grown in full sun has a productive life of six to eight years and shade-grown coffee eighteen to twenty-four years (even more if plants are cut back and harvested from the new shoots), the relative value of land and labor can shift over time. Historically, most commercial production came from landholdings of 500 hectares or more. Today holdings of less than 5 hectares of planted coffee account for more than half of global production. Small producers are able to substitute unpaid family labor for both paid outside labor and many of the more expensive chemical inputs.

Two species account for the bulk of the coffee produced around the world—arabica (*Coffea arabica*) and robusta (*C. canephora*). Arabica came from the highlands of

Ethiopia and was the first type of coffee that was produced for sale. Production of robusta coffee developed after World War II. The two species, and improved varieties developed from them, differ in taste, aroma, caffeine content, disease resistance, and optimum cultivation conditions. Natural variations in soil, sun, moisture, slope, disease, and pest conditions dictate which coffee is most effectively cultivated in which region of the world. The two coffees are compared in Table 3.3. In general, arabica coffee is produced in Latin America while robusta coffee is produced in West Africa and Southeast Asia. However, Brazil is both the world's largest arabica producer and the second largest (after Vietnam) robusta producer.

**Table 3.3 Comparison of Arabica and Robusta Coffee Varieties**

| | Arabica | Robusta |
|---|---|---|
| Altitude of cultivation | 500–2000 m | 0–1000 m |
| Temperature requirements | Moderate | More heat tolerant<br>More sensitive to cold |
| Humidity requirements | Lower | Higher |
| Soil requirements | Fertile soil | Poorer soils |
| Disease resistance | Low | Higher |
| Flavor profile | Fuller flavor | Weaker flavor |
| Caffeine content | Lower | Higher |
| Average price | Higher (up to 30%) | Lower |
| Labor as percentage of total variable costs | 40% | 60% |
| Agrochemical and material inputs as percentage of total variable costs | 25% | 15% |
| Overhead as percentage of total variable costs | 35% | 25% |
| Proportion of world supply | 75% | 25% |
| Main products | High-quality brands and specialty coffees | Instant, flavorings. mass-produced brands |

Source: De Graaf 1986, as cited in Manion et al. 1999.

Note: Overhead includes capital, administration, and management.

In the 1990s there was considerable expansion of coffee production into new areas. The new coffee producers, including Vietnam and India, were able to be competitive in spite of low prices because labor was cheap and they could produce robusta coffee on relatively poor soils. Traditional coffee producers, however, such as Colombia, Costa Rica, and Mexico, were able to maintain coffee production in the face of higher land and labor costs by increasing yields from arabica coffee and by focusing on the small but growing markets for higher quality and certified shade-grown and organic coffee.

In the future coffee production will expand in those areas that have low input costs of production (e.g. inexpensive land and labor) with respect to the price that can be obtained for the coffee. Thus, expansion is certain to happen in India and Vietnam and perhaps in Myanmar, Laos, and Cambodia. Future environmental costs of coffee production are likely to be most pronounced in these regions. However, in Costa Rica and Colombia it is unlikely that coffee will hold its own unless a way can be found to certify and market more of it at higher prices so that producers can receive an increasing amount of every dollar paid in consuming countries.

*Full-Sun Versus Shade-Grown Coffee*

The two main types of coffee production systems are often characterized as "full-sun" and "shade-grown" coffee. Most commodities in the world are produced by genetic varieties that are fairly similar and whose production has very similar methods and environmental costs. This is not the case with coffee. The two main species used for coffee production require different growing conditions.

Full-sun coffee, sometimes referred to as "technified," high-input coffee, tends to be robusta coffee planted in monocrop stands. Robusta originated in West Africa and performs better in hotter and wetter climates. However, few absolute statements can be made about either variety of coffee. In some climates arabica can also be planted in full sun, as it is in parts of Brazil. Shade-grown coffee, by definition, is planted among other, taller trees, often in association with other subsistence or cash crops. Traditionally, shade-grown coffee was part of a small farmer's overall farming strategy. Arabica is most often grown in shade and therefore incorporated into other existing farming and agroforestry systems or polyculture production systems. Increasingly, full-sun coffee is grown both on small farms as well as on large-scale plantations using more chemicals and increased mechanization.

Often presented as two distinct systems of production, in fact, shade-grown and full-sun coffee production systems are different ends of a continuum. Growers employ a range of different techniques depending on economic, microclimate, and farm-specific factors (e.g. finances, farm size, experience with coffee production, history of coffee growing and coffee diseases in the area, etc.).

Since the end of World War II, technological innovations have led to the introduction of high-yielding varieties of coffee that grow best in monocultures with full sun (or close to full sun) and agrochemical inputs. This "sun" coffee is planted in much higher densities. For example, traditional shade-grown coffee is planted in densities of 1,100 to 1,500 plants per hectare, while sun coffee is grown in monocultures of 2,400 to 7,000 plants per hectare (Manion et al. 1999).

*Costs of Production of Full-Sun Versus Shade-Grown Coffee*

The cost of coffee production varies from one region to another and seems to be more related to local land and labor costs than to the species or varieties produced. Labor costs for coffee account for 40 to 60 percent of the variable costs of production, but shade

coffee has higher labor costs per unit of coffee produced. Africa has the highest overall cost of production at U.S.$1.14 per pound. Latin America has an average cost of production of $0.74 and Asia $0.69 per pound (Talbot 1997, as cited in Manion et al. 1999). Typically, costs of production tend to be 50 to 60 percent of the export costs of green coffee (Manion et al. 1999).

Governments play a vital role in determining the profit of growers. Through ad valorem taxes, countries receive an average of 10 to 50 percent of the export value of green coffee (Manion et al. 1999). In most cases these funds are invested back into the coffee industry. However, corrupt states have been known to misappropriate them.

Another important issue that affects the type of coffee production that is undertaken is the value of local currency. This can have two different types of impacts. Many of the chemicals and fertilizers used in coffee production are imported. If local currency values decline, imported inputs become more expensive relative to the value of the raw coffee. Furthermore, increased production reduces market price, potentially leaving producers in a worse position. Over time, this will result in less coffee production, but producers that are dependent on coffee can suffer a severe drop in income in the short term. On the other hand, coffee producers who use low-input, shade-grown methods and who live in countries with low currency values will be inclined to plant coffee much longer than farmers from countries with higher-valued currency because the relative value they can obtain on the global market is higher for them.

Producers respond to coffee prices. If prices are high, they invest in new plantings. In Brazil, if the prices fall, marginal producers will destroy their trees. The present low prices are caused by investments made when prices were higher. Precipitous price falls beginning in 1989 caused growers in Brazil to reduce the number of coffee trees from 4.2 billion to 3.2 billion by mid-1992 (May et al. 1993). As a result, prices bounced back and others began to plant, contributing to the current crisis.

The microeconomics of sun versus shade-grown coffee are not always obvious or consistent. In Nicaragua, for example, sun coffee has significantly higher production costs. Even so, comparing the average profits for Nicaraguan producers of traditional, low-input (semi-technified), and high-input (technified) coffee over the past five years underscores why the transition to full sun coffee is occurring. The yields from the full sun coffee are more than seven times those of the traditional production systems and nearly three times those of the low-input production systems. Similarly the per-hectare profits of the full sun, high-input coffee producers, based on a five-year average, are nearly three times those of traditional producers and nearly twice those of traditional low-input producers (Banco Central de Nicaragua and MAGFOR 1997/98, as cited in McEwan and Allgood 2001). In Colombia, however, the data suggest that the reverse is true.

The intensity of production is increasing. In the past, dense plantings of coffee contained 2,400 trees per hectare. Today more than 5,000 trees per hectare are common in many parts of the world, and as many as 15,000 trees per hectare can now be found in parts of Brazil. In the past it was common for coffee trees to be harvested for up to twenty or thirty years, then fifteen to eighteen years became the norm. As noted above, full sun

coffee is now normally grown for only six to eight years. This allows producers to shift crops more quickly in response to changing prices.

Until recently coffee was always picked by hand. However due to the cost of labor and the problems of organizing and managing large labor forces, many commercial coffee farmers are now using machines to pick coffee. Some of the machines beat the bushes in a process that is best described as a "car wash." Other machines in use now in Brazil in the most dense coffee stands actually cut the trees off 7 to 10 cm (3 to 4 inches) above the ground and separate the coffee cherries from the rest of the plant. The coffee plant then regrows for one year and the second year blooms again and then is harvested by cutting it off again. This can be repeated for three or four cycles.

Coffee planted at 5,000 bushes per hectare can produce 3,300 kilograms per hectare each year. Coffee planted at 15,000 bushes per hectare and harvested by cutting almost to the ground can produce 5,400 kilograms per hectare every two years (or 2,700 kg/ha/yr). The advantage of the latter system, however, is that the mechanical picking reduces the need for and the cost of labor. In parts of Brazil, due to specific labor laws, temporary contracted coffee pickers can cost farmers as much as U.S.$9 a day even though the worker only receives 45 percent of that. In addition, producers in Brazil are finding that with intensive plantings, irrigation doubles coffee production and justifies the use of modified center pivot or even the more expensive drip irrigation systems.

Another issue may also be beginning to affect production. It is predicted that the increased numbers of producers who do not use pesticides (either because of their outright cost or to comply with certification guidelines) is actually causing an increase in coffee borer or *broca* and other pests. This has long been a problem in Colombia, but it is now also becoming a problem for El Salvador, Mexico, and other Central American producers. In El Salvador investments in fertilizers and pesticides have declined by as much as 40 percent, and now total production is declining by as much as 15 to 20 percent (I & M Smith Ltd. 2002).

## Processing

Coffee processing can have significant environmental impacts. Within twenty-four hours of being picked, coffee should be processed to retain its overall quality. This is the most serious time constraint associated with coffee production. The first task is to remove the seeds from the fleshy fruit of the coffee "cherry." This is done either through wet or dry processing. In the dry procedure, the cherries are dried and then threshed. The amount of water used in dry processing is 1.4 to 14 liters per kilogram of processed coffee depending on the equipment. The main waste is the hulls themselves, which represent 50 percent of harvested weight, and parchment, the thin covering on the seed that represents 12 percent of the harvested weight (May et al. 1993). These materials can be used for fuel, organic matter for soil conditioning, fertilizer, or animal bedding. Since most processing is done at central locations, it is expensive to haul the material back to the farms. Dry processing of the cherries is difficult in many countries of the humid tropics.

In wet processing, machines are used to remove the outer hulls and most of the pulp. The remaining pulp is allowed to ferment for a few hours until it can be easily removed. The beans are then dried either in the sun or in mechanical dryers that are fueled with wood or coffee husks. In Costa Rica, the wet processing system requires 3,000 to 4,000 liters (3 to 4 cubic meters) of water to process 240 kilograms of coffee. In El Salvador, where water is scarcer, only one tenth as much water is used to process coffee. The pulp from wet processing creates a serious waste disposal problem, as discussed later under "Degradation of Water Quality."

Final processing for coffee depends, to some extent, on the market. In Brazil, for example, the domestic market accounts for 40 percent of unroasted beans. This breaks down to 8 to 9 million sacks used by the roasting and grinding industry and 0.8 million sacks for the manufacture of instant coffee. Of the 60 percent that is exported, about 2.4 million sacks are used to make instant coffee while about 15 million sacks are exported as green beans (May et al. 1993).

## Substitutes

Tea and hot chocolate are partial substitutes for coffee. Postum is a caffeine-free, cereal-based substitute designed by food manufacturers in the United States to take the place of coffee. This product was developed when coffee prices were high and when consumers were concerned about the levels of caffeine in coffee. A wide range of coffee substitutes (both with and without caffeine) can be found in both the United States and Europe.

In different parts of the world local substitutes have existed for some time as sources of caffeine. Tea in Asia and cocoa in the American tropics were traditional sources of caffeine for large populations prior to the introduction of coffee. Chicory was often used in parts of Europe and Louisiana. Guarana in Brazil and yerba maté in Paraguay, Argentina, Uruguay, and Brazil are popular high-caffeine beverages that partially substitute for coffee. However, from a flavor point of view there are no direct substitutes for coffee.

Although not commonly thought of as such, caffeinated soft drinks such as colas are perhaps the most important substitute beverages for coffee, at least in developed countries as well as those countries that are adopting similar consumption practices (e.g. Mexico). From 1962 to 1989 the percentage of Americans drinking soft drinks almost doubled to 62.1 percent from 32.6 percent; this is precisely when the per-capita consumption of coffee was declining.

Similarly, there is also thought to be a correlation between coffee and cigarette consumption. It has been noted that when people cut back on their smoking, they drink more coffee. If this is true, then a market swing in the United States is probably already underway, as the absolute number of smokers is declining. However, similar changes in Europe and China could stimulate considerable increases in demand for coffee.

## Market Chain

The general market chain (the stages between producers and consumers) for coffee includes on-farm growing, harvesting, primary processing and sorting, export, shipping, distribution, roasting, packaging, redistribution to retail stores or made into coffee in cafes and restaurants, and ultimately purchased by consumers. The actual number of players can vary considerably within the market chain as one entity can often fill a number of the different functions (see Table 3.4). There are also major differences between coffee market chains for domestic consumption and those for international coffee trade and consumption.

In addition, of course, there can be considerable competition between the different layers of the market chain for a greater share of the value added to the product as it moves from producer to consumer. In some instances this has resulted in bypassing some traditional players altogether. For example, Nestlé established processing facilities in major producing countries such as Brazil and Côte d'Ivoire. Other multinational corporations prefer to undertake processing in the consuming countries.

The International Coffee Agreement was created in 1962 and the International Coffee Organization (ICO) was created in 1963 when the agreement went into effect. The goal of the agreement was to introduce stability in the coffee market and to protect countries (and producers) from coffee dumping and vast price swings. The ICO, which has 55 member countries, put the sixth and most recent version of the International Coffee Agreement into effect on October 1, 2001 (ICO 2003). The agreement will be in effect for six years. During the initial agreement, many consuming countries decided to allow more value-added activities to take place in producing countries. Increasing income in those countries was seen as a way to improve the standard of living of many rural poor and to increase political stability. The fact that higher prices were passed on to consumers was seen to be more than offset by the overall political stability achieved.

During a two-year suspension of the International Coffee Agreement's quota and control provisions in 1989, the system began to change, and the consuming countries assumed greater control of the market. This change had quite significant impacts on where value was captured from coffee. In 1985, $0.38 of every dollar spent for retail roasted coffee in the United States went to the producer countries. Just ten years later in 1995, only $0.23 made it back to the producer countries. This amounted to a 40 percent reduction to producer countries while the retail price of coffee increased by more than 30 percent in real terms.

Even taking into consideration these issues, coffee still brings more money to producers in absolute terms than other commodities such as sugar, tea, bananas, oranges, cotton, or tobacco. The capital also tends to be more broadly distributed to people in producing countries when compared to minerals such as petroleum or bauxite. In 1994 more than U.S.$12 billion worth of coffee (80 percent of world production) was traded between countries. This sum was equal to the entire flow of foreign aid from the United States during the same year.

Depending on the location, the amount of money distributed through the coffee market chain can vary somewhat. According to *The New Internationalist* (1995), for example, growers (including agricultural labor) can receive up to 10 percent of the retail price paid for coffee while shippers and roasters generally receive the bulk of all value from coffee at some 55 percent. In 1997 coffee growers received about 5 percent of every dollar spent on coffee. Farm laborers received about 8 percent, transport and loss accounted for 6 percent, and the value added in the producer country (e.g. processing, grading, bagging) amounted to another 3 percent. By contrast, the value added in consuming countries (e.g. shipping, roasting, grinding, packaging, and transportation) amounted to 67 percent. The retail share of every dollar was about 11 percent (Talbot 1997). In Europe, where there is more competition between roasters, retailers can receive as much as 25 percent of the value of all coffee sales.

By 2002, however, this picture had changed. The combined farmers' and farm laborers' share of the final sales of coffee had slipped from 13 percent to 7 percent. Roasters, retailers, and global buyers, on the other hand, accounted for 29, 22 and 8 percent, respectively of the final price of coffee (*The Financial Times* 2002). In 2002, it was interesting that while the price of coffee had fallen more or less continuously for a few years, the price declines were not passed on to consumers. Instead, players in the chain simply increased their profit margins as a result of the lower prices. Looked at another way, in 2001, coffee exports generated $8 billion for the economies of producer countries, but more than $50 billion for the economies of the consuming countries (McEwan and Allgood 2001).

The coffee trade has become increasingly centralized since World War II. This has culminated with a few giant multinational corporations dominating world trade. By the mid-1990s, for example, two roasting companies, Nestlé (55 percent) and Kraft (25 percent), controlled 80 percent of the market in the United Kingdom. Today, while there is a tremendous rush for better coffee in the United Kingdom, sales of instant coffee still dominate the market (by 87 percent). Globally, the five dominant importers account for more than 40 percent of the global coffee trade (*The Financial Times* 2002). In the rest of Europe similar dominance is common. In France five roasters control 90 percent of the market, while in Italy the top five roasters control 70 percent of the market (*The Financial Times* 2002).

## Market Trends

Between 1960 and 2000 coffee production increased 2.9 million metric tons, or 61 percent. International trade in coffee doubled over the same period. During the same forty-year period, prices declined 57 percent.

Coffee, like cocoa, is a classic commodity that has been studied for years. Both supply and demand respond to changes in prices. There are wide price swings because producers respond to high prices by planting. Because coffee is a tree, once it has been planted producers only need to cover variable costs to continue producing. This means that

additional product will cause a long-term price decline until trees go out of production. Of course, the variable costs of large producers are higher than those of smaller ones who provide their own labor, so with declining prices larger producers are more likely to take out coffee sooner than smaller ones.

From the end of World War II through the end of the 1980s, price came to dominate the retail coffee sector, particularly in the United States, and quality suffered accordingly. In the United States in 1962, coffee consumption began a thirty-five-year decline that has only recently come to an end. Beginning in the 1980s and gaining momentum in the 1990s, increasing numbers of consumers began to pay more for specialty coffees, arabica beans, and darker roasts which have now been made available by thousands of independent roasters as well as a few larger retail companies such as Starbucks.

Retail specialty coffee beverage sales in the United States have reached more than $3 billion with another $2 billion in sales of roasted beans. This new "quality-based" coffee industry in the United States represents more than 5 percent of global output. Price increases in 1994 and 1997 did not slow growth in this market, so it is likely to continue to grow for some time. If demand in specialty coffees continues, this will exert pressure to increase coffee production in pristine mountain areas because of the unique flavor profiles those conditions can produce in the coffee grown there. This could lead to considerable habitat conversion and environmental degradation.

Running parallel to the increase in high-quality coffee is a growing specialty market for coffee certified as grown in ways that are environmentally or socially sustainable. A major portion of this developing market is also for organic coffee. Organic coffee is produced without synthetic fertilizers or pesticides, and growers use natural chemicals and predators to keep pests in check. Today, certified organic producers receive an additional $0.15 per pound for their coffee, which can represent a 30 to 50 percent premium depending on local markets if they can sell it as organic. However, as much as two-thirds of certified organic coffee still does not have markets, and producers are forced to sell it at normal market prices through the commercial market. This is a particular problem with smaller-scale coffee producers who have little market clout.

Fair Trade certification is slightly different from, but complementary to, organic certification. Fair Trade importers bypass traditional middlemen and buy directly from producer cooperatives in order to return a larger share of the coffee dollar directly to the producer. Fair Trade coffee focuses more on worker and producer rights and the benefits that they receive from the sale of their product. Today there are more than 500,000 farmers who produce and sell more than 14,545 metric tons (32 million pounds) of Fair Trade coffee. While growing, this production represents only half of one percent of total coffee production. To put this in perspective, the largest single conventional producer in the world, Brazil's Ipanema Agro Industry, has 12.4 million trees planted on 5,000 hectares and produces up to 3,266 metric tons (7.2 million pounds) per year (Manion et al. 1999). Fair Trade programs have developed certification programs to create consumer confidence in product claims. These programs, however, are often subjective and not always verified by a third party.

In addition to these coffee certification programs, a number of other smaller programs have been developed as well. For example there are such general coffee labels as shade-grown coffee and songbird-friendly coffee. The profusion of certification programs and ecological labels, brands, and claims has tended to raise awareness of the many issues related to coffee production but left most consumers rather confused about what each represents, much less which is "best." What would be best for producers and consumers alike is if the different certification programs could get together and agree on one or two standard sets of measurable criteria that were evaluated by third-party certifiers. One way to begin to get to this point is to undertake a side-by-side comparison of the different programs to identify which actually deliver the results that are most important to producing environmentally and socially sustainable coffee.

While only a small part of the coffee market in the past, specialty coffee of all kinds is now estimated at 10 to 15 percent of the global market and expected to grow by some 15 percent per year in the near future (McEwan and Allgood 2001).

While forecasting the coffee market is more of an art than a science, it seems at this time that most increased demand for coffee will come in China, Russia, and Eastern Europe as well as other developing countries. Any sustained expansion in demand will tend to eliminate stocks (probably within a year or two) and have to be supplied from new sources. Traditional markets in the United States and Europe are not expected to contribute to absolute growth, but they are likely to stimulate the production and processing of higher-quality coffee.

## Environmental Impacts of Production

The main negative environmental impacts from coffee production include habitat conversion, soil degradation, pesticide use, and degradation of water quality. Each of these impacts is discussed separately.

*Habitat Conversion*

The most serious impact of coffee cultivation continues to be the conversion of natural forest areas to plant coffee. Increasingly, it is full-sun coffee that is being established in plantations. Natural ecosystems are destroyed as a result of the expansion of sun coffee production. The affected natural systems will never fully recover.

The data suggest that there is a strong correlation between full-sun coffee production and deforestation. Of the fifty countries in the world with the highest deforestation rates from 1990 to 95, thirty-seven were coffee producers. This is in part linked to the fact that the highest levels of deforestation are in tropical countries where coffee is also grown. Even so, the top twenty-five coffee exporters had a combined average annual forest cover loss of 70,000 square kilometers during the same years (Manion et al. 1999).

The large, monocrop plantations typical of full-sun plantations cause the greatest reductions in biodiversity. Studies in Colombia and Mexico indicate that full-sun coffee plantations support 90 percent fewer bird species than shade-grown coffee.

The severe thinning or clearing of forests for planting shade-grown coffee is also a major concern. Considerable biodiversity is lost both above and below ground. Microorganisms in particular are affected through clearing, soil disturbance, and exposure. Even with shade coffee the number of tree species can be reduced by 80 percent or more. Mammals and reptiles show declines in populations and species diversity relative to natural forests. Bat species are reduced by half or more in agroforestry systems such as shade-grown coffee. Furthermore, species that do better in disturbed ecosystems tend to dominate areas of shade-grown coffee.

Some observers have suggested that because much shade coffee is grown in areas of human habitation that are being deforested, species that can move easily often seek refuge in the shade-grown coffee areas. Migratory bird populations, for example, may be forced to seek shelter in an ever-shrinking area, whether they are in transit or at a traditional seasonal resting place. While shade-grown coffee can support high wild species diversity of mobile species in comparison to full-sun coffee or many other agricultural activities, it is no substitute for the preservation of pristine natural areas.

There is no evidence that any area of coffee production, whether shade or full sun, has ever been allowed to revert back to "natural" forest. Habitat conversion, it seems, is forever. In regions like Paraná in Brazil and Java in Indonesia, shade-grown coffee has given way to full-sun coffee or other agricultural crops altogether. This conversion can mean a reduction in the local labor needs. Those displaced by the conversion of land from coffee production to other crops often migrate to frontier areas (e.g.in the Amazon and Cerrado in the case of soybean expansion in Brazil). Or, overpopulation in agricultural areas can cause the migration of poor farmers or landless people to frontier areas where they plant coffee (e.g. in the outer islands of Indonesia and in central Vietnam). In both instances, the production of coffee contributes to serious declines in both biodiversity and ecosystem functions.

In Vietnam, Papua New Guinea, Laos, Myanmar, and Mexico coffee production is expanding into previously pristine natural areas. Colombia, in turn, has increased production by converting to more sun-grown coffee. It is not clear whether the land used for new producers in China, New Caledonia, Samoa, and Mauritius has come from converting pristine areas, or from conversion of other agricultural lands. There is little data globally to indicate what the previous land use was for new coffee production areas.

Another driving force of habitat conversion is the increasing market for high-grade specialty coffees. These coffees tend to be produced in new, out-of-the-way areas with unique soils and topographies that give the beans unusual flavor profiles. Such, coffee is often produced in areas that are too steep or otherwise of too poor quality for the production of other food and cash crops. These are precisely the types of areas that are rich in biodiversity or, at the very least, have become local biodiversity refuges in the face of the expansion of other forms of agricultural production. They are also typically

the types of areas that are most prone to erosion. Consequently, the demand for higher-quality arabica coffee may exacerbate environmental degradation. Even the demand for shade-grown and songbird-friendly coffee may not actually reduce the impact of the business if it is produced in previously isolated areas rich in biodiversity. For example, lands that have been set aside for preservation in Mexico, Vietnam, Kenya, Nicaragua, and Indonesia have reportedly been invaded illegally by coffee producers.

*Soil Degradation*

Historically coffee production in places such as Brazil has been characterized by a frontier, throw-away mentality. Coffee production has tended to migrate across the landscape, as plantations are abandoned and new ones started on fresh soil. Such migration left behind lands that were suitable first for short-term agriculture, then for extensive cattle grazing, and finally were often abandoned once soil degradation and erosion left them unproductive. In some instances, extensive use of fertilizers and other agrochemicals allowed such lands to continue to be used, but with their own particular set of environmental impacts.

One of the most degrading forms of coffee cultivation for soils is the use of herbicides to produce "clean" fields free of other vegetation. The use of herbicides to produce weed-free fields (or rather fields free of any other vegetation except coffee) on the slopes of coffee farms, particularly those at high elevations, is one of the major causes of soil exposure and erosion. Low, creeping cover crops such as the legume *Arachis pintoi* can be used to maintain ground cover and reduce soil erosion and exposure of the soil to sun, wind, and rain.

*Pesticide Use*

Coffee production in countries like Brazil has involved the extensive use of chemicals to combat pests and diseases. Prior to the 1970s producers used benzene hexachloride 1.5 gamma isomer (BHC) in two sprayings to combat bean borer. Later to combat rust, producers used twenty sprayings of a copper fungicide with BHC and foliar fertilizer. Eventually, BHC powder was replaced by lindane emulsion. BHC and lindane are organochlorines, whose use has since been prohibited due to their persistence in the environment. Many problems owing to chemical poisoning were registered among workers. No one investigated the impact on other species or the residuals in the coffee itself (May et al. 1993).

There has been a dramatic increase in the transformation of production from shade-grown to full-sun coffee. One estimate suggests that half of the coffee produced in northern Latin America had been converted to full sun by 1990. Full sun coffee is also referred to as "technified," high-input coffee production. This form of coffee production results in lower populations of predaceous insects, increased solar radiation, and reduced nutrient cycling. Technified coffee production also results in a spiraling dependence on agrochemicals such as herbicides, fungicides, nematicides, and fertilizers. In Costa Rica, for example, the government recommends that sun coffee producers apply 30 kilograms of nitrogen per hectare per year compared with shade coffee producers who use little or

none. In Colombia, with some 86 percent of coffee production technified, the country applies more than 400,000 metric tons of chemical fertilizers, at least when they can afford them during periods of high international prices.

*Degradation of Water Quality*

Coffee processing degrades freshwater bodies in many tropical ecosystems. Traditionally, when "cherries" were processed at the plantations, coffee pulp was used as mulch on the crop. Now that processing often occurs farther from the fields, pulp produced from wet pulping operations (which is the preferred and most common processing technique) is increasingly dumped in rivers. In the rivers it is a source of pollution because its decomposition uses much of the available oxygen, and the lower oxygen levels in water lead to fish kills. (This type of pollution is measured as biological oxygen demand, or BOD.)

A study in Central America in 1988 showed that processing 550,000 metric tons of coffee generated 1.1 million metric tons of pulp and polluted 110,000 cubic meters of water per day. This was equated with a city of 4 million dumping raw sewage into the region's waterways. In that period, Costa Rica estimated that coffee processing was responsible for two-thirds of the pollution, as measured by total biological oxygen demand, in its rivers. As freshwater supplies become scarcer and demand for fresh water increases, this issue will become even more important (Manion et al. 1999).

## Better Management Practices

Historically, there have been many opportunities to learn from experiences on the ground with coffee production. Such experiences provide a context within which key conservation strategies can be developed. A number of better practices have been identified for coffee production. Some examples are briefly described here. These deserve more detailed analysis, so that they can be adapted and used by other producers and encouraged by governments around the world (through linkage to credit, price supports, licenses or permits, etc.). The goal here is to reduce environmental impacts; one of the best ways to do this is to increase the longevity of each planting of coffee so that the owners will not be tempted to move to other areas and convert more habitat for any purpose, whether it be coffee or something else. Equally important is discouraging the conversion of shade-grown coffee to large, monoculture stands of full-sun coffee. Other ways to reduce environmental damage include: diversifying production and sources of income, incorporating fallowing strategies, reducing input use, reducing water use, and reducing soil erosion. Appropriate and detailed conservation strategies will be required, ideally for each key ecoregion or at the very least each country in question.

*Halt the Expansion of Coffee Production in Natural Forests*

In several areas, but particularly Vietnam and other countries in Southeast Asia, coffee production is expanding into natural forests. Due both to the associated environmental damage and the short-term nature of the investment, this type of expansion of coffee

planting should be prohibited. The vast majority of expansion of this type is for the production of robusta coffee because it is more productive in hotter, sunnier climates and on poorer soils. However, given the amount of degraded land or marginal existing agricultural lands that could support robusta coffee trees, there is no reason to clear pristine habitat to plant coffee. With the agrochemicals available today and with improved overall production and management practices, much previously degraded land can be brought back into production.

Another way to halt the expansion of coffee into biodiverse-rich areas around the world is to create and enforce permanent protection status in tropical forest areas that are located on the frontier of expanding coffee-producing areas. These areas can be identified in part due to their biodiversity value, but they can also and increasingly be identified because they are not suitable for long-term, sustained production of coffee. In some areas, zoning may be a useful tool for protecting lands whose slopes or fragile soils make them unsuitable for long-term coffee production. Restricting coffee production, creating protected areas, and implementing zoning regulations are all ways to prevent needless environmental degradation that benefits no one in the end.

*Discourage the Conversion of Shade-Grown Coffee to Sun Coffee.*

For existing coffee-producing areas shade coffee systems are preferable to full-sun production systems. Though shade plantations contain significantly less biodiversity than pristine habitats, they support more species than full-sun plantations. In addition, the shade plantations maintain higher levels of soil moisture, enhance nutrient cycling, and decrease erosion. In short, most ecosystem functions are preserved, even though considerable biodiversity is sacrificed. From a conservation point of view, shade coffee can serve as a useful compromise for continuing coffee production in existing areas or as an intermediary step in habitat restoration, but it is not a natural habitat itself.

The long-term economic implications of the conversion from shade to full-sun coffee are not well understood. For full-sun producers, the increased costs of inputs for producing their coffee are more than offset by the dramatic increase in yields. Hence, production increases. The question is: how low can the price of coffee go before it is too great to be offset even by greater productivity? Full-sun coffee producers are more reliant on expensive inputs and tend to have greater working capital costs if not overall debt. This, too, affects their ability to weather poor prices.

*Diversify Production and Sources of Income*

With the global drop in coffee prices, there is an increasing awareness that dependence solely on coffee is not a healthy strategy for producers. Instead, diversified agricultural production systems could best protect the incomes and viability of coffee producers, particularly the small producers that are responsible for most of the coffee grown in the world.

If this is the case, then there is a need to focus on integrating high-value crops such as vegetables and fruits that can be interplanted with higher value arabica coffee.

Interspersing coffee with fruit trees, vegetables, and/or ornamentals can diversify sources of income and reduce dependence on a single product. While such diversified production systems do not restore biodiversity to the levels found in native stands, they maintain higher levels of biodiversity than the alternatives, and they tend to yield more financially stable local economies as well.

Another key issue is the development of alternative markets and the ability to supply them. These skills are not common among producers and have been sadly lacking to date in the different, alternative coffee marketing programs. Coffee production and even other agricultural crops may be only one source of income for producers in the future. For example, it is possible that coffee growers could receive payments for carbon sequestration—either in above ground biomass or by building carbon and organic matter on or in the soil. Studies would need to be undertaken to show the relative value of sun and shade-grown coffee for carbon sequestration. Ecotourism, particularly bird watching, could also be incorporated into coffee-growing areas as another stream of income where shade trees have been left and birds migrate through. As producers in other parts of the world have found, these sources of income could rival or even exceed those from coffee.

*Incorporate Fallowing Strategies*

Fallowing, in conjunction with enrichment planting of cover crops to build up the soil, is another effective strategy for coffee producers and for conservation. Through planned fallows, soils can be returned to their former vitality in a relatively short time. Fallowing can be seen as an overall investment strategy. Fallowing is a way to generate nutrients at the site that would otherwise need to be purchased. It can be profitable in its own right as legumes build up soil nitrogen levels through nitrogen fixation, and other cover crops recover potassium and phosphorus that had leached to soil depths but can be brought to the surface as both deep roots and mycorrhizae are developed. Through the development of a proper fallow plan, even future shade trees can be planted during the fallow period.

In five to seven years of careful cover cropping it is possible to rejuvenate the same area for intensive use. This is already done with black pepper production in Japanese colonies established in the Amazon, where there is crop rotation every seven years. The black pepper vines are just as healthy and productive as they were some seventy years ago when they were started in the Tome Acu area of Pará state. For small-scale coffee producers, the challenge will be to do this on a rotational basis (perhaps only a few trees or 100 square meters at a time), or to plant cash crops during the fallow to reduce the impact of lost coffee income during the period of rejuvenation.

*Reduce Input Use*

Some of the best prices for coffee, even in the face of declining overall world prices in 2002, are those for shade-grown highland coffee from Guatemala and Mexico. In these areas, even when the average world price has been declining, the price of fine highland, shade-grown coffee has remained relatively stable. For example, in Nicaragua specialty coffee is currently selling for U.S.$1.20 per pound while the regular price for coffee is $0.55 per pound (McEwan and Allgood 2001).

Unfortunately, the specialty markets that support such prices are not well developed and cannot handle all of the certified coffee that is currently available. Yet if markets can be successfully developed and maintained, biodiversity and habitat improvements can be incorporated into coffee production systems in ways that do not affect overall profitability and that may in fact increase overall producer financial viability through certification. This could happen in several ways—either through a premium paid to the producer for certified product, giving the producer access to more transparent information about actual prices for conventional coffee, or the producer reducing overall costs and/or increasing production through the adoption of better management practices that are required by certification.

In shade coffee systems there is negligible use of pesticides, and both the substances used and levels of use can be dictated by certifiers. Furthermore, there are now management techniques that use microorganisms to manage fungal diseases. Native microorganisms and effective microorganisms (EMs), naturally occurring or applied organisms that speed up the breakdown of organic matter, suppress many fungal problems simply by providing competition to the pathogens.

*Reduce Water Use in Processing*

Coffee production should minimize water use and prevent water pollution to the greatest extent possible. Both Colombia and Costa Rica are experimenting with low-effluent processing systems that are said to produce coffee of a comparable quality to that of a traditionally washed product. This technology should be encouraged. Processors should screen and recycle the water that they use so that less water is used overall and less organic matter is put into rivers. Saving the pulp to compost or to use as mulch will both increase the organic matter in the soil and help the soil retain more water. These two factors will increase production.

One way to reduce waste is to encourage anaerobic fermentation before washing occurs. This process can decompose mucilage on the seed and makes it easier to wash. An added benefit is that it takes less water to wash the seed as well. This strategy is cost effective for processors but the technology is not well known.

Much of the coffee pulp in Costa Rica is put into windrows for drying and composting even though it can take up to six months for full composting to occur. However, coffee processors have found that by inoculating the waste with microorganisms they can reduce the compost time to less than three months. The compost is then returned to the associate growers.

Effective microorganisms are also being introduced directly into the processing stream so that effluents are largely decomposed by the time the wastewater leaves the plant. The microorganisms digest the waste and speed up the overall decomposition. This reduces the total amount of organic matter with high biological oxygen demand released into local waterways.

*Reduce Soil Erosion*

It has taken considerable time and a lot of mistakes to identify and analyze better management practices for managing soils in coffee plantations, especially with all of the cultural and geographical variations. In the early years of coffee production in Brazil, for example, people established plantations by planting rows of coffee trees perpendicularly up hillsides. This practice guaranteed severe erosion. It is now clear, for example, that planting on contours around hills and spacing the trees so that they are staggered up hillsides reduces erosion tremendously. The Brazilian government tied coffee-planting loans to such improved practices and noticed an immediate reduction of soil erosion. For example, a comparison of perpendicular and contour planting on steep slopes showed a reduction in soil losses from 4.4 to 3.1 metric tons per hectare in only a few years. Furthermore, contour planting reduced runoff by 25 percent, thus retaining more water for the crop. Contour strips (alternating bands of trees with bands of other vegetation) were also found to provide erosion control, but the most effective practice to reduce erosion was to plant grass between the bushes. This practice was found to reduce soil losses to 0.2 metric tons per hectare and rainfall runoff by 90 percent (May et al. 1993).

## Outlook

Coffee is big business and as such attracts big bucks. For example, subsidies have stimulated coffee production throughout the world. Such subsidies will not disappear, so the question is whether they can be used more effectively for poverty alleviation and environmental gain. Since society pays for subsidies, they should accomplish societal goals. One such goal would be a measurable reduction of the negative impacts of production on the natural resource base; another could be an improvement of the overall welfare of coffee producers and those who work for them. In this light, full-sun coffee might be acceptable on degraded land, but clearing forests or even converting shade-grown coffee systems is not acceptable. In any case, if markets exist for full-sun coffee, it should not need to be subsidized.

Subsidies could also be used to encourage farmers to convert to multiple cropping systems that are more ecosystem and biodiversity friendly. Financial incentives (either through loans based on better management practices, purchase contracts, or certification) can encourage farmers to make improvements toward this end.

The most successful basis for the development of any strategy to reduce the negative environmental impacts of coffee production would be to develop a better understanding of how the international coffee market chain works for the vast majority of lower-grade coffee that moves through it. A value-chain analysis, from producer to consumer, should be undertaken for the global coffee market in order to identify potential partners and strategic entry points to promote more sustainable coffee production and marketing systems, not just for high-end beans but for mass-market robusta varieties that are sold in cans or processed into instant coffee as well.

Recently, there has been considerable interest on the part of many who support organic, fair-trade, and "ecolabeled" coffees to encourage highly visible companies such as Starbucks to make commitments to purchase certified coffees. Aside from the fact that no one can agree which coffees Starbucks should purchase, this need not be the only or the biggest game in town. BP-Amoco is one of the more progressive companies, and it is clearly positioning itself as a green, socially responsible corporate player. Furthermore, BP-Amoco sells more coffee than Starbucks. Why is it not being targeted?

The coffee industry will shortly launch a campaign to bolster the price of coffee. Any such program should, to the maximum extent possible, reduce the overall environmental impact of coffee production while at the same time insuring that improved prices actually make it all the way to the producers.

## Resources

*Web Resources*

www.ico.org
www.rainforestalliance.org/programs/cap/program-description3.html#coffee
www.cambicommodities.org
www.eldis.org/csr/coffee.htm
www.coffeeresearch.org
www.consumerscouncil.org

Additional resources can be obtained by searching on "coffee" on the WWF International Intranet:
http://intranet.panda.org/documents/index.cfm

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