WORLDWATCH PAPER **168**

Venture Capitalism for a Tropical Forest

COCOA IN THE MATA ATLÂNTICA

CHRIS BRIGHT
AND RADHIKA SARIN

STATE OF THE WORLD LIBRARY **2003**

Venture Capitalism for a Tropical Forest

COCOA IN THE MATA ATLÂNTICA

CHRIS BRIGHT AND RADHIKA SARIN

Thomas Prugh, *Editor*

WORLDWATCH PAPER 168

December 2003

FINANCIAL SUPPORT for the Institute is provided by the Aria Foundation, the Richard & Rhoda Goldman Fund, The William and Flora Hewlett Foundation, The Frances Lear Foundation, the Merck Family Fund, the NIB Foundation, The Overbrook Foundation, the V. Kann Rasmussen Foundation, the A. Frank and Dorothy B. Rothschild Fund, The Shared Earth Foundation, The Shenandoah Foundation, Turner Foundation, Inc., the U.N. Environment Programme, the Wallace Global Fund, the Weeden Foundation, and The Winslow Foundation. The Institute also receives financial support from its Council of Sponsors members Adam and Rachel Albright, Tom and Cathy Crain, John and Laurie McBride and Kate McBride Puckett, Robert Wallace and Raisa Scriabine, and from the many other friends of Worldwatch.

ISBN 1-878071-72-6

Library of Congress Control Number: 2003114194

Printed on paper that is 100 percent recycled, 100 percent post-consumer waste, process chlorine free.

Contents

Acknowledgments: The authors would like to express their gratitude to the following people, who donated their time and thoughts to this project over the past two years, by reviewing drafts, playing host to the lead author, or providing valuable information and perspective: Martin Aitken, Paulo de Tarso Alvim, Eduardo Athayde, Marcella Athayde, Aline Tristão Bernardes, Joaquim Blaines, Vera and Ozeias Gomes da Costa, Deborah Faria, Cristiane Fontes, Jaqueline Goerck, Paulo Yoshio Kageyama, Maria Cecília M. Kierulff, Roberto Klabin, Marc Nüscheler, Renata Pardini, João Louis Pereira, Rui Rocha, Sebastião Salgado, and John Tuxill. We have benefitted greatly from these and our other collaborators, and we hope that they will find our work useful, even where our conclusions may differ from theirs.

Within the Institute, our work was greatly strengthened by the advice of our fellow researchers Brian Halweil and Danielle Nierenberg. Clayton Adams assisted us with our figures. The lead author is also grateful to Ashley Mattoon, a former Worldwatch researcher, for her collaboration on field research conducted in 2001. We thank our editor, Thomas Prugh, for his thoughtful attention to our text, and the Institute's art director, Lyle Rosbotham, for giving our research its final form.

Finally, we would like to extend our deepest gratitude to Nell Stone, whose gifts to the Institute made our project possible. We hope that this report, and the efforts that follow from it, will build a lasting legacy from her generosity.

Chris Bright is a senior researcher at the Worldwatch Institute, where he studies conservation and biodiversity decline. He is the author of *Life Out of Bounds: Bioinvasion in a Borderless World,* published by W.W. Norton and Worldwatch in 1998. Chris is also cofounder and president of the Earth Sangha, a Buddhist environmental nonprofit that focuses on forest restoration.

Radhika Sarin, formerly a staff researcher at the Worldwatch Institute, is now international campaign coordinator at the Mineral Policy Center, a nonprofit dedicated to reducing social and environmental damage from mining. She is the author of "A New Security Threat: HIV/AIDS in the Military," in the March/April 2003 issue of *World Watch* magazine, and a coauthor of a chapter on the global consumer society in the 2004 edition of the Institute's annual *State of the World*.

SUMMARY

By turning a cocoa-growing tradition into an "eco-business," farmers and investors could help save the Brazilian Atlantic Forest, one of the most biologically diverse and endangered forest biomes in the world. Such an effort could also increase rural employment and help build an economy that can sustain the forest instead of destroying it.

The Atlantic Forest extends along most of Brazil's coast and is the third largest biome in the country. Although it is not as well known as that other great Brazilian forest, the Amazon, it is far more endangered. Only about 7 percent of the Atlantic Forest remains in its original state.

Cocoa is the basic ingredient of chocolate. It comes from the seeds of a small, tropical rainforest tree, the cacao. Cocoa is of interest to conservation because it is a relatively high-value crop, and because the cacao tree tolerates shade. These qualities allow cocoa to be grown profitably under forest canopy; in effect, cocoa can help pay for rainforest conservation.

Cocoa is already a major crop in the northern part of the Atlantic Forest biome, primarily in the state of Bahia. Most Brazilian cocoa is grown under native forest canopy, in an agroforestry system known as *cabruca*. Cabruca is hardly virgin forest—its understory consists mostly of cacao trees and its overstory has been extensively thinned. But its value for conservation is now considerable because so little undisturbed forest remains. Cabruca has become, by default, the dominant forest type within the Bahian cocoa belt.

But for several reasons, the cabruca system is in decline.

Relatively few forest saplings are coming up in the cabruca patches, so the native forest overstory is not regenerating. And some farmers are growing their cocoa outside cabruca or abandoning the crop altogether. If it continues, the decline of cabruca would greatly diminish the prospects for saving the northern portion of the Atlantic Forest.

We argue that the cabruca system should be revived, but in a form better suited to current conditions. Our strategy, which we call "forest cocoa," is designed to promote a set of ecological and social goals. Its ecological aims are to ensure that the cabruca patches are regenerating, to eliminate the use of disruptive agricultural chemicals, and to contribute to forest restoration within the cocoa belt. Its social aim is to help create a stronger—and greener—rural economy. Forest cocoa would build employment through local cocoa processing; it would also encourage the development of other forms of ecocommerce, such as forest restoration and ecotourism.

Forest cocoa would have a political goal as well: its marketing would be designed to create an international consumer constituency for the forest. That constituency could become a donor base for restoring, not just cabruca, but the Atlantic Forest as a whole.

The Chocolate Forest

Imagine a tropical rainforest, once as vast as the horizon, now reduced to an archipelago of fragments. The fragments are dissolving slowly into a landscape of pasture, banana, and coffee, plantations of rubber and eucalyptus, vacation homes, squatter settlements, and roads. Yet even in their battered state, these fragments are among the most valuable pieces of natural real estate in the world: few other places on Earth are home to so many different kinds of living things. But this is not a form of wealth that translates readily into human prosperity, and on their edges, the fragments often give way to the realm of the poor, who hunt the forest's animals and cut its wood to build their homes. These are a people largely without legal title to land or home, largely unemployed, not starving or outwardly miserable for the most part, but without much prospect of a better life—a people effectively dispossessed in their own land.

Imagine that within some of these fragments there is a crop, once highly profitable but fallen upon hard times, partly because of a virulent disease, partly because of a long-term depression in crop prices. Before its decline, this crop supported many of the local people and allowed the fragments to "pay for themselves"—farmers didn't have to cut the forest to make a living out of it. But even though the crop was far more compatible with the forest than, say, pasture or eucalyptus, it was not being grown in a way that would permit the forest's long-term survival. The farmers weren't allowing enough forest saplings to come up, to renew the forest. And the fragments were too small and isolated to support viable populations of many of the wild plants and animals within them.

Now imagine that a group of thoughtful investors has examined this apparently unpromising situation, and discovered a huge opportunity. The investors realize that a conventional economic recovery may be feasible, since disease-resistant crop varieties are now available and since crop prices have, for the present at least, come roaring back. But the opportunity that they see is not a return to business as usual. Instead, they put together a strategy for growing and selling the crop as a kind of "eco-business"—a green enterprise that combines agroforestry with sophisticated marketing designed to link consumers in distant countries with the forest itself.

Finally, imagine that this new strategy, and the consumer dollars that it attracts, begin to restore the forest to at least a shadow of its former vigor. Since the farmers' objective is no longer simply maximum production, there's room in the fragments to allow more saplings to spring up. Since the forest itself has become a revenue source, it makes economic sense to expand the fragments towards each other, and begin to reconstitute larger blocks of forest. That creates more wildlife habitat: there's more room in the landscape for all those parrots and frogs, orchids and monkeys that fascinate the foreign consumers. And there's more—not less—room for the people as well. There's more employment, because agroecology requires more labor than conventional production; there are more educational possibilities; there's more science, more tourism.

This is an ideal, of course, but it's not as far-fetched as it may sound. The forest in question is part of the Mata Atlântica, or Atlantic Forest of eastern Brazil. The Atlantic Forest biome stretches along the Brazilian coast from around South America's "snout," all the way to Brazil's southern border and into Argentina and Paraguay. (See Figure 1.) The Atlantic Forest accounts for 13 percent of Brazil's area, which makes it the third largest biome in the country, after the more famous Amazon forest and the Cerrado, the savannah-woodland formation that lies inland from the Atlantic Forest. But unfortu-

FIGURE 1

The Mata Atlântica Biome

Source: See Endnote 1 for this section.

nately, the biome's original extent and its current condition are two very different things: only about 7 percent of the Atlantic Forest's original cover remains.[1]*

And yet that 7 percent is a repository of extraordinary wealth, as is apparent just from the trees themselves. Botanists have found as many as 476 tree species in a single hectare of primary ("old growth") Atlantic Forest.[2] Compare that to a

*Endnotes are grouped by section and begin on page 54.

forest type that is very diverse by temperate zone standards: one hectare of high quality deciduous forest in the southeastern United States might contain, say, 15 or 20 tree species.[3] Some parts of the Atlantic Forest have the highest level of tree species diversity per unit area ever recorded.[4] So it's not surprising that the Atlantic Forest should be considered a "biodiversity hotspot." The hotspots are areas that have been identified as global conservation priorities because they are unusually rich in biodiversity and highly threatened. Those portions of the hotspots that still have their original cover account for less than 1.5 percent of the planet's land surface. (No aquatic hotspots have been designated.) But that tiny percentage belies their biological importance: the hotspots are the *exclusive* home of 36 percent of all terrestrial vertebrate species and 44 percent of all species of vascular plants, a category that includes nearly all plants except for some fairly simple forms like mosses. Tropical forest biomes loom large in the hotspot analysis; they account for 15 of the 25 hotspots.[5]

The crop in question is cocoa, the primary ingredient of chocolate. Cocoa comes from the fruit of a small tree, the cacao (*Theobroma cacao*), which is native to northern South America and perhaps also to southern Central America.[6] The cacao fruit is about the size of a small melon and is packed with large seeds (the cocoa beans). These are removed from the fruit, lightly fermented, and dried, at which point they are usually sold into the international cocoa market. Eventually, the beans are roasted, ground, and processed in various ways to make cocoa, cocoa butter, and chocolate. Around 80 percent of Brazil's cocoa comes from the southeastern part of the state of Bahia.[7] That part of Bahia lies within the region that produced those record-setting botanical surveys.[8] Some of the Bahian forest fragments still qualify as primary but many have been converted to *cabruca*, an agroforestry system in which the forest is thinned and the original understory is essentially replaced with a dense planting of cocoa. Because the cacao tree's native habitat is forest understory, it lends itself to shade cultivation. Some 50 to 60 percent of Bahian cocoa is currently grown in cabruca.[9] (Other ways of growing cocoa are described later in this paper.)

Brazil's cocoa yield peaked in the late 1980s, at roughly 400,000 tons* per year, which at the time accounted for about 15 percent of world production. But in 1989, a fungal "witches' broom" pathogen (*Crinipellis perniciosa*) spread to Bahia from Amazonia. (The pathogen gets its common name from the bushy growths that form on the branches of infected trees.) The ensuing epidemic drove production down to a quarter of its peak and threw some 90,000 farm laborers out of work. Today, Brazil produces only about 6 percent of the world's cocoa.[10] But production is likely to rebound because broom-resistant cocoa varieties are now available, and because a resurgence in cocoa prices is likely to encourage more and more farmers to graft those new varieties onto their old rootstocks.

The new growing strategy mentioned above is essentially the subject of this paper. We argue that, while there is no single, universally applicable "best way" to grow cocoa, current conditions in Bahia offer a crucial opportunity to develop an approach to cocoa agroforestry that could do two very important things: It could help save the northern portion of the Atlantic Forest, and it could serve as a huge field laboratory for learning about how conservation, tropical agroforestry, and marketing could all work together. We call this approach "forest cocoa" and describe it below.

Finally, the group of investors is, we hope, to be found among the readers of this paper. In a sense, this paper is a kind of investment prospectus, even though it doesn't have much to say about financial returns. But of course, thoughtful investment can yield many kinds of benefits.

Why Cocoa?

The principal conservation value of cocoa is its shade tolerance. Cocoa can be used to make money in tropical rainforests while maintaining a good deal of the original

*All tonnages cited in this paper are in metric tons.

canopy—that is, the biggest trees, whose tops form the "roof" of the forest. (Note the qualification: the fact that cocoa *can* do this doesn't mean that it generally *is* doing it.) Assuming that a forest must "work" to justify its existence—in other words, that the park option is not viable—cocoa may be worth considering if the cacao tree's growing requirements can be met. But of course, in order to produce enough cocoa to make the effort worthwhile, the forest will have to be modified. In primary or even established secondary (regrowth) rainforest, that will probably mean substantial ecological disruption. Much of the understory will have to be replaced with cacao trees. And since the shade in these forests is likely to be too dense to allow much of a yield, the canopy will have to be thinned. Some of the big trees will have to be either cut down or killed and left standing. It's difficult to quantify all this disruption in a consistent way, but it would be reasonable to expect at least a 40 percent canopy loss in the conversion of intact canopy to cocoa production.[1] Understory disruption is likely to be even more substantial.

An obvious question arises at this point: are there any economic activities that are less disruptive to rainforest than cocoa? The answer is "yes, but." There are, in the first place, traditional, light-on-the-land activities—for example, the tapping of the native rubber trees in Amazonia. In many tropical forests, the gathering of latex, fibers, fruits, medicines, and other non-timber forest products is a major economic activity; with careful development, such activities may greatly reduce deforestation from slash-and-burn agriculture (where immigrant pressure is not too high).[2] But at least in their low-impact forms, these activities do not generally attract heavy investment or yield high gross revenues—the qualities necessary to compete against conventional development. Nearly all of the world's rubber, for example, comes from plantations, not forest rubber tappers.

There's a high-tech version of light-on-the-land as well: bioprospecting, the search for commercially valuable genes in wild plants and sometimes also in wild animals. But this remains an uncertain enterprise, both legally and biologically.

Identifying DNA with commercial potential, figuring out who "owns" it, determining a fair price for it, and actually making money out of it—these are hardly simple matters. As a regular revenue source for most forests, bioprospecting is still a very long shot.

Yet another relatively low-impact option is ecotourism. Either alone or in combination with other activities, such as our forest cocoa approach, ecotourism may prove to be an important source of conservation revenue. But as an alternative to agroforestry, ecotourism suffers from two major limitations: it requires a fairly sophisticated infrastructure, in the form of hotels, comfortable access to sites, trained staff, and so forth; and it is best suited to spectacular natural areas. There are many fragmented forests that are probably never going to become tourist destinations.

If some degree of pervasive disturbance is inevitable, then another question arises: what about selling timber, the most important forest product of all? Attempts to do this in an ecologically benign way are known as sustainable forest management, or SFM. Typically, SFM calls for the harvest of a constant volume of wood from a forest at a regular interval (usually 10 to 30 years) while leaving, at each harvest, much of the best timber standing, in order to perpetuate the forest. (Conventional, non-SFM logging in tropical forests is usually a one-shot deal; it can involve clearcutting but is more commonly some form of "high grading," in which the best timber is cut and the loggers move on.) There is an obvious need in these forests for better timber management, but it's not clear that the current forms of SFM provide a broadly applicable solution. Compared to conventional logging—or for that matter, to cocoa farming—SFM tends to be expensive to establish and maintain because it usually requires a good deal of surveying and policing to protect seed trees and minimize logging damage. Nor do these expenses necessarily guarantee a lower level of disruption over the long term because the repeated bouts of cutting inevitably affect the structure and species composition of the forest, and because any type of logging opens up forest, making it more vulnerable to fire and more accessible to hunters. (In tropical rainforest, hunting and burning are major agents of ecological disruption.) Finally, of course, there are some forests, like the northern part of the Atlantic Forest biome, that are so endangered that *no* form of logging could be considered sustainable. From an ecological perspective, SFM is far preferable to the wholesale forest loss that often follows conventional timber operations, when land-hungry settlers invade along the logging roads. But as with any other conservation strategy, SFM has its share of drawbacks.[3]

But the obvious alternative to shade cocoa is not timber or ecotourism or bioprospecting—it's the most famous tropical forest crop of all: shade coffee. Coffee and cocoa may be the only major, internationally traded crops that can be grown in large quantities under tropical rainforest canopy. There are, however, some big differences between the two crops, and three of those differences are especially relevant to the strategy recommended here. First, cocoa requires more water than coffee, and cocoa requires water all the time; it does not tolerate dry spells.[4] This difference means that coffee can be grown commercially outside rainforest areas, but cocoa cannot be. Cocoa is exclusively a rainforest crop; whatever value it might add to rainforest areas cannot be undermined by growing it elsewhere. Second, cocoa has a higher "horticultural potential" than coffee. The cacao tree is highly responsive to extra care. Skilled smallholders, whose cocoa orchards are small enough to "garden," can achieve rates of productivity beyond the reach of big farms, which have too many trees to look after individually. Smallholders on the Indonesian Island of Sulawesi, for example, manage yields as high as 2,000 kilograms of beans per hectare per year; in most places, 1,000 kilos would be a respectable average yield on a large farm.[5] In other words, cocoa rewards labor. And the third difference: cocoa is less visible than coffee in the marketplace for ecologically and socially responsible products. Shade-grown, organic, bird-friendly, and fairly traded: these labels are not nearly as common on cocoa as they are on coffee. In this market, cocoa may offer substantial entrepreneurial space.

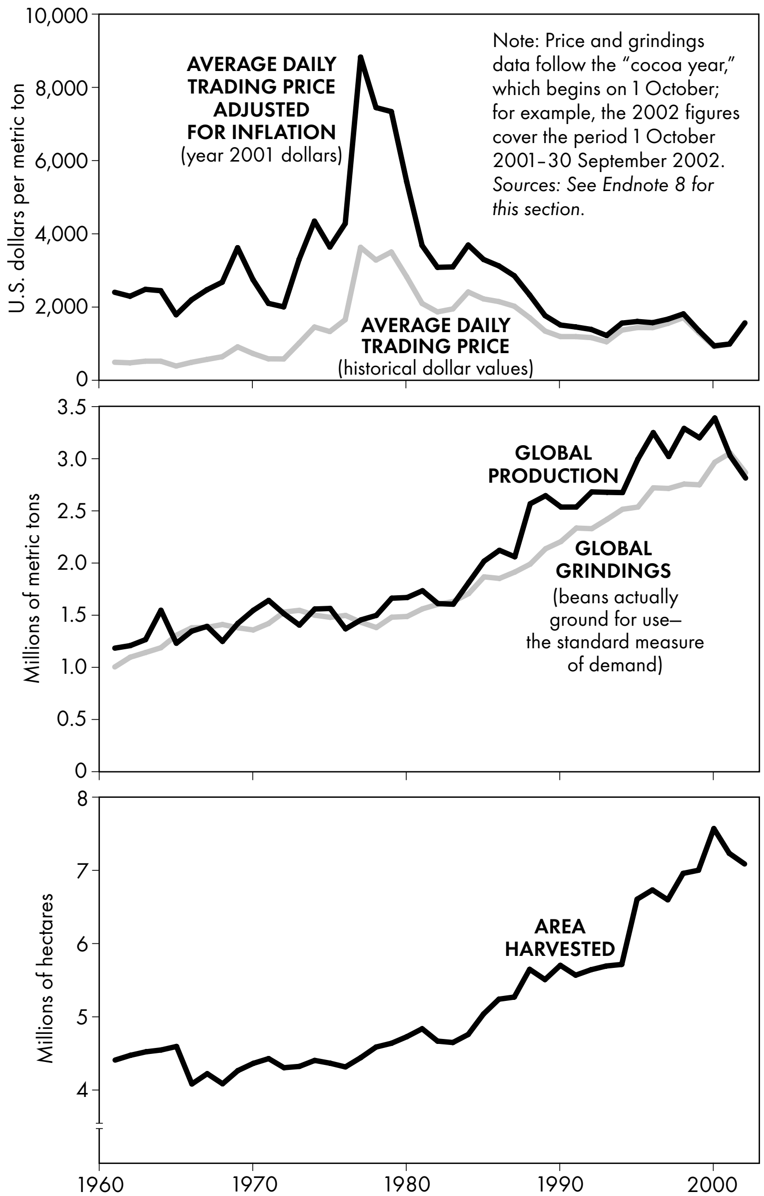
But forest conservation would be a new use for cocoa.

During its more than 400 years as a plantation crop, in the Caribbean and northern South America, in the Indonesian-Malaysian archipelago, and most recently in west Africa, cocoa has been an agent of deforestation.[6] At present, over 7 million hectares (70,000 square kilometers) are in cocoa production worldwide; that's an area a little larger than the country of Ireland.[7] Production area has grown substantially in recent decades, expanding by nearly a quarter since just 1990.[8] (See the "area harvested" graph in Figure 2, page 16.) And although the picture varies considerably from one region to the next, much of that expansion has come at the expense of forest. In Côte d'Ivoire, which accounts for nearly a third of global area harvested, 90 percent of the boom planting during the 1970s and 1980s occurred in forested lands. In Sabah and Sarawak, Malaysia, the forests gave up ground for 80–90 percent of the Malaysian boom during the 1980s, although in Peninsular Malaysia, most expansion occurred under coconut groves rather than in forest. In Indonesia, 50 percent of recent expansion occurred in forest, but roughly half of that involved the expansion of cocoa following logging.[9] (Production area in Brazil contracted during the 1990s because of the witches' broom.[10]) On a global scale, cocoa's contribution to tropical deforestation is minute—perhaps one-third of 1 percent of the world's original tropical forest area is now in cocoa. But on a regional scale, cocoa farming has sometimes been a major force in the landscape. For example, cocoa accounts for more than 13 percent of the original forest lands of Côte d'Ivoire, and cocoa is still chewing up forest in parts of west Africa and Indonesia.[11]

When cocoa replaces forest, the result is not a single, uniform landscape type, because cocoa is grown in so many different ways. Traditionally, smallholders have usually established orchards by thinning a patch of forest and planting cocoa into it, an approach that a Bahian farmer would recognize as cabruca. But in most places, older orchards have often had most of their shade cut away. In some areas, both smallholders and plantation owners are growing their cocoa under some form of introduced shade, rather than within native forest. This shade may be a uniform crop—rubber, for example, or coconut. Or

FIGURE 2

World Cocoa Trading Prices, Production, Grindings, and Area Harvested, 1961–2002



it may be a complex polyculture of various fruit and timber species. In still other cases, cocoa is being grown in full sun. This type of cocoa, sometimes called "technified" because it often depends on chemical inputs, is usually a plantation enterprise. But smallholders sometimes adopt the technique as well. For example, some small-scale farmers on Sulawesi have reclaimed deforested bottomland for what is primarily sun cocoa production—an interesting exception to the general smallholder use of traditional shade.[12]

Much of this variety can be understood in terms of a cocoa cycle, a concept that has been helpful in revealing both economic and land-use patterns in cocoa production. In highly simplified form, here's what the cycle suggests. As cocoa production gets under way in a region, the planting of new orchards into previously undisturbed forest creates a production boom: the cacao trees bear heavily because they are young and the soil is fertile, at least by tropical forest standards. But eventually, production drops off as the trees age, soil fertility declines, and increasing numbers of pests and diseases find their way into the orchards. Farmers are apt to respond to the decline by cutting away more of the original canopy, because additional light tends to stimulate more fruit production over the short term. But continued exposure to strong light is hard on both the cacao trees and the soil, so the yield eventually sags even further. Yet more shade may then be cut to try to restore production—and the syndrome may proceed to a point of near exhaustion, in which the cacao trees are at least 30 years old, the soil has deteriorated considerably, little original shade is left, and production is at a low ebb. At this point, shade may become attractive again; a canopy may be reintroduced to attempt to restore the orchards and diversify income through the cultivation of other fruit and timber species. Some orchards may be abandoned entirely in favor of fresh soils, as the "cocoa front" pushes deeper into the forests. Where such expansion is no longer feasible, the cocoa boom may go bust and regional production is likely to be eclipsed by a boom elsewhere. This boom-bust cycle has been a major force in driving large-scale cocoa farming from one region to another.[13]

In the context of this cycle, technified sun cocoa could be seen as an attempt to break the pattern of decline, by relying heavily on artificial fertilizers and pesticides and on increasingly sophisticated plant breeding. We are interested in breaking the cycle as well, but we would like to do that while the cocoa landscape is still at least partially forested. Our approach is also technified in some respects, but it is about as far from sun cocoa as it is possible to get. We argue for a strategy that contains six elements, three of them primarily ecological and three social. We list these below, beginning with the ecological elements.

We propose a form of cocoa that is:

1. Organic

Organic crops are grown without synthetic fertilizers and pesticides. Organic production is important to our approach because the routine use of artificial fertilizers and pesticides is disruptive to natural and seminatural areas. Nutrient pollution from artificial fertilizers degrades soils and injures aquatic life when it leaches into streams. Pesticides present health risks to workers and can poison a broad range of wildlife, especially nonpest insects, birds, fish, and aquatic invertebrates. (Cocoa, seemingly so benign a crop, has often been treated with some very "dirty" pesticides, including, for example, the organochlorine insecticides DDT, heptachlor, endrin, aldrin, and lindane; the latter is still a standard treatment in west Africa.[14]) Instead of spraying, organic growers try to create conditions in which infestations are much less likely to occur in the first place.

2. Grown under regenerating native forest canopy

In terms of preserving biodiversity, cocoa farming under thinned native forest canopy is one of the best agricultural options available for lowland tropical areas.[15] It can be a profitable option as well, and the profit can provide an economic rationale for preserving the forest. Retaining most of the forest canopy can also make organic production easier: many pests and diseases tend to be less prevalent in shaded cocoa orchards, and shade reduces the need for fertilizer by preserving the original soil biota and nutrient cycles, aspects of the soil that tend to degrade in strong light.[16] But this valuable native

canopy is not a static "given" that can simply be taken for granted. If it is to endure, it must be managed sustainably; instead of maintaining the understory exclusively in cocoa, some forest saplings should be planted or allowed to come up, to replace the canopy trees when they eventually die.

3. Embedded in a native forest restoration effort

Many tropical forest fragments are too small to survive indefinitely in their current state, because their plant and animal populations aren't large enough to be genetically stable over the long term. For example, one recent Atlantic Forest field study concluded that fragments would have to be at least 20,000 hectares to maintain indefinitely viable populations of five common forest mammals (three primates and two rodents). Only about 20 percent of protected areas in the biome are of this size.[17] Some of these "range demanding" species may play critical roles in perpetuating the forest itself. Many Atlantic Forest trees, for example, rely at least partly on large-gaped birds such as toucans and guans to disperse their seed, but such birds rarely occur in small or even medium-sized fragments.[18] Small fragments are also highly vulnerable to "edge effects"—the extra heat, drying, and other forms of disruption that typically occur in an area that was once forest interior and that is now exposed to open ground.[19] Conserving these fragments, therefore, requires the restoration of additional forest, to expand the fragments and connect them to each other.[20] In highly populated landscapes, where re-establishing natural forest may be impractical, restoration of open ground to cocoa under native shade could help maintain local agriculture, bridge the fragments, and soften edge effects.

4. Processed locally

At present, over 80 percent of the cocoa exported from producing countries is shipped in the form of unprocessed beans, an arrangement that captures little of the commodity's total value for the producing economies.[21] (Cocoa bean prices vary wildly, but at the average 2002 world trading price, last year's harvest was worth about $4.4 billion; the world retail cocoa market, on the other hand, is worth $42–60 billion annually, depending on how "cocoa product" is defined.[22])

Because relatively small sums are flowing back to the farms, it is difficult for farmers to invest in conservation—or indeed in anything else. But where conditions permit, farmers or farm cooperatives could build their own small-scale processing plants and begin producing either intermediate "industrial chocolate" or even finished retail products. Local processing could help capture more revenue for cocoa regions and increase employment in the sector.

5. Developed as part of a broader vision of "ecological commerce"

It would be risky to found a major conservation effort on the fortunes of a single crop. Biological diversity is likely to be best served by some degree of economic diversity, and so are the local people. Farmers may be able to supplement their cocoa with other organic cash crops, and in cocoa regions that still have significant forest cover, the forests themselves may furnish additional opportunities for environmentally sustainable employment. Ecological restoration, ecotourism, and the maintenance and protection of forest preserves are among the obvious possibilities. (Of course, most of these activities will require external funding; one potential approach is discussed in the final section of this paper.)

6. Marketed in a way that builds an international constituency for the forest, its wildlife, and its people

When consumers buy organic produce, they are purchasing more than simply the commodities themselves: they are using their money to endorse a certain relationship to the land—a "land ethic," to use Aldo Leopold's famous phrase.[23] Forest cocoa could encourage this purchasing habit in a way that helps consumers build more meaningful connections with tropical forests. In effect, the marketing of forest cocoa would involve a form of eco-labeling.[24] And that label would be a tool for creating a stronger interest in forest conservation.

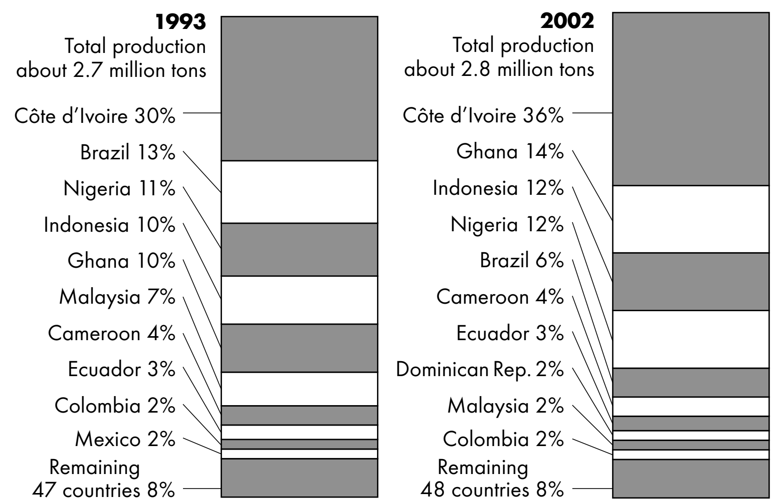
Contemporary cocoa farming offers precedents for all six of these items. Several are already established in more than one cocoa-growing region. What we are proposing is to put them all together, in order to take full advantage of the ways in which they complement each other, and to aim for large-scale rather than small-scale operation. And we argue that at the present time, the best place to do this is in Bahia, Brazil.

Why Bahia?

Cocoa is grown commercially in nearly 60 countries, but production is concentrated in just a few of these. Côte d'Ivoire, the world's leading cocoa producer, accounted for 36 percent of the 2002 harvest, according to the United Nations Food and Agriculture Organization (FAO), and that's down from the peak Ivoirian share of 41 percent in 1999 and 2001. (See Figure 3.) The top five producers in 2002 (Côte d'Ivoire, Ghana, Indonesia, Nigeria, and Brazil) accounted for 80 percent of global production.[1] From an ecological perspective, however, the critical issue is not so much the amount of cocoa harvested, but the area planted in cocoa. Unfortunately, there is no comprehensive data

FIGURE 3

The Top 10 Cocoa Producers, 1993 and 2002



Note: Share percentages for 2002 do not add to 100 due to rounding.
Source: See Endnote 1 for this section.

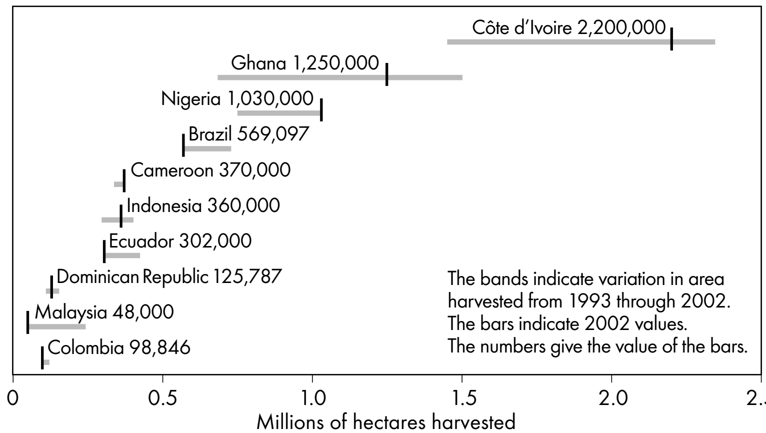
set that measures this area directly, but some general inferences can be drawn from FAO data on annual area harvested. In any particular country, area harvested may vary considerably over the years, as growers react to changing cocoa prices, the condition of their orchards, and so forth. So to get a sense for the total area planted in cocoa, it is best to look at the area-harvested figures for a long period—say, a decade. Figure 4 shows those data for countries that have harvested at least 100,000 hectares (10,000 square kilometers) of cocoa at least once since 1993. A caveat is in order here: in countries where the maximum area harvested occurred years ago, some of that area now probably consists of abandoned cocoa orchards or something else entirely, like pasture. But despite the imprecision, the FAO data give a rough idea of the importance of cocoa in the landscapes of the major producing countries. (Note that the table, which begins on page 24, contains direct estimates of area planted, but these are not from a uniform data set.)

In terms of both area harvested and production, Brazil's cocoa industry had been in decline for over a decade before production began to pick up somewhat in 2001.[2] The most conspicuous cause of the decline was the witches' broom epidemic. But even if the broom had never arrived in Bahia, Brazil's market share would almost certainly have slipped anyway, assuming production remained focused on generic cocoa. That's partly because farm labor costs are far higher in Brazil than they are in the major west African cocoa producers. (These costs are discussed below.) It's also because Brazilian farmers face greater land-use constraints than do their west African competitors: at least 20 percent of a Brazilian cocoa farm is supposed to be maintained as forest, and producing cabruca doesn't count towards that share (unless the farm is under 50 hectares and provides at least 80 percent of family income).[3] The very standards that are contributing to Brazil's social advancement—safeguards for the forest and a minimum wage—tend to work against the production of cocoa as an international bulk commodity.

This fundamental disadvantage may be masked to some degree during periods of strong demand, when cocoa prices are

FIGURE 4

Countries That Have Harvested at Least 100,000 Hectares of Cocoa at Least Once During the Period 1993–2002



Note: cocoa area data are "not always reliable." This observation, from the FAO Agriculture database, is a diplomatic understatement. Compare the FAO figure for Nigeria's 2002 area harvested, above, with the equivalent figure from the USDA Foreign Agricultural Service: 1,030,000 hectares (FAO) versus 430,000 hectares (USDA).

Sources: See Endnote 1 for this section.

high, but the cocoa market is notoriously unstable, and Brazil's competitive weakness virtually guarantees a bust whenever prices sag.[4] Instead of continuing to compete in a market for which it is no longer suited, the Brazilian cocoa sector would do better to develop products that play to its own particular strengths. A forest cocoa strategy would allow that to happen. The strategy could also be adapted, although probably with varying degrees of success, to other major producers.[5] (See the table.) But it is particularly well suited to Brazil, as can be seen from the following characteristics of rural Bahia.

A pervasive "native shade culture." The Bahian cabruca system has proved to be very durable—not because of its conservation value but because of its financial value. Bahian cocoa farmers have been, and for the most part still are, wealthy or at least comfortably well off, so they have tended to see their

TABLE

Cocoa Culture in Major Producing Countries: Some Important Factors

Factor	Brazil	Cameroon	Côte d'Ivoire
Area planted (hectares)	480,000–600,000	349,800	1,558,000–2,000,000
Average farm size (hectares)	28	5.7	2.8–4.9
Main methods of cultivation	Dense shade in native forest.	In south central Cameroon, dense shade, in both native forest and agroforest. Towards the coast, sun or light shade.	Two-thirds in sun; some light shade in agroforest; in the east, some dense shade in native forest.
Farm conditions	Half of stock is >30 years old. Some cocoa area is being converted to other uses.	Nearly half of stock is >30 years old. Some land available for expansion.	20% of stock is >30 years old. Little land is available for expansion.
Cocoa and local forests	Very little primary forest remains in cocoa areas; native forest overstory of cocoa farms is declining.	Slash and burn, for planting both cocoa and subsistence crops, is still common in cocoa areas.	Virtually no primary forest remains in the cocoa areas.
Reputation for quality	Medium quality. Noticeable but rather mild aroma. Can be smoky-tasting.	Medium quality. Variable. Quality may have declined since the 1980s. Full aroma; desirable red color.	High quality but sometimes astringent or moldy-tasting.
Prospects for organic production	Good. Pervasive shade culture; fungus-resistant cultivars; organic farming is well established.	Uncertain. Very high pest pressure; 50-80% losses, primarily to black pod (a fungus). In the southwest, an increased use of fungicides. Even so, a little certified organic cocoa is being grown.	Uncertain to poor. Fairly low pest pressure but since the mid-1990s there has been strong growth in fertilizer and pesticide use.

Table (continued)

Factor	Dominican Republic	Ecuador	Ghana
Area planted (hectares)	120,000	280,000	1,300,000
Average farm size (hectares)	Not available.	4.5	1.2–6.3
Main methods of cultivation	Shade in native forest or under fruit trees.	Light shade, in agroforest that includes both native and introduced species. Some sun.	30% in dense shade in native forest, 60% in light shade, mostly in native forest, 10% in sun.
Farm conditions	No overview is available.	A very stable cocoa area. Tree stock is highly varied; no overview available.	Nearly half of stock is >30 years old. Some land available for expansion.
Cocoa and local forests	No overview is available.	Cocoa is apparently no longer displacing native forest.	Logging and government pressure to reduce shade on cocoa is driving forest decline in the cocoa areas.
Reputation for quality	Lower quality. The Sánchez variety, which accounts for 96% of exports, can be rather insipid.	Medium quality. Variable. A major producer of aromatic "fine cocoas," used mainly to add flavor to other cocoas.	High quality. The industry standard.
Prospects for organic production	Excellent. The Dominican Republic produces about half of the world's organic cocoa.	Uncertain. The government encourages high-density plantings of disease-resistant clones. Pest management ranges from the use of gasoline and DDT to de facto (if not certified) organic.	Uncertain to poor. High pest pressure. Agrochemical subsidies were canceled in the mid 1990s, but the government facilitates private financing for pesticides, especially on larger farms.

Table (continued)

Factor	Indonesia	Malaysia	Nigeria
Area planted (hectares)	450,000–710,000	132,000, down from over 410,000 in the late 1980s. Much of this area was converted to oil palm.	430,000
Average farm size (hectares)	2–4	Not available, but 85% of production comes from holdings >40 hectares.	1.7–4.7
Main methods of cultivation	Primarily sun; some light shade in agroforest.	In peninsular Malaysia, light shade, usually under coconut; some sun. On Sabah, mostly sun.	Primarily light shade in agroforest.
Farm conditions	Stock is very young. A good deal of land is available for expansion.	Stock is young. Major expansion is not likely given the emphasis on oil palm.	60% of stock is >30 years old. Little land is available for expansion.
Cocoa and local forests	On Sulawesi, where 75% of Indonesian cocoa is grown, farmers are still clearing primary forest.	Since the cocoa bust of the 1990s, cocoa is no longer a significant pressure on primary forest.	Virtually no primary forest apparently remains in cocoa region.
Reputation for quality	Lower quality. Little aroma.	Lower quality. High shell content; can be acid.	Medium quality. Once similar to Ghana cocoa but has become very inconsistent.
Prospects for organic production	Uncertain to poor. A serious threat from the cocoa pod borer, Southeast Asia's most important insect cocoa pest. Widespread fertilizer and herbicide use.	Uncertain to poor. Official interest in integrated pest management includes cocoa, but extensive pesticide use is routine on the plantations.	Poor. Losses to black pod are as high as 70%. Since 2000, agrochemicals have been subsidized for cocoa; pesticide use is increasing.

Note: Because the data on cocoa farming are vague, conflicting, and incomplete, this table conveys only a general picture. Colombia, one of the countries listed in Figure 4, is excluded here for lack of information.

Sources: See Endnote 5 for this section.

farms as long-term investments. From this perspective, timber is a valuable resource, not just an obstacle to farming. Logging is also much more labor intensive than planting cocoa, and cocoa has historically brought a good price, so farmers have tended to maintain most of their timber for the day when it might be needed, and plant cocoa beneath it, thinning the canopy only as much as necessary to achieve a reasonable yield. (In conversion to cabruca, about a third of the trees usually seem to have been removed, mainly the larger ones, leaving canopy coverage at around 50 to 60 percent.) This interest in shade cultivation has persisted, despite roughly two decades of official attempts to persuade farmers to reduce canopy coverage to as low as 10 percent in order to boost their cocoa yields. Many farmers have responded by opening up their cabruca to some degree, and a few have eliminated the canopy entirely, to grow cocoa in full light or under some form of introduced shade. But the norm is still densely shaded cabruca. And as the primary forest has disintegrated—in southern Bahia, only around 4,200 square kilometers of original forest remain—cabruca has become, by default, a major conservation asset. The region's cocoa belt covers some 13,400 square kilometers, of which 4,800–6,000 square kilometers is actually planted in cocoa, and most of that planting is likely still cabruca.[6] Although many other countries grow some cocoa under native shade, Brazil has the largest "cocoa forest" in the world.

A high percentage of large farms. In general, cocoa today is a smallholder crop. Thousands of west African cocoa farms consist of less than 1 hectare (about 2.5 acres) and there are very few if any farms in that region of as many as 100 hectares. The average farm size in Côte d'Ivoire is probably under 3 hectares. In the tropical Americas excluding Brazil, farm size is generally somewhat higher. In Ecuador, for example, the average cocoa farm is 4.5 hectares. Indonesian cocoa is also almost entirely a smallholder enterprise. In Malaysia, on the other hand, cocoa is generally grown on plantations of 40 hectares or more. But when it comes to farm size, Brazil is in a class by itself. Over 80 percent of Brazilian cocoa is in holdings of at least 40 hectares (that's just cocoa area; it doesn't include the forest reserves on the farms). Over 55 percent of the country's cocoa is in holdings larger than 100 hectares, and about 120 farms, accounting for 5 percent of Brazil's cocoa area, have holdings of over 1,000 hectares.[7]

It is true that the concentration of land into large holdings has been a great impediment to social progress in Brazil and many other countries. Today in Brazil, for example, less than 3 percent of the population owns two-thirds of the arable land, according to the Landless Workers' Movement, or MST (for Movimento dos Trabalhadores Rurais Sem Terra), the nongovernmental organization that is the prime mover of land reform in Brazil. Roughly 166,000 landless Brazilian families are now living in squatter camps on ranches and large farms, where they are attempting to practice subsistence farming on small plots.[8] There are landless people in Bahia, and the MST does work there, but the organization is not focused on cabruca or the surviving primary forest fragments. The MST's main concern is with large tracts of cleared farmland, much of which, it says, is not being worked. As for the forests themselves, the concentration of land ownership offers an opportunity of great ecological significance. That's because it is much more difficult to maintain forest in a landscape that is composed primarily of smallholdings than in a landscape dominated by large farms. And in Bahia, not surprisingly, the larger blocks of cabruca and surviving natural forest are not the aggregations of many smallholdings; they are primarily contained on large farms.[9] For this reason, our strategy envisions increased employment as its primary social aim, rather than the redistribution of privately held forested land. (In Bahia, most forest is privately owned.)

Forest protection laws that have a chance of becoming meaningful. As in most of the developing world, environmental legislation in Brazil has generally been more of a theoretical than a practical exercise. "Brazil has some of the best environmental laws in the world," Roberto Klabin, president of the Brazilian nonprofit SOS Mata Atlântica, once told the lead author.[10] "The problem is that nobody pays any attention to them." Commercial timber operations are illegal within the Atlantic Forest biome, but clandestine logging continues to be

a problem in Bahia and elsewhere. The government of Bahia has been attempting to shut down all of the sawmills in the state for several years but this has proved to be a very difficult task. In August 2002, even the transport of raw wood was outlawed in order to make it easier to go after the loggers, who have reacted by hiding their poached timber amidst other goods on large flatbed trucks. Unfortunately, a kind of cowboy atmosphere still prevails out in the countryside. In August 2003, for example, a Bahian environmental official was hospitalized after suffering multiple stab wounds in a knife assault, after photographing a logging truck moving through his municipality. This most recent outrage is likely to provoke additional federal and state investigation of the logging issue.[11]

Progress is more evident on the farm reserve issue. The law that requires farmers in forest areas to maintain at least 20 percent of their land in natural forest had also been frequently ignored. But at least in Bahia, it is now very difficult to run a farm that does not have its reserve designated, because the reserve paperwork is generally required in order to get loans and extension support, or to satisfy other government requirements.[12] There are still huge gaps in Brazil between law and fact, but the past several years have seen significant progress.

A commitment to conservation planning on a landscape level. In badly fragmented forest biomes like the northern part of the Atlantic Forest, simple preservation of the surviving fragments is no longer an adequate conservation strategy, because the fragments are too small to be viable over the long term. But southeastern Bahia, the cocoa-growing area, is home to a forest corridor initiative designed to conserve the best remaining fragments and begin the task of reconnecting them, by restoring intervening areas, wherever possible, either to natural forest or to working agroforest. The project is funded primarily from the G7 Pilot Program to Conserve Brazilian Rain Forests, administered by the World Bank, and has numerous partners both within Brazil and abroad. Our forest cocoa strategy could play an important role in that effort.[13]

Established experience with organic production. In Bahia, widespread organic production would not have been possible had it not been for a major achievement in plant breeding: the Brazilian federal cocoa agency (the Comissão Executiva do Plano da Lavoura Cacaueira, or CEPLAC), in collaboration with other researchers and the farmers themselves, has succeeded in propagating cocoa clones that are resistant to the witches' broom fungus. (These clones are not genetically engineered; they are selections of cacao trees found to have natural resistance to the broom.)[14] Without readily available broom-resistant clones, no form of cocoa agriculture in Bahia could be considered stable. With them, it should be possible to scale up efforts like the organic program operated by a local environmental nonprofit, the Instituto de Estudos Sócio-Ambientais do Sul da Bahia (IESB), in conjunction with two farm cooperatives. As of July 2003, the program had enrolled 131 farms, of which 38 had completed the three-year transition to certified organic. Those 131 farms cover about 6,800 hectares, mostly in cabruca; the certified farms account for 1,600 hectares of the total.[15] One of the cooperatives that IESB is working with, an organization known as Cabruca (Cooperativa dos Produtores Orgânicos do Sul da Bahia), is developing a capacity to market the organic crop to foreign processors.[16] It is true that the organic ideal does not as yet have wide appeal among Bahian farmers, but organic cultivation would fit well with the pervasive shade culture and with the farmers' habit of using chemicals only occasionally, when they are cheap and cocoa prices are high, rather than routinely, as part of a commitment to high-input agriculture.[17]

These five characteristics suggest that Bahia would be an especially good setting for our strategy, but that doesn't mean that forest cocoa would be a panacea for the northern reach of the Atlantic Forest. There are many areas within the northern part of the biome where cocoa cannot be grown; some of the region's best primary fragments lie outside the cocoa belt, on soils unsuitable for cocoa, and could not benefit directly from any kind of cocoa reform.[18] Even in the cocoa-growing region, there are serious conservation problems that forest cocoa cannot address—for example, the conservation of species that cannot exist outside primary forest, and that

therefore cannot disperse through corridors of secondary natural forest or cabruca.[19] But even where other solutions must be sought, there is no reason to think that forest cocoa would hinder the search. Indeed, it would likely be an indirect support, by slowing forest loss and publicizing the value of the biome. And beyond Brazil, portions of the strategy could reinforce other forms of socially responsible cocoa.[20] (See the sidebar, pages 32 and 33.)

Where forest cocoa would be helpful, it is likely to be very helpful. In southeastern Bahia, where probably less than 5 percent of primary forest remains, cabruca is now the most common forest type. The region's complex landscape—a patchwork of vestigial primary forest, stands of second growth, cabruca, and pasture—still supports an extraordinary array of wildlife. For many of the animals inhabiting remnant patches of primary forest, nearby cabruca provides additional foraging space. In one night, for example, researchers near the Una reserve, along the coast of southern Bahia, found 23 bat species foraging in one cabruca stand.[21] Some endangered primates, like the golden-headed lion tamarin (*Leontopithecus chrysomelas*), also use cabruca in this way.[22] And in 1994, a new member of the ovenbird family was discovered in cabruca: the pink-legged graveteiro ("twig-gatherer") spends most of its time in the canopy, upside-down, foraging for insects. This little bird was unusual enough to merit, not just a new species, but a new genus. (It's classified as *Acrobatornis fonsecai*.)[23]

The social opportunities could be as substantial as the ecological ones—indeed, they will have to be for the strategy to succeed, according to Eduardo Athayde, president of the Atlantic Rainforest Open University (UMA), in Salvador, Bahia. "Building an eco-business in this region," says Athayde, "translates into three big objectives: education, employment, and conservation. To make meaningful progress, we can't just choose one or two of these goals. We have to do all three of them at once, and fit them together, into what I call an econological whole—a social, economic, and ecologically integrated activity."[24] To develop the practical implications of this approach, UMA is organizing a "Chocolate Farm" project,

SIDEBAR

Constructive Cocoa Elsewhere: A Few Examples

The Dominican Republic produces roughly half the world's certified organic cocoa, about 6,000 tons per year. The cocoa is grown primarily in the shade of forest or fruit trees, by smallholders who belong to organic cooperatives. The largest such cooperative, CONACADO, claims a membership of about 9,000 farmers. The Dominican Republic is a world leader in the export of certified organic tropical foods. Most of the country's organic cocoa is also certified as *fairly traded*: it is sold into an audited system designed to improve the farmers' lives, in part by charging a premium that is returned to the cooperatives.

Indonesia is seeing an innovative use of cocoa for the reclamation of degraded lowlands on the island of Sulawesi, where 75 percent of the country's cocoa is grown. These areas, once largely forested, are now often covered with tough, invasive grasses of little economic value. The cocoa orchards are smallholdings in sun or light introduced shade. Some of them are around 20 years old but many were established more recently, during the 1990s. Despite the relatively rich alluvial soils, production is maintained with artificial fertilizers; some pesticides are also used. Perhaps more complex forms of agroforestry cropping could largely eliminate the need for agrochemicals; if so, this approach could have great potential for rehabilitating other degraded areas.

Ecuador is the setting for an ingenious marketing initiative organized by a local nonprofit, Conservación y Desarrollo (CyD), a partner of the

on a 90-hectare cocoa farm near the town of Buerarema.

It would be a tragic blunder to ignore the ecological and social opportunities that cocoa farming has created in Bahia—but those opportunities will not last indefinitely. Some cabruca has been cleared for other crops or for pasture, and nearly all of it is degrading slowly, as more and more big trees die without descendants to replace them.[25] The loss of cabruca is further isolating the natural forest fragments from each other, and exacerbating disruptive edge effects. There are social trends to contend with as well: more and more cocoa farmers are selling their farms to developers and corporations. For the old Bahian cocoa oligarchy, farm ownership is almost an end in itself, an attitude that encourages the tendency to see cabruca

Sidebar (continued)

New York-based Rainforest Alliance. The program serves cocoa smallholders in the hinterland of the city of Guayaquil, where farmers often have no way of moving their harvest to market on their own. Many have had to sell their beans, at steep discounts, to middlemen, known as "coyotes." Farmers also depend on coyotes for credit and supplies—a relationship ripe for abuse. CyD organized a cooperative that instituted strict integrated pest management and better harvest procedures. The resulting high-quality cocoa attracted the interest of exporters in Guayaquil, who now dispatch trucks directly to the co-op. The farmers receive a better price while improving their land.

Ghana is the source of the first farmer-owned, fairly traded chocolate products. In 1998, the members of Kuapa Kokoo, a Ghanaian fair trade cooperative, decided that they wanted a more direct connection with the consumers of their cocoa. With the help of several private charities and businesses, as well as a loan guarantee from the British government, the 35,000-member co-op established its own chocolate manufacturer, the Day Chocolate Company. Marketed under the "Divine" label, Day chocolates now compete directly with the big mainstream brands, primarily on the shelves of British markets. Day Chocolate is unique, not just because it is marketing fairly traded chocolate in the mainstream, but because the Ghanaian farmers have a direct ownership stake in it.

Sources: See Endnote 20 for this section.

as a long-term investment. For companies, of course, the farms are a means to an end; short-term profit is likely to matter most. For all these reasons, the longer it takes to act, the less there will be to save. The time for forest cocoa is now.

On the Farm

The soils of the Amazon Basin, like those of many tropical rainforest areas, are generally a discouraging medium for agriculture, and that's one of the reasons why these areas are being deforested so rapidly. In tropical rainforest, most of the nutrients essential to plant growth usually reside in the vegetation itself, rather than in the soil. When a peasant farmer burns a plot of forest for planting, the ash returns some of those nutrients to the soil—enough for a year or two of farming, before the soil declines to a state of acidic, low-nutrient infertility. What was once a patch of forest has become an unproductive weed-lot and the farmer, no better off than before, must burn more forest for fresh soil. Poor soil means poor people.[1]

But here and there throughout Amazonia, there are islands of intense fertility—patches of a hectare or two, or sometimes tracts several hundred hectares in extent, where rich, black soil extends down as deep as two meters. This *terra preta*, or "dark earth," as the locals call it, is not a natural condition. It's the result of intensive farming by ancient Amazonian people. Their technique is not well understood, but it apparently involved leavening the soil with large quantities of charcoal and organic waste, and perhaps also with starter batches of soil laden with beneficial microorganisms from already established patches of terra preta. To the scientists studying it, terra preta is a startling reminder that modern farming still has much to learn from traditional practices. Evidently a central problem of contemporary developing-world agriculture—how to manage soil sustainably with local resources—was confronted and solved hundreds of years ago by the indigenous farmers of the Amazon basin. Except that these farmers didn't simply maintain their soil fertility—they radically improved it!

A modern version of the terra preta recipe could be an enormous boon to tropical agriculture, although it probably wouldn't remove poor farmers from the deforestation cycle. That's partly for social reasons—higher soil fertility would likely encourage more immigration into forest areas—and partly for agronomic reasons—steady cultivation of annual crops, like corn and beans, would likely exhaust even terra preta. But a new terra preta would really come into its own in an agroforestry setting, which was probably its predominant original use. The shade of tree cover keeps down aggressive weeds, a major problem in high-fertility soils under strong light; shade also helps preserve the fertility of the soil itself.

The research into terra preta suggests strongly that some of the biggest possibilities in agricultural development may lie well outside standard, mainstream agribusiness. Forest cocoa—in addition to being an excellent setting for "terra preta nova"—offers a range of similar opportunities. Consider the five on-farm activities described below: each corresponds to a component of our forest cocoa agenda, and each is an invitation to redefine agriculture.

1: The organic transition

Organic agriculture is predicated on the idea that farmer skill, rather than chemicals, should be the main resource for addressing two basic issues: the maintenance of crop health, and nutrient management. To take the latter issue first, the "fixed nitrogen" flow, in particular, is crucial to any farming system, because plants require large quantities of this nutrient, and because harvest inevitably removes a good deal of it from the system. (In order for plants to use it, nitrogen must be fixed—that is, attached—to oxygen or hydrogen; fixation occurs in nature through lightning strikes and the activities of certain soil microbes.) The conventional answer to nitrogen loss is to inject more of it in the form of artificial fertilizer. This practice can cause several problems. Because the nitrogen in artificial fertilizer is contained in simple compounds and in fairly concentrated form, a considerable amount of it is likely to evaporate or leach out of the soil before the crop can absorb it. The consequent nitrogen pollution of air and water is a major and growing problem in many parts of the world. The use of artificial fertilizer also encourages dependence on agrochemical companies; fertilizer prices can become an important determinant of the harvest. And finally, fertilizer application tends to become a substitute for more thoughtful soil management. The notion that you can pour your solution out of a bag is very seductive.[2]

In order to make cocoa an effective conservation tool, we need environmentally benign growing regimes that maintain soil health and allow cocoa to be grown in the same place, profitably, for the very long term. There are some areas of relatively long-term cocoa stability—in Trinidad, for example, in Ecuador, and to a lesser extent, in Bahia.[3] But even in these places, improved nutrient management would be a great benefit—a form of insurance for the long term. Shade can help maintain soil fertility, but shade alone certainly does not guarantee fertility.[4] A much more sophisticated form of nutrient management would appear to be necessary. Such techniques are already available; one that has been developed specifically for Bahian forest canopy uses a combination of fast-growing native tree species, some annual crops, and some tree crops to build soil at the same time that it produces a harvest.[5] (Some of the trees used are legumes—that is, they are in the bean family—and they have a common legume characteristic: their roots host nitrogen-fixing microbes.) Like the terra preta discoveries, sophisticated agroforestry cropping such as this suggests that one of the most promising frontiers in agricultural research today is not biotechnology or synthetic chemistry but agroecology.

Crop health, the other important management issue for organic agriculture, overlaps considerably with nutrient management, since plants, like people, benefit from proper nutrition. Poor soil may lead to weak growth that is more vulnerable to pests, but plants can also "overeat"—too much nitrogen, a condition often encountered in artificially fertilized crops, can also produce weak, vulnerable growth. By taking an interest in crop health, organic farmers are practicing a kind of preventive pest control: infestations are much easier to manage in a plant population that is not highly stressed in other ways. When infestations do occur, a well-conceived organic protocol is likely to emphasize some form of physical management, rather than chemical intervention. With cocoa, for example, the most serious pest problems that New World growers face are usually fungal infestations, and the use of fungicides on cocoa has not generally yielded very satisfactory results.[6] Recent research suggests that a better approach may be an intensive regimen of *rampassen*, a cocoa pest control technique in which as much infected material as possible is removed from the orchard on a regular basis. Researchers have found that intensive, weekly rampassen can substantially reduce

infestations of the three most common fungal cocoa pathogens in South America—and that the increased yield can justify the increased labor costs.[7] The success of this one, relatively simple procedure suggests how much could be achieved by combining a whole set of best practices. Organic agriculture is entrepreneurial: it encourages innovation on the farm.

Organic cocoa orchards generally produce less cocoa per unit area than do conventional orchards. In Bahia, yields currently range from 40 to 90 percent of conventional yields, depending primarily on soil fertility.[8] More intensive soil building could well improve those yields but even at their current levels, net organic profits can equal or exceed those of conventional farming. That's because organic growers are not buying expensive agricultural chemicals, and because organic cocoa may sell for more, depending on the price of conventional cocoa. When conventional prices are low, organic growers usually reap a premium; but when conventional prices surge, as they have over the last couple of years, the price gap disappears. (For more on prices, see "From Farm to Market," below.)

2: Managing cabruca as a living resource

Conventionally maintained cabruca is really a form of slow-motion deforestation. Those big trees will eventually die, and in most cabruca there are relatively few small and middle-aged trees available to replace the giants. Sustainable management of the cabruca must therefore involve some degree of restoration. In part, this may be a simple matter of allowing "volunteer" saplings to come up amidst the cocoa understory. But additional enrichment planting is likely to be necessary, since even abandoned Brazilian cocoa orchards may lack tree species that are important for succession back to natural forest.[9] Cabruca management ought to begin with a survey of baseline conditions, particularly of the tree cover. In the Bahian cocoa belt, such surveys could contribute substantially to our understanding of the Atlantic Forest's ecology and history.

3: The 20 percent natural forest law

Compliance with this law in the Atlantic Forest region has not been comprehensively assessed. The lead author's admittedly rather anecdotal field observations and conversations suggest that compliance still varies greatly, but as already mentioned, the law appears to be gaining ground, at least in the Bahian cocoa region. Our forest cocoa strategy would strengthen that trend by delivering a premium to farmers for doing what they're supposed to do anyway. (The premium is discussed in the next section.)

Where reforestation is necessary to satisfy the law, it should be done with seedlings derived from local, native tree populations whenever possible. (Propagation of these seedlings can supplement the income of small-scale farmers; IESB has such a program.) Top priority should be given to replanting bare stream banks and the immediate borders of forest fragments or cabruca, particularly where the planting could function as a link between fragments.[10] Wherever possible, in other words, reforestation should encourage the formation of forest corridors. Even where the 20 percent requirement has been met, stream-bank and any obvious corridor planting should be a part of basic land stewardship.

Meeting the 20 percent requirement, or surpassing it where feasible, could obviously improve the wildlife value of the farms, and it could help integrate the farms into broader landscape restoration efforts. But it could also confer some direct benefits on agriculture. The most important of these is likely to be improved hydrological stability. Throughout much of the biome, deforestation appears to have caused a drying trend; in some areas the trend has advanced to the point at which it has crippled agriculture. To the south of Bahia, for example, in some parts of the state of Minas Gerais, land that was once rainforest is now too dry for crops and has become sparse pasture.[11] Preventing anything similar from happening in Bahia should be a top priority. Forest restoration may also make it easier to manage some crop pests. Restored forests will help vary the landscape, thereby making it more difficult for pests of any particular crop to dominate. Forests may also provide habitat for the pests' own predators and diseases.[12]

4: Moving from cocoa to chocolate

Setting up a small chocolate production facility, or contracting with an established local chocolate producer, would allow a farm or a group of farms to develop its own chocolate brand. That could help capture additional revenue for the farms and encourage consumers to take an interest in them. The cacao tree, like the grape vine, is an artisan's crop, at least potentially: fine chocolate, like fine wine, can be produced efficiently on a small scale. Commercial chocolate-making equipment has recently undergone a bout of miniaturization that makes small-scale production even more feasible. It is now possible to set up an entire chocolate factory in a couple of medium-sized rooms, bring in beans and other raw materials, and ship out chocolate liquor or even finished chocolate products. The lead author has seen such an installation, on the grounds of CEPLAC, in Itabuna, Bahia. More sophisticated processing would be a logical next step for Bahian cocoa, and one that could help advance the forest cocoa strategy as a whole. Marc Nüscheler, the president of the Cabruca Cooperative, reports that his European contacts are now more interested in processed organic cocoa, rather than just beans. Nüscheler also says that he has not been able to identify a single, organic-certified cocoa processing plant in the United States. That may be a niche that Bahian growers could readily fill.[13]

A few farms elsewhere are already running independent chocolate operations. Hawaiian Vintage Chocolate, for example, offers a line of gourmet chocolates produced from its own cocoa.[14] There's no reason why entrepreneurial Bahian farmers couldn't take this approach as well. It is, to say the least, peculiar that the main cocoa processors in Brazil—mostly operations owned by big multinational cocoa traders—have been consistently importing cocoa from Africa and Malaysia. It may benefit Bahian farmers to take a more active hand in guiding their crop to market.

5: Developing the farms as centers for ecological commerce

It is critical that the economy of rural Bahia create additional jobs without doing additional damage to its residual forests. Ultimately, we would hope that both the economy and the forests could grow in ways that strengthen each other. That prospect is still rather remote, but there are a number of near-term opportunities that could bring it closer. There is, in the first place, the obvious possibility of growing and processing other crops that could be sold as forest-linked; for example, the Cabruca Cooperative is now selling a selection of palm hearts and dried fruits. Another obvious possibility for southern Bahia is ecotourism. Ilhéus, the main city within the cocoa belt, already has good hotels and restaurants, and there are spectacular beaches and forests within easy driving distance.[15] One such forest, just outside the city, is an object of great scientific interest because of its botanical diversity; even though the "Mata Esperança da Costa Atlântica" is formally a park, it is not adequately protected from the poor people who have settled along its edges and who use the park as a woodlot. Ecotourism revenues might allow for the hiring of a proper park staff, which would preserve the forest and provide at least a few of these people with jobs.[16] Some of the cocoa farms would also qualify as interesting tourist destinations, particularly those with reasonably intact forest preserves.

Eventually, it's possible that the farms could begin harvesting information as well as crops. Since cabruca has become by default a major forest resource in the northern Atlantic Forest, any activity focused on this hotspot—whether for scientific study, conservation, bioprospecting, or ecotourism—is a potential client for the farms' forest data. How many different types of trees are there in cabruca? Are there any more rare animals that have yet to be discovered—rare amphibians, maybe, or even another rare bird? Where are the best places for viewing primates or birds? Are there data on soil conditions that could help in the design of agroforestry projects elsewhere? These are just a few of the more obvious lines of inquiry that lead into cabruca. As a product, information has the wonderful quality of stimulating additional demand for itself. (When was the last time you heard a scientist say that an issue did *not* require additional study?) Cabruca, along with the natural forest fragments around it, makes up an enormous natural library, very little of which has been read. In fact, very little has even been catalogued properly. In our current state of ignorance, simply organizing botanical surveys of the farms is likely to yield scientifically interesting results. This effort could be used to stimulate additional scientific research on and around the farms. It could also serve as the first step in developing cabruca as an information resource.

From Farm to Market

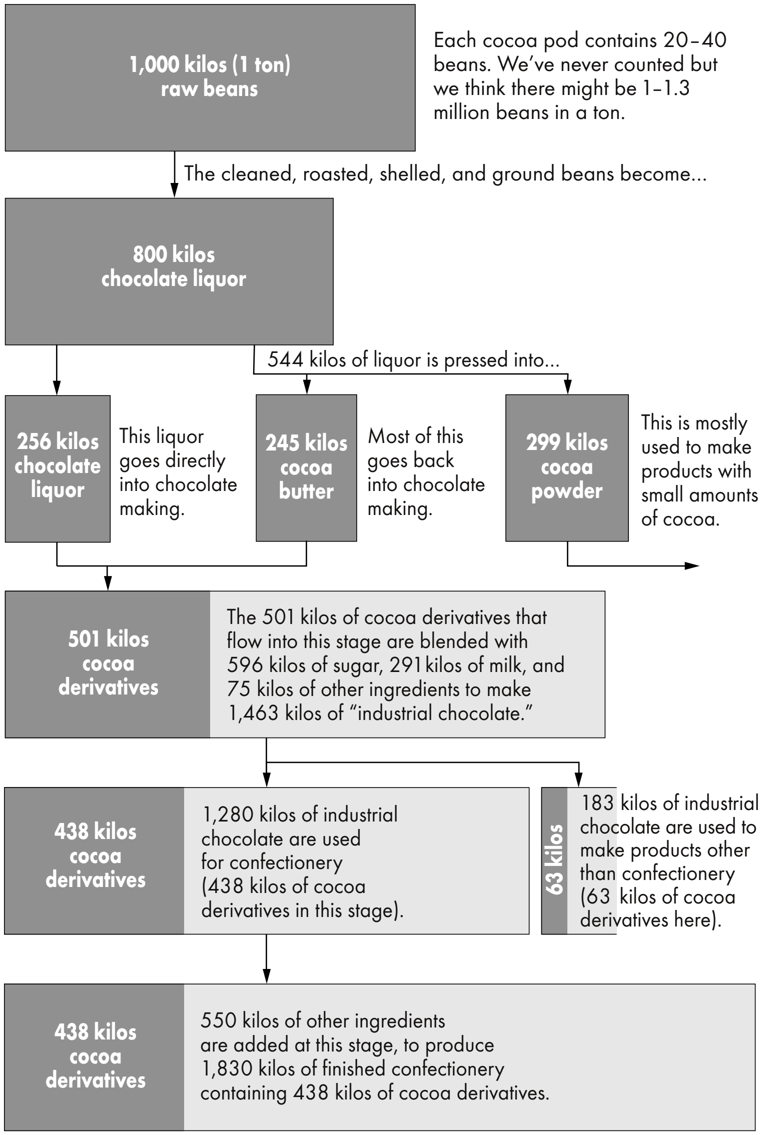
The first recorded transoceanic shipment of cocoa beans arrived in Seville, Spain, from Veracruz, Mexico, in 1585.[1] Just 64 years after the Aztec empire fell to Cortez, cocoa was on its way to becoming a global agricultural commodity. Today, around 3 million tons of beans, worth over $4 billion, are exported from producing countries every year. (See Figure 2, page 16.) And yet, despite the size and sophistication of this business, modern cocoa farmers are still shipping their beans out in much the same condition that those Maya farmers did more than four centuries ago. Almost invariably, farmers sell unprocessed, generic beans. A growing share of those beans is now processed to some degree in the producing countries, but 82 percent of the harvest still leaves those countries in the same form that it left the farms—as beans. (Nearly all of the remainder is exported in a semi-processed form, as cocoa paste, cocoa butter, and powder; very little finished chocolate is exported from cocoa-growing countries.)[2]

The perceived role of the farmer is to feed the raw material into the system; in its assumptions about what farmers are for, so to speak, the chocolate industry is following the standard model of industrialized agriculture.[3] The industry is typical of that model in other ways as well. For example, it has created a complex processing and marketing system.[4] (See Figure 5, next page.) Its products are ubiquitous (in industrialized countries) and very cheap, and it operates over vast distances. Its power and ubiquity have the curious effect of making the farmers' products available everywhere, while reducing the farmers themselves, even as a class, to near

FIGURE 5

How Cocoa Is Processed

Very roughly, here is what would happen to 1 ton of raw beans if they were processed in a way that reflected the general material flows through the industry.



Sources: See Endnote 4 for this section.

complete anonymity.

Anonymity wouldn't necessarily be a bad thing if it were profitable. But it isn't consistently so. The value of the beans, given above, is the world market price (the trading price), not the price that the farmer gets (the "farmgate price"). As a percentage of the world market value, farmgate prices vary from one country to another, depending on how the national cocoa industry is organized. In countries with centralized marketing systems, the farmgate share tends to be lower than in countries with more open, free-market systems. (That does not, in our view, mean that centralized systems are inherently oppressive; their fairness and effectiveness depend, among other things, on what they do with the revenue they retain.) In any case, the gap seems to be narrowing, since the centralized systems appear generally to be increasing the farmgate share. Côte d'Ivoire and Ghana, the world's two largest producers, are cases in point; farmers in these countries now receive about 70 percent of the world market price, a considerable increase from the 50 percent level typical of the mid-1990s. On the other hand, in free-market systems, such as in Brazil or Malaysia, the farmgate share might average around 80 or 90 percent. But in free-market systems there is typically a good deal of variation in farmgate prices; any particular farmer's price will depend on the quantity and quality of the beans on offer, and on trading prices at the time the beans are sold.[5] Of course, even where the farmgate share is high, farm revenue is still a relatively small part of the industry's total revenue. By a very generous estimate (assuming an 80 percent farmgate share of the average 2002 world trading price for cocoa beans, and a low-end value for chocolate sales of $42 billion) farmers would account for 8.4 percent of industry revenue. But the actual figure is likely to be considerably lower than that.

What do these percentages really mean to the farmers? Keep in mind that the farmgate price is just gross revenue; it's not profit. A farmer's net revenue in any particular year depends on many factors. In one way or another, of course, it depends on what is happening in the international cocoa market; that farmgate percentage has to be translated into actual currency.

(If the farmer works within a centralized system, the market influence is indirect, since it's mediated by national pricing.) Farm profit also depends on what is happening on the farm itself—on the yield, for example, on the cost of the labor required to tend the cocoa and harvest it, and on the cost of inputs such as fertilizer and pesticide. Sometimes cocoa farming is a money-making proposition. Sometimes it isn't.

By encouraging Bahian farmers to move out of the basic commodity market for generic cocoa and towards more value-added products, our approach should help increase farm revenue. Two overlapping marketing principles are essential to our strategy:

Focus on high value, not high volume.

In the market for generic cocoa, Brazil, which currently produces about 6 percent of the world's crop, is not well positioned to compete with the west African states, which dominate the market with roughly two-thirds of world production. Brazil's big competitive disadvantage is a relatively high cost of production, particularly when it comes to labor. Many west African farms run entirely or to a substantial degree on free family labor. The paid labor that is used is very cheap; for example, in Côte d'Ivoire, where roughly a third of the world's cocoa is grown, child workers are likely to earn the equivalent of $80 per year and adults around $135 per year.[6] In addition to the cheap labor, some west African states attempt to reduce farmers' production costs by subsidizing agrochemical use, either directly or by facilitating low-interest loans. Such programs are in place, for example, in Ghana and Nigeria.[7] In Brazil, on the other hand, most cocoa is grown on large farms that run entirely on paid labor. Brazil's minimum wage currently works out to 2,880 reals per year for full-time work.[8] At September 2003 rates of exchange, that's equivalent to around $1,000—a painfully small sum by industrialized country standards, but far beyond west African farm pay. In addition to the salary, employers pay for a benefits package that nearly doubles the labor cost.[9] And agrochemicals are not subsidized in Brazil, although cocoa farm loans may require their use.

Apart from the economic disadvantages that Brazil

suffers in this market, attempting to maximize production of generic cocoa would be a poor ecological choice as well. An emphasis on high volume would almost certainly lead to further thinning of cabruca, in order to gain the temporary advantage of additional light. And any increased emphasis on sun cocoa would risk "uncoupling" the crop from cabruca—thereby eliminating a major economic justification for maintaining cabruca in the first place. Emphasizing high *value*, on the other hand, could play to the latent or developing local strengths described above: the capacity for organic production and local processing, and the potential links to eco-tourism and forest restoration.

Don't just sell chocolate—sell a connection to the forest.

Our second marketing principle would invite consumers to see their purchasing as a conservation tool, as is often done, for example, with sustainable coffees—that is, coffees that are organic, shade-grown, fairly traded, or some combination thereof. ("Fairly traded" refers to products certified by the Fair Trade system, which is designed to improve the lives of developing-world workers; the cost of such products includes a premium that is returned to the producing communities.[10]) Sustainable coffees can be expensive. At the retail level, for example, shade-grown coffee may cost as much as a third more than standard coffee.[11] But despite the extra costs, sustainable coffee sales are growing very rapidly—in the neighborhood of 25 percent a year. If you include both certified and noncertified forms, global retail revenue now amounts to $565 million.[12] Presumably, much of this growth is driven by consumer concern for tropical forests, and for the people who live in them.

A similar interest in environmental benefits is contributing to the growth of organic foods in general. On a retail level, the global organic market is now worth some $23 billion annually. In the United States, organic retail sales have been expanding at about 20 percent per year over the past decade or so, and about 30 percent of the U.S. population now consumes organic products at least once a week.[13] The connection to conservation appears to be an important factor in this growth. According to a 1999 ABC News poll, for example, 57 percent of the U.S. public regards organic foods as better for the environment. The poll found the perceived environmental benefits to be "the single most persuasive attribute of organic foods"—a benefit more frequently cited than any perceived health benefits, or improvements in taste, or anything else.[14] A 2002 poll by the Biodiversity Project found that 36 percent of the U.S. public regards buying organic as a "very effective" way to take individual action to protect biodiversity; another 41 percent regards it as a "somewhat" effective way of doing so.[15]

Bahian cocoa farmers could capitalize on this type of consumer interest by developing a premium for "forest-grown" cocoa. By making a cogent argument that their customers are buying, not just chocolate, but the preservation of a global biodiversity hotspot, farmers would in effect be creating a new value for their product, a new reason to buy it. This approach would also add a degree of moral weight that could help build the business itself, especially if that business involved the development of its own brand. With a serious mission behind it, a farm or farm coalition could probably exert a much stronger claim on a distributor's or vendor's attention than they might otherwise achieve. In effect, this approach becomes a way of broadening the social significance of farming: in addition to being producers of food, the farmers become caretakers of the forest.

Of course, forest cocoa would cost more than ordinary cocoa. But how much more? Pricing is a complicated matter, but one obvious point of reference would be the cost of a fairly expensive "sustainable cocoa" already on the market—for example, standard-quality cocoa beans that are certified as both organic and fairly traded. The minimum price for such beans was $1,950 per ton in September 2003.[16] That's about 20 percent more than the price of standard-quality ordinary cocoa, at its September 2003 average of $1,625 per ton.

A 20-percent increase sounds pretty steep, but assuming that the final product is not destined for the lowest end of the price scale—as convenience store chocolate—that extra cost would probably not amount to much from the retail consumer's point of view. To see why it wouldn't, consider a small but fairly upscale box of chocolate tablets that the lead author bought while writing this paper.[17] Its chocolate was 60 percent cocoa, which is fairly high by U.S. mass-market standards (the typical formulas use less cocoa and more sugar and vegetable oil). It weighed 100 grams and sold for $3.99 before sales tax. At that September trading price, the beans used to make that cocoa would have cost about 12 cents; that's 3 percent of the retail price. How much would those beans have cost if they had come from an organic, fairly traded source? About 15 cents—still less than 4 percent of the retail price. The extra cost of using "sustainable cocoas" does not in itself place the products that contain them at the top of the chocolate price range—or indeed anywhere near it, as serious chocolate aficionados can readily testify.

We believe that our forest strategy could justify a cocoa bean price at least as high as the current sustainable cocoa prices (although in the absence of marketing studies we grant that we cannot prove it). But those are just bean prices; if the chocolate itself came from Bahia, then the local share of the retail price could be considerably higher than just 3 or 4 percent. And of course, pricing is not just bean counting, so to speak—it's also a matter of psychology: if the product is upscale, consumers may tolerate a somewhat higher price if they are encouraged to see their purchases as both a sensual indulgence and an act of international civic virtue. After all, who remembers the cost of even an ordinary box of chocolates?

We would suggest pricing the retail product in a way that allows a memorable percentage or absolute amount (say, 10 percent or $1.00) to be invested in preservation of the cabruca and the restoration of nearby forests. We would also suggest making that premium explicit—and as conspicuous as possible. And finally, we would suggest making it as easy as possible for consumers to donate more. The product packaging should advertise a website that shows the farms, the forests, and the people, and that accepts credit card and Paypal donations, as well as orders for more chocolate. This approach would begin the process of moving the customer-farmer transaction beyond cocoa and into a realm that is not limited by demand for a particular commodity.

Beyond Cocoa

Perhaps the most serious criticism that could be leveled against the strategy advocated in this paper is not so much a matter of technical specifics, but a basic, contextual point. Forest cocoa might help preserve the cabruca but it's difficult to imagine selling enough of it to fund large-scale restoration, which is likely to be an expensive operation. And besides, our strategy would create a more diffuse form of production, thereby lowering yields. In the absence of field trials and marketing studies, it's impossible to know for sure whether the system could be tuned in a way that would allow the higher retail prices to compensate for a lower level of production (lower, that is, than conventional production in good years). No matter how benign the forest cocoa system might be, one might end up suspecting that it would be too thin a revenue source for achieving the objectives that make up its organizing rationale.

Of course, in order to bring this model into the field, it will be necessary to collect better data on both its ecological and economic implications. Such data could help address these basic concerns, but the fundamental answer to this conundrum lies elsewhere. If our strategy is to succeed, it will have to be developed from the beginning as something more than a narrow agricultural program. It will require a broader undertaking, in which cocoa becomes a constituency-building mechanism, a bridge product that can be used to bring together the for-profit and nonprofit sectors. From this perspective, the ultimate measure of success will be the degree to which forest cocoa generates revenue, *in addition to cocoa sales,* for the preservation and restoration of the Mata Atlântica.

The long and largely unsuccessful struggle to conserve

tropical forests is badly in need of new ideas—preferably big ones. One of the most promising new approaches involves the leasing of "conservation concessions," an idea pioneered by Jared Hardner and Richard Rice, natural resource economists affiliated with Conservation International (CI), and several colleagues.[1] In this scenario, which has already been implemented in forests in Peru, Guatemala, and Guyana, conservationists bid on leases to public forests, just as timber companies do. The value of these leases is often $1 per hectare per year or even less. And since the profits from logging these areas also frequently turn out to be fairly low, conservationists with reasonably deep pockets may be able to outbid the loggers. When the conservationists lease a concession, the government still gets its annual payments, just as it would with a logging concession, and at least a portion of those payments, one hopes, could go towards improving the lives of the local people. But the big difference is that the forest remains intact.

This approach has much to recommend it. Once government officials get over the idea that the only way to earn money from nature is to destroy it, then the conservation concession option takes on a kind of "no brainer" quality that makes you wonder why it wasn't tried sooner. But like all tools, its strengths presuppose some limitations. At least as initially developed, the concession approach requires a large, reasonably well-funded organization, or network of organizations, on the sponsoring end of the operation. It's true that it may sometimes be possible to secure a windfall concession for very little money, such as the deal that CI worked out in 1999 with a logging company that held rights to 45,000 hectares of Bolivian forest near the Madidi National Park. For a $100,000 payment to the company, CI was able to retire the concession permanently, and the government agreed to integrate the area into the park. But such deals are unlikely to become standard operating procedure, since a single, modest payment won't generally be a politically viable incentive for permanently protecting a tract of land. Instead, concession holders should expect to make those lease payments for the life of their concessions—usually 40 years or so—and then hope to renew them. At the $1 per hectare rate, an area the size of that Bolivian forest would cost $45,000 per year to protect, or $1.8 million over the term of a 40-year lease. That would still be a wonderful deal—no question about it. But there are many wonderful deals in conservation that never get funded.

In their article in the May 2002 issue of *Scientific American*, Hardner and Rice present the conservation concession approach as an alternative to the purchasing of green products, like forest cocoa—not as an alternative in the sense of a complete replacement, but as another option that might in many cases be a preferable conservation strategy. In some contexts, however, the best option might be an amalgam of both. The northern part of the Atlantic Forest is one such area. There are no logging concessions to bid for there because logging is illegal; there are many poorly maintained parks, but these are protected already—officially if not always in fact—so the concessions idea, at least in its original form, wouldn't appear to apply. But there is the cabruca and the other, mostly privately owned forests. Since these forests are generally the property of farmers, who expect to make a profit off the land, the concession idea might achieve a good intuitive fit, as a private sector counterpart to the larger conservation concessions on public land.

Forest cocoa could be an effective tool for developing a funding base for those private concessions. There is, in the first place, a lot of money in chocolate—at least in comparison to what is currently spent on conservation. Hardner and Rice estimate, for example, that the international community now spends at least $500 million annually on hotspot conservation. That's not a trivial sum, but it's just a little over 1 percent of the low-end estimate of the annual value of chocolate ($42 billion).

If the forest cocoa strategy could be used to turn even a tiny percentage of chocolate consumers into regular donors to the forest, that would multiply many times over the value of any forest premium built into the price of the chocolate itself. The key term, of course, is "regular." Conventional charitable donations are solicited as essentially independent gifts, each of which usually requires a substantial investment

of fundraising effort. If you've ever worked with a charity, you probably know how much money has to be spent on, well, bringing in money. It would be much more efficient to enroll donors in a credit or debit card system that allows them to send a small sum to a project, on a regular basis, indefinitely. Like the conservation concession idea, this approach also has a precedent in a type of transaction that is already widely accepted. It's like a utility payment. You pay your cable TV bill and you get to watch cable TV.[2] You make your regular forest donation, and you get to watch, presumably on the web, the effort to restore the Atlantic Forest. Not a bad deal for a few dollars a month!

That's the amalgam: a well-designed, sustainably grown crop that builds a broad donor base for the preservation and restoration of the forest that it comes from. What would such an effort ultimately mean for the land and the people who live on it? As the concession approach takes root, it would presumably mean the establishment of conservation liens on forested farmland, in exchange for regular payments to the farmers. It would mean that some cabruca might eventually be retired as forest, and still be a paying proposition. It would mean additional employment in such activities as ecological restoration, surveys of the flora and fauna, and park maintenance. And it would mean that farmers have opportunities to recreate their relationship to the land—and to the people who buy their crop.

Appendix

Where to look for more information on cocoa, the Atlantic Forest, and agroforestry:

Cocoa

The Comissão Executiva do Plano da Lavoura Cacaueira
www.ceplac.gov.br
The Brazilian federal cocoa agency, based in Itabuna, Bahia.

ED&F Man Cocoa
www.edfman.com/cocoa
An international cocoa trader that publishes regular production reports and forecasts.

Fairtrade Labelling Organizations International
www.fairtrade.net
The hub of the Fairtrade system.

The International Cocoa Organization
www.icco.org
The administrating agency for the International Cocoa Agreements and the publisher of extensive sets of production and consumption statistics.

LMC International
www.lmc.co.uk/cocoa
An independent, non-trading consultancy for the cocoa sector, and the publisher of a monthly cocoa bulletin.

Smithsonian Migratory Bird Center shade cocoa paper archive
http://nationalzoo.si.edu/ConservationAndScience/MigratoryBirds/Research/Cacao
The proceedings of a conference on sustainable cocoa, held in Panama City from 30 March to 2 April, 1998.

World Cocoa Foundation
www.chocolateandcocoa.org
An industry-funded foundation that promotes socially and environmentally responsible cocoa.

The Atlantic Forest

Atlantic Rainforest Open University
www.uma.org.br
The Worldwatch Institute's Brazilian publisher and the organizer of an ecobusiness Chocolate Farm project in Bahia.

Instituto de Estudos Sócio-Ambientais do Sul da Bahia
www.iesb.org.br
A southern Bahian NGO that operates an organic cocoa program and other forest conservation projects.

Instituto de Pesquisas Ecológicas
www.ipe.org.br
A research and conservation NGO whose work within the Atlantic Forest biome includes the "Green Hug" Project, in which formerly landless people plant agroforest to buffer native forest and improve farm income.

Instituto Terra
www.institutoterra.org
An NGO engaged in forest restoration in Minas Gerais, south of Bahia.

Movimento dos Trabalhadores Rurais Sem Terra
www.mstbrazil.org
The Landless Workers Movement, an organization devoted to helping poor people obtain land for subsistence farming.

SOS Mata Atlântica
www.sosmatatlantica.org.br
An NGO based in São Paulo, devoted to the conservation and restoration of the Atlantic Forest.

Agroforestry

The Alternatives to Slash and Burn Programme
www.asb.cgiar.org
An international consortium of institutions dedicated to reducing poverty and conserving tropical forests.

Center for International Forestry Research
www.cifor.cgiar.org
A research institution committed to conserving tropical forests and helping the local communities who depend on those forests.

The International Institute of Tropical Agriculture
www.iita.org
A research organization devoted to improving agriculture and natural resources management in sub-Saharan Africa, for the benefit of poor people in the region.

World Agroforestry Centre
www.worldagroforestrycentre.org
A research and development institution focused on agroforestry systems that can improve natural resources management and rural economies in the developing world.

Endnotes

The Chocolate Forest

1. On the size of the Atlantic Forest in comparison to other Brazilian biomes, see Russell A. Mittermeier, Norman Myers, and Cristina Goettsch Mittermeier, *Hotspots: Earth's Biologically Richest and Most Endangered Terrestrial Ecoregions* (Mexico City: CEMEX/Conservation International, 1999), pp. 137, 149. Recent estimates of surviving primary Atlantic Forest cover vary from around 2 to 12 percent: see, for example, S. Saatchi et al., "Examining Fragmentation and Loss of Primary Forest in the Southern Bahian Atlantic Forest of Brazil with Radar Imagery," *Conservation Biology*, August 2001, p. 868, table 1. The most common estimate appears to be around 7 percent; see, for example, Mittermeier et al., op. cit. this note, p. 34, table 5. In Figure 1, the outline of the biome is derived from L. Patrícia C. Morellato and Célio F.B. Haddad, "Introduction: The Brazilian Atlantic Forest," *Biotropica* 32.4b (2000), p. 788, figure 2.

2. L.D. Thomaz and R. Monteiro, "Composiçao Florística da Mata Atlântica de Encosta da Estaçao Biológica de Santa Lúcia, Município de Santa Teresa, ES," *Boletim do Museu de Biologia Mello Leitao*, 7 (1997), pp. 3–48.

3. Marc D. Abrams and Carolyn A. Copenheaver, "Temporal Variation in Species Recruitment and Dendroecology of an Old-Growth White Oak Forest in the Virginia Piedmont, USA," *Forest Ecology and Management* 124 (1999), pp. 275–84 (14 tree species); unpublished data from Chris Bright's botanical surveys in the same region.

4. See the United Nations Environment Programme—World Conservation Monitoring Centre World Heritage Site description of the "Brazilian Discovery Coast," www.unep-wcmc.org/sites/wh/discover.html, viewed 2 September 2003.

5. Mittermeier et al., op. cit. note 1, pp. 27–38.

6. Cacao's native range is uncertain. See Allen M. Young, *The Chocolate Tree: A Natural History of Cacao* (Washington, D.C.: Smithsonian Institution Press, 1994), pp. 2–8. Recent DNA analysis seems to favor an exclusively South American origin: see J.C. Motamayor and C. Lanaud, "Molecular Analysis of the Origin and Domestication of *Theobroma cacao* L.," in Johannes M.M. Engels et al., eds., *Managing Plant Genetic Diversity* (Wallingford, U.K.: CABI Publishing, 2002), pp. 77–87.

7. For the period 1992–2001, Bahian production ranged from 76 to 88 percent of the total harvest from Brazil's main producing states: see the Brazilian Ministry of Agriculture and Food Supply statistical spreadsheet for cocoa at www.agricultura.gov.br/spa/3112b.xls, viewed 2 September 2003.

8. The region extends from southeastern Bahia into the adjoining coastal state of Espírito Santo; see United Nations Environment Programme, op. cit. note 4.

9. João Louis Pereira, Centro de Pesquisas do Cacau (Itabuna, Bahia), e-mail to Chris Bright, 2 May 2001.

10. Overviews of the witches' broom epidemic: J.L. Pereira, L.C.C. de Almeida, and S.M. Santos, "Witches' Broom Disease of Cocoa in Bahia: Attempts at Eradication and Containment," *Crop Protection*, August 1996, pp. 743–52; and Paulo de Tarso Alvim, "O Cacau da Bahia e Seu Futuro" (Ilhéus, Bahia: Comissão Executiva do Plano da Lavoura Cacaueira, 1997). Number of job losses: João Louis Pereira, Centro de Pesquisas do Cacau (Itabuna, Bahia), e-mail to Chris Bright, 12 September 2001. The percentages of world production are calculated from the United Nations Food and Agriculture Organization FAOSTAT-Agriculture database, at http://apps.fao.org/page/collections?subset=agriculture, viewed 3 September 2003.

Why Cocoa?

1. This appears to be the minimum canopy loss in conversion to Bahian cabruca: Norman D. Johns, "Conservation in Brazil's Chocolate Forest: The Unlikely Persistence of the Traditional Cocoa Agroecosystem," *Environmental Management*, January 1999, p. 35.

2. For an economic overview of nontimber forest products, see Theodore Panayotou and Peter S. Ashton, *Not by Timber Alone: Economics and Ecology for Sustaining Tropical Forests* (Washington, D.C.: Island Press, 1992), pp. 70–98. Recent development of such products is covered in the publications of the Alternatives to Slash-and-Burn Programme of the Consultative Group on International Agricultural Research; see www.asb.cgiar.org.

3. This critique of SFM derives mainly from Richard E. Rice et al., *Sustainable Forest Management: A Review of Conventional Wisdom*, Advances in Applied Biodiversity Science 3 (Washington, D.C.: Conservation International, Center for Applied Biodiversity Science, 2001). See also William F. Laurance, "Tropical Logging and Human Invasions," *Conservation Biology*, February 2001, pp. 4, 5.

4. A concise overview of the cultivation requirements for cocoa is available on the International Cocoa Organization website, at www.icco.org/questions/tree.htm, and for coffee, on the International Coffee Organization website, at www.ico.org/frameset/coffset.htm (both viewed 3 September 2003).

5. For the Sulawesi growers, see Robert A. Rice and Russell Greenberg, "Cacao Cultivation and the Conservation of Biological Diversity," *Ambio*, May 2000, p. 170; for the average yield, see the International Cocoa Organization website, at www.icco.org/questions/yield.htm (viewed 3 September 2003).

6. A brief history of cocoa cultivation is available in Allen M. Young, *The*

Chocolate Tree: A Natural History of Cacao (Washington, D.C.: Smithsonian Institution Press, 1994), pp. 14–47.

7. United Nations Food and Agriculture Organization FAOSTAT-Agriculture database, at http://apps.fao.org/page/collections?subset=agriculture, viewed 3 September 2003.

8. Figure 2 data for nominal prices and grindings come from the International Cocoa Organization *Quarterly Bulletin of Cocoa Statistics*. Inflation-adjusted prices were derived with the U.S. implicit GNP price deflator, U.S. Commerce Department, Bureau of Economic Analysis. Production and area harvested data come from UN Food and Agriculture Organization, op. cit. note 7, viewed 7 August 2003.

9. Rice and Greenberg, op. cit. note 5, p. 169.

10. João Louis Pereira, Centro de Pesquisas do Cacau (Itabuna, Bahia), e-mail to Chris Bright, 2 May 2001.

11. For percentage of global deforestation and Côte d'Ivoire, see Rice and Greenberg, op. cit. note 5, p. 169. For Indonesia, see François Ruf and Yoddang, "Cocoa Migrants From Boom to Bust," in François Gérard and François Ruf, eds., *Agriculture in Crisis: People, Commodities and Natural Resources in Indonesia, 1996–2000* (Montpelier, France: CIRAD/Richmond, U.K.: Curzon Press, 2001), pp. 106, 131, 132. For west Africa, see B. Duguma, J. Gockowski, and J. Bakala, "Smallholder Cacao (*Theobroma cacao* Linn.) Cultivation in Agroforestry Systems of West and Central Africa: Challenges and Opportunities," *Agroforestry Systems* 51.3 (2001), pp. 177–79.

12. For an overview of cocoa cultivation, see Rice and Greenberg, op. cit. note 5. For the Sulawesi farmers, see François Ruf and Honoré Zadi, "Cocoa: From Deforestation to Reforestation," paper presented at the workshop on sustainable cocoa, Panama City, 30 March–2 April 1998, available on the website of the Smithsonian Migratory Bird Center, at http://nationalzoo.si.edu/ConservationAndScience/MigratoryBirds/Research/Cacao/ruf.cfm, viewed 14 February 2003.

13. For an account of the cocoa cycle, see Ruf and Zadi, op. cit. note 12; for a history of cocoa booms and busts, see William Gervase Clarence-Smith, ed., *Cocoa Pioneer Fronts Since 1800: The Role of Smallholders, Planters, and Merchants* (New York: St. Martin's Press, 1996).

14. René Philippe et al., "Rational Chemical Pest Control," in Dominique Mariau, ed., *Integrated Pest Management of Tropical Perennial Crops*, (Enfield, New Hampshire: Science Publishers, 1997), pp. 25–35.

15. Rice and Greenberg, op. cit. note 5, p. 169.

16. For reduction of some pests under shade, see Rice and Greenberg, op. cit. note 5, p. 171; for shade and nutrient cycles, see J. Beer et al., "Shade Management in Coffee and Cocoa Plantations," *Agroforestry Systems* 38 (1998), pp. 139–64; and P.L. Mafongoya, K.E. Giller, and C.A. Palm, "Decomposition and Nitrogen Resease Patterns of Tree Prunings and Litter," ibid., pp. 77–97.

17. Adriano G. Chiarello, "Density and Population Size of Mammals in Remnants of Brazilian Atlantic Forest," *Conservation Biology*, December 2000, pp. 1,649–57.

18. See Jose Maria Cardoso da Silva and Marcelo Tabarelli, "The Future of the Atlantic Forest in Northeastern Brazil," *Conservation Biology*, August 2001, pp. 819, 820, and the two previous articles to which this one responds.

19. Claude Gascon, G. Bruce Williamson, and Gustavo A.B. da Fonseca, "Receding Forest Edges and Vanishing Reserves," *Science*, 26 May 2000, pp. 1,356–58; and André Augusto Jacinto Tabanez and Virgilio Maurício Viana, "Patch Structure Within Brazilian Atlantic Forest Fragments and Implications for Conservation," *Biotropica* 32.4b (2000), pp. 925–33.

20. Virgilio M. Viana, André A.J. Tabanez, and João Luis F. Batista, "Dynamics and Restoration of Forest Fragments in the Brazilian Atlantic Moist Forest," in William F. Laurance and Richard O. Bierregaard, Jr., eds., *Tropical Forest Remnants: Ecology, Management, and Conservation of Fragmented Communities* (Chicago, University of Chicago Press, 1997), pp. 351–65.

21. Kees Burger and Hidde P. Smit, "Understanding the Changes in the Cocoa and Chocolate Market," a paper from the Economic and Social Institute, Free University, Amsterdam (December 2000), p. 4, table 1.

22. Annual average trading prices are available in International Cocoa Organization *Quarterly Bulletin of Cocoa Statistics*. The 2002 figure is $1,580 per ton. The bean value estimate was derived by multiplying that figure by 2.8 million, the number of tons produced in 2002 (see UN Food and Agriculture Organization, op. cit. note 7). For the global worth of cocoa retail, see Trevor Datson, Reuters report beginning "Chocoholism reached almost epidemic proportions," London, 12 February 2003 ($42 billion), and United Nations Conference on Trade and Development, "UN Cocoa Conference Ends 10-Day Session; Will Resume Work in February 2001," press release TAD/INF/2874, 28 November 2000 ($60 billion).

23. See "The Land Ethic" essay in Aldo Leopold's *A Sand County Almanac, and Sketches Here and There*, originally published in 1949 by Oxford University Press.

24. See the website of the Global Ecolabelling Network, at www.gen.gr.jp, viewed 25 September 2003.

Why Bahia?

1. UN Food and Agriculture Organization FAOSTAT-Agriculture database, at http://apps.fao.org/page/collections?subset=agriculture, viewed 6 August 2003. The FAO statement on cocoa area, mentioned in Figure 4, is available in the agricultural production notes to the database; see www.fao.org/waicent/faostat/agricult/prod-e.htm, viewed 22 September 2003. The USDA figure for Nigeria is from Ali Michael David, "Nigeria Cocoa Annual 2003," USDA Foreign Agricultural Service GAIN Report NI3012, p. 3, available at www.fas.usda.gov/scriptsw/attacherep/default.asp, viewed 10 September 2003.

2. Raymond Colitt, "Brazilian Cocoa Winning Battle With Witch's Broom," *Financial Times*, 6 June 2001; and Anon., "Brazil Fighting Witches Broom," *ICCO Cocoa Newsletter*, August 2001, pp. 6, 7.

3. Brazilian Federal Law 4771/65.

4. National cocoa prices are tracked in the LMC International *Commodity Bulletin: Cocoa*, available by subscription at www.lmc.co.uk/cocoa/index.html. Brazilian prices are usually among the highest.

5. The sources for the table are as follows. **Area planted:** *Brazil:* Robert A. Rice and Russell Greenberg, "Cacao Cultivation and the Conservation of Biological Diversity," *Ambio*, May 2000, p. 170, table 2; and Norman D. Johns, "Conservation in Brazil's Chocolate Forest: The Unlikely Persistence of the Traditional Cocoa Agroecosystem," *Environmental Management*, January 1999, p. 32. *Cameroon:* Rice and Greenberg, op. cit. this note, p. 170, table 2. *Côte d'Ivoire:* Judith Ganes-Chase, "Cocoa Update: An Examination of the Fundamentals," J. Ganes Consulting, LLC, 5 February 2002, p. 2; and Koffi N'Goran, "Reflections on a Durable Cacao Production System: The Situation in Ivory Coast, Africa," paper presented at the workshop on sustainable cocoa, Panama City, 30 March–2 April 1998, available on the website of the Smithsonian Migratory Bird Center, at http://nationalzoo.si.edu/ConservationAndScience/MigratoryBirds/Research/Cacao, viewed 14 February 2003. *Dominican Republic:* Carlos G. Suarez, "Dominican Republic Cocoa Update 2003," USDA Foreign Agricultural Service GAIN Report DR3017, p. 3, at www.fas.usda.gov/scriptsw/attacherep/default.asp, viewed 10 September 2003. *Ecuador:* Laurence D. Fuell and Carlos M. Yugcha, "Ecuador Cocoa: Cocoa Annual Report 1999," USDA Foreign Agricultural Service GAIN Report EC9013, p. 2, available at the USDA FAS website cited above. *Ghana:* Yaw Asante-Kwabia, "Ghana Cocoa: Ghana Cocoa Situation Report 2000," USDA Foreign Agricultural Service GAIN Report GH0002, p. 2, available at the USDA FAS website cited above. *Indonesia:* Anita Katial-Zemany, Titi S. Rahayu, and Niniek Alam, "Indonesia Cocoa Report 2002," USDA Foreign Agricultural Service GAIN Report ID2031, p. 4, available at the USDA FAS website cited above; and B.K. Matlick, "Machete Technology: What Small Cocoa Farmers Need!" paper presented at the workshop on sustainable cocoa, available on the Smithsonian website cited above. *Malaysia:* Abdullah A. Saleh and Raymond Hoh, "Malaysia Cocoa: Cocoa Annual-Revised 1999," USDA Foreign Agricultural Service GAIN Report MY9068, p. 1, available at the USDA FAS website cited above. *Nigeria:* David, op. cit. note 1, p. 3.

Average farm size: *Brazil and Ecuador:* Rice and Greenberg, op. cit. this note, p. 169. *Cameroon:* Sustainable Tree Crops Program, International Institute of Tropical Agriculture, "Child Labor in the Cocoa Sector of West Africa: A Synthesis of Findings in Cameroon, Côte d'Ivoire, Ghana, and Nigeria" (Lambourn, U.K.: IITA, August 2002), p. 17, table 6. *Côte d'Ivoire and Nigeria:* Rice and Greenberg, op. cit. this note, p. 169; and Sustainable Tree Crops Program, op. cit. this note, p. 17, table 6. *Ghana:* Asante-Kwabia, op. cit. this note, p. 3; and Sustainable Tree Crops Program, op. cit. this note, p. 17, table 6. *Indonesia:* François Ruf and Yoddang, "Cocoa Migrants From Boom to Bust," in François Gérard and François Ruf, eds., *Agriculture in Crisis: People, Commodities and Natural Resources in Indonesia, 1996–2000*, (Montpelier, France: CIRAD / Richmond, U.K.: Curzon Press, 2001), p. 106. *Malaysia:* Rice and Greenberg, op. cit. this note, p. 170.

Cultivation: *Brazil:* See discussion and references in text. *Cameroon:* François Ruf and Honoré Zadi, "Cocoa: From Deforestation to Reforestation," paper presented at the workshop on sustainable cocoa, available on the Smithsonian website cited above; and B. Duguma, J. Gockowski, and J. Bakala, "Smallholder Cacao (*Theobroma cacao* Linn.) Cultivation in Agroforestry Systems of West and Central Africa: Challenges and Opportunities," *Agroforestry Systems* 51.3 (2001), p. 178. *Côte d'Ivoire:* Rice and Greenberg, op. cit. this note, pp. 170, table 3, 171; F. Herzog, "Multipurpose Shade Trees in Coffee and Cocoa Plantations in Côte d'Ivoire," *Agroforestry Systems* 27.3 (1994), 259–67; and Ruf and Zadi, op. cit. this note. *Dominican Republic:* Danielle Nierenberg, staff researcher, Worldwatch Institute, personal communication to Chris Bright, 17 September 2003. *Ecuador:* Eric Boa, Jeffery Bentley, and John Stonehouse, *Cacao and Neighbour Trees in Ecuador*, Final Technical Report (Egham, U.K.: CABI Bioscience, 2000), pp. 2, 8–10. *Ghana:* Beatrice Padi and G.K. Owusu, "Towards an Integrated Pest Management for Sustainable Cocoa Production in Ghana," paper presented at the workshop on sustainable cocoa, available on the Smithsonian website cited above. *Indonesia:* Ruf and Zadi, op. cit. this note; and LMC International, "Indonesia—Cocoa Profile" (Oxford: LMC, 2000), pp. 86, 87. *Malaysia:* Ruf and Zadi, op. cit. this note. *Nigeria:* P.A. Okuneye et al., "Environmental Impacts of Trade Liberalization and Policies for Sustainable Management of Natural Resources: A Country Study on Export Crop Promotion in Nigeria," an executive summary of a research project for the U.N. Environment Programme (2000), p. 13.

Farm conditions: *Brazil, Cameroon, Côte d'Ivoire, Ghana, Indonesia, Malaysia, and Nigeria:* Rice and Greenberg, op. cit. this note, p. 170, table 3. For *Brazil*, see also Johns, op. cit. this note, p. 39. For *Malaysia*, see also Poh-Soon Chew, "Perennial Tree Crop Plantation Systems in Malaysia: A Model for Productive Efficient Sustainable Tree Farms in Developing Countries in the Tropics," paper presented at the International Fertilizer Industry Association—FAO Conference on "Global Food Security and the Role of Sustainable Fertilization," Rome, 26–28 March 2003, p. 5. *Ecuador:* Rice and Greenberg, op. cit. this note, p. 171; and Boa, Bentley, and Stonehouse, op. cit. this note, pp. 25, 26.

Local forests: *Brazil:* See discussion and references in text. *Cameroon:* Duguma, Gockowski, and Bakala, op. cit. this note, p. 182. *Côte d'Ivoire:* N'Goran, op. cit. this note. *Ecuador:* Boa, Bentley, and Stonehouse, op. cit. this note, p. 10.

Ghana: Padi and Owusu, op. cit. this note. *Indonesia:* Ruf and Yoddang, op. cit. this note, pp. 105, 106, 131, 132, 146–48. *Malaysia:* Chew, op. cit. this note, p. 9, makes this point on plantations generally. *Nigeria:* David, op. cit. note 1, p. 3.

Quality: *All countries:* Benoît Daviron, "Economic Aspects of Quality," in Centre de coopération internationale en recherche agronomique pour le développement (CIRAD), *Cocoa Meetings: The Various Aspects of Quality*, (Montpellier: CIRAD, 1996), pp. 129, 130. For *Cameroon,* see also Duguma, Gockowski, and Bakala, op. cit. this note, p. 182. For *Dominican Republic*, see also Pascal Liu et al., *World Markets for Organic Fruit and Vegetables* (Rome: International Trade Centre, Technical Centre for Agricultural and Rural Cooperation, and UN Food and Agriculture Organization, 2001), chapter 3, Dominican Republic, table 2, available at www.fao.org/docrep/004/y1669e/y1669e00.htm, viewed 20 September 2003.

Organic prospects: *Brazil:* See discussion and references in text. *Cameroon:* Rice and Greenberg, op. cit. this note, p. 170, table 3; Duguma, Gockowski, and Bakala, op. cit. this note, p. 179; Ruf and Zadi, op. cit. this note; and Liu et al., op. cit. this note, chapter 3, Cameroon, section 5.2.1. *Côte d'Ivoire:* Rice and Greenberg, op. cit. this note, p. 170, table 3; and Ruf and Zadi, op. cit. this note. *Dominican Republic:* Swiss Import Promotion Programme (SIPPO), Forschungs Institut für biologischen Landbau, and Naturland, *The Organic Market in Switzerland and the European Union—Organic Coffee, Cocoa and Tea, Part A: Market of Organic Coffee, Cocoa and Tea* (Zürich: SIPPO, 2002), p. 26, table 15. *Ecuador:* Laurence D. Fuell and Carlos M. Yugcha, "Ecuador Cocoa: Cocoa Annual Report 1999," USDA Foreign Agricultural Service GAIN Report EC9013, p. 2, available at the USDA FAS website cited above; and Boa, Bentley, and Stonehouse, op. cit. this note, p. 17. *Ghana:* Rice and Greenberg, p. 170, table 3; Padi and Owusu, op. cit. this note; and Asante-Kwabia, op. cit. this note p. 3. *Indonesia:* Ruf and Yoddang, op. cit. this note, pp. 108, 123–27. *Malaysia:* Rice and Greenberg, op. cit. this note, p. 170; and Asna Booty Othman and K. Palasubramaniam, "Country Report: Malaysia," paper presented at the Programme Advisory Committee meeting of the FAO Programme for Community IPM in Asia, Ayutthaya, Thailand, November 2001, p. 1. *Nigeria:* Rice and Greenberg, op. cit. this note, p. 170, table 3; and David, op. cit. note 1, p. 1.

6. Norman D. Johns, "Conservation in Brazil's Chocolate Forest: The Unlikely Persistence of the Traditional Cocoa Agroecosystem," *Environmental Management*, January 1999, pp. 31–47; for the low-end estimate of cocoa area planted, which is likely to be closer to current conditions, see Robert A. Rice and Russell Greenberg, "Cacao Cultivation and the Conservation of Biological Diversity," *Ambio*, May 2000, p. 170, table 2.

7. Rice and Greenberg, op. cit. note 6, pp. 169, 170 and table 2.

8. For the MST, see www.mstbrazil.org, the organization's English-language site (which links to its Portuguese site).

9. Keith Alger, "The Reproduction of the Cocoa Industry and Biodiversity in Southern Bahia, Brazil," paper presented at the workshop on sustainable cocoa, Panama City, 30 March–2 April 1998, available on the website of the Smithsonian Migratory Bird Center at http://nationalzoo.si.edu/ConservationAndScience/MigratoryBirds/Research/Cacao/alger.cfm, viewed 9 September 2003.

10. Roberto Klabin, Fundação SOS Mata Atlântica, interview with Chris Bright, 26 March 2001, São Paulo.

11. Rui Rocha, Instituto de Estudos Sócio-Ambientais do Sul da Bahia (IESB), e-mail to Chris Bright, 3 September 2003; and Marc Nüscheler, Cabruca—Cooperativa dos Produtores Orgânicos do Sul da Bahia, interview with Chris Bright, June 16, 2002, at the Nüscheler farm in southern Bahia (on earlier efforts to shut down the sawmills).

12. Marc Nüscheler, Cabruca—Cooperativa dos Produtores Orgânicos do Sul da Bahia, e-mail to Chris Bright, 30 August 2003.

13. Conservation International, Center for Applied Biodiversity Science, *Designing Sustainable Landscapes/Planejando Paisagens Sustentáveis: The Brazilian Atlantic Forest / A Mata Atlântica Brasileira* (Washington, D.C.: Conservation International, 2000); and Anon., "Conservation Corridors: Helping People and Nature Co-exist," *Conservation Frontlines*, an on-line update from Conservation International at www.conservation.org/xp/frontlines, viewed 8 September 2003.

14. Colitt, op. cit. note 2; and Anon., op. cit. note 2.

15. Rui Rocha, Instituto de Estudos Sócio-Ambientais do Sul da Bahia (IESB), e-mail to Chris Bright, 11 August 2003. Organic cocoa production in Bahia is described in Leila Gusmão, "Cacau Orgânico É Produzido com Sucesso no Sul da Bahia," *Agora—Meio Ambiente* (Itabuna, Bahia), 1–7 June 2002, pp. 4, 5.

16. Nüscheler, op. cit. note 12.

17. Johns, op. cit. note 6, p. 43.

18. Alger, op. cit. note 9.

19. Jaqueline M. Goerck, "Patterns of Rarity in the Birds of the Atlantic Forest of Brazil," *Conservation Biology*, February 1997, p. 117.

20. The sources for the sidebar are as follows. *Dominican Republic*: Swiss Import Promotion Programme (SIPPO), Forschungs Institut für biologischen Landbau, and Naturland, *The Organic Market in Switzerland and the European Union—Organic Coffee, Cocoa and Tea, Part A: Market of Organic Coffee, Cocoa and Tea* (Zürich: SIPPO, 2002), p. 26, table 15; Pascal Liu et al., *World Markets for Organic Fruit and Vegetables* (Rome: International Trade Centre, Technical Centre for Agricultural and Rural Cooperation, and UN Food and Agriculture

Organization, 2001), chapter 3, Dominican Republic, at www.fao.org/docrep/004/y1669e/y1669e00.htm, viewed 20 September 2003; and La Siembra Cooperative's description of CONACADO, at www.lasiembra.com/conacado.htm, viewed 23 September 2003. *Indonesia:* François Ruf and Honoré Zadi, "Cocoa: From Deforestation to Reforestation," paper presented at the workshop on sustainable cocoa, Panama City, 30 March–2 April 1998, available on the website of the Smithsonian Migratory Bird Center, at http://nationalzoo.si.edu/ConservationAndScience/MigratoryBirds/Research/Cacao, viewed 14 February 2003; and François Ruf and Yoddang, "Cocoa Migrants From Boom to Bust," in François Gérard and François Ruf, eds., *Agriculture in Crisis: People, Commodities, and Natural Resources in Indonesia, 1996–2000*, (Montpelier, France: CIRAD / Richmond, U.K.: Curzon Press, 2001), pp. 112, 143. *Ecuador:* Rainforest Alliance, *2001 Annual Report* (New York: June 2002), p. 16. *Ghana:* the Day Chocolate Company website, at www.divinechocolate.com, viewed 23 September 2003.

21. Deborah Faria, Projeto RestaUna, interview with Chris Bright, 5 April 2001, Ilhéus, Bahia.

22. J.M. Dietz, S.N. de Sousa, and R. Billerbeck, "Population Dynamics of Golden-Headed Lion Tamarins *Leontopithecus chrysomelas* in Una Reserve, Brazil," *Dodo: Journal of the Wildlife Preservation Trusts*, 32 (1996), pp. 115–22.

23. The species was not formally described until 1996: José Fernando Pacheco, Bret M. Whitney, and Luiz A. Pedreira Gonzaga, "A New Genus and Species of Furnariid (Aves: Furnariidae) from the Cocoa-Growing Region of Southeastern Bahia, Brazil," *Wilson Bulletin* 108.3 (1996), pp. 397–433.

24. Eduardo Athayde, UMA—Atlantic Rainforest Open University, conversation with Chris Bright, 26 September 2003.

25. S. Saatchi et al., "Examining Fragmentation and Loss of Primary Forest in the Southern Bahian Atlantic Forest of Brazil with Radar Imagery," *Conservation Biology*, August 2001, pp. 868, 869.

On the Farm

1. Our account of terra preta follows Charles C. Mann, "The Real Dirt on Rainforest Fertility," *Science*, 9 August 2002, pp. 920–23.

2. For an overview of nitrogen pollution, see Danielle Nierenberg, "Toxic Fertility," *World Watch*, March/April 2001, pp. 30–38.

3. Trinidad and Ecuador are mentioned in this connection in Robert A. Rice and Russell Greenberg, "Cacao Cultivation and the Conservation of Biological Diversity," *Ambio*, May 2000, p. 171.

4. David N. Fernandes and Robert L. Sanford, Jr., "Effects of Recent Land-Use Practices on Soil Nutrients and Succession Under Tropical Wet Forest in Costa Rica," *Conservation Biology*, August 1995, p. 915.

5. Ernst Götsch, *Break-Through in Agriculture* (Rio de Janeiro: Assessoria e Serviços a Projetos em Agricultura Alternativa, May 1995); see further Fabiana Mongeli Peneireiro, "Sistemas Agroflorestais Dirigidos pela Sucessão Natural: Um Estudo de Caso," M.S. dissertation submitted to the School of Agriculture at the University of São Paulo (Piracicaba, Estado de São Paulo: Universidade de São Paulo, June 1999).

6. Ulrike Krauss and Whilly Soberanis, "Biocontrol of Cocoa Pod Diseases With Mycoparasite Mixtures," *Biological Control*, October 2001, p. 149.

7. W. Soberanis et al., "Increased Frequency of Phytosanitary Pod Removal in Cacao (*Theobroma cacao*) Increases Yield Economically in Eastern Peru," *Crop Protection* 18 (1999), pp. 149–58.

8. Rui Rocha, Instituto de Estudos Sócio-Ambientais do Sul da Bahia (IESB), e-mail to Chris Bright, 11 August 2003.

9. E.N. Fernandes and S.G.D. Vinha, "Floral Recomposition of the Zoobotanical Park at the Cacao Research Center, Bahia, Brazil," *Revista Theobroma* 14 (1984), pp. 1–26.

10. For stream-bank restoration in the Atlantic Forest, see Luiz Mauro Barbosa, "Considerações Gerais e Modelos de Recuperação de Formações Ciliares," in Ricardo Ribeiro Rodrigues and Hermógenes de Freitas Leitão Filho, eds., *Matas Ciliares: Conservação e Recuperação* (São Paulo, Editora da Universidade de São Paulo, 2000), pages 289–312. On the importance of linking, see Conservation International, Center for Applied Biodiversity Science, *Designing Sustainable Landscapes/Planejando Paisagens Sustentáveis: The Brazilian Atlantic Forest/A Mata Atlântica Brasileira* (Washington, D.C.: Conservation International, 2000), pp. 4–7.

11. Chris Bright's personal observations and Sebastião Salgado, Instituto Terra, interview with Chris Bright, 4 June 2002, Aimorés, Minas Gerais.

12. U. Krauss and W. Soberanis, "Rehabilitation of Diseased Cacao Fields in Peru Through Shade Regulation and Timing of Biocontrol Measures," *Agroforestry Systems* 53.2 (2001), pp. 179–84.

13. Marc Nüscheler, Cabruca—Cooperativa dos Produtores Orgânicos do Sul da Bahia, e-mail to Chris Bright, 30 August 2003.

14. See www.hawaiianchocolate.com, viewed 10 September 2003.

15. The region's most extensive eco-tourist project thus far is the Área de Proteção Ambiental (APA) Itacaré/Serra Grande; see www.itacare.com/itacare/apa/guia.php, viewed 9 September 2003.

16. Chris Bright, "$300,000," *World Watch*, November/December 2001, p. 14.

From Farm to Market

1. Sophie D. Coe and Michael D. Coe, *The True History of Chocolate* (London: Thames and Hudson, 1996), p. 133.

2. Kees Burger and Hidde P. Smit, "Understanding the Changes in the Cocoa and Chocolate Market," a paper from the Economic and Social Institute, Free University, Amsterdam (December 2000), p. 4, table 1.

3. A critique of that system is available in Brian Halweil, "Where Have All the Farmers Gone?" *World Watch*, September/October 2000, pp. 12–28.

4. Figure 5 is adapted from Burger and Smit, op. cit. note 2, page 3, figure 2, with additional data on processing from the International Cocoa Organization website at www.icco.org/questions/process1.htm, viewed 22 July 2003.

5. See the International Cocoa Organization website at www.icco.org/questions/price4.htm, viewed 16 July 2003.

6. Sustainable Tree Crops Program, International Institute of Tropical Agriculture, "Child Labor in the Cocoa Sector of West Africa: A Synthesis of Findings in Cameroon, Côte d'Ivoire, Ghana, and Nigeria" (Lambourn, U.K.: IITA, August 2002), p. 14.

7. Yaw Asante-Kwabia, "Ghana Cocoa: Ghana Cocoa Situation Report 2000," USDA Foreign Agricultural Service GAIN Report GH0002, p. 3, at www.fas.usda.gov/scriptsw/attacherep/default.asp, viewed 10 September 2003; and Ali Michael David, "Nigeria Cocoa Annual 2003," USDA Foreign Agricultural Service GAIN Report NI3012, p. 1, at the website above.

8. Anon. "Brazil Raises Minimum Wage," BBC News, 1 April 2003, at http://news.bbc.co.uk/go/pr/fr/-/2/hi/business/2905511.stm, viewed 22 July 2003.

9. Eduardo Athayde, UMA—Atlantic Rainforest Open University, e-mail to Chris Bright, 30 August 2003.

10. For a full account of the system, see the website of the FairTrade Labelling Organizations International, at www.fairtrade.net.

11. We compared the "favorites" list of standard coffees at www.thecoffeefool.com with the list on www.songbirdcoffee.com (and adjusted for the difference in the size of the bags sold); both sites viewed 11 September 2003.

12. Daniele Giovannucci, "Sustainable Coffee Survey of the North American Specialty Coffee Industry," conducted for the Summit Foundation, the Nature Conservancy, the North American Commission for Environmental Cooperation, the Specialty Coffee Association of America, and the World Bank, July 2001, pp. 4, 5.

13. Organic market statistics are available from the Organic Trade Association, at www.ota.com/organic/mt/business.html, viewed 11 September 2003.

14. Daniel Merkle, "Why Do People Buy Organic?" ABC News Polls, at http://abcnews.go.com/onair/DailyNews/poll_2000203.html, viewed 11 September 2003.

15. Belden Russonello and Stewart, *Americans and Biodiversity: New Perspectives*, poll and analysis conducted for the Biodiversity Project (Washington, D.C.: Belden Russonello and Stewart, April 2002), p. 67.

16. FairTrade Labelling Organizations International, "Fairtrade Standards for Cocoa," January 2003, p. 11. This document is available on the FLO International website, at www.fairtrade.net/sites/standards/sp.htm.

17. Feodora Hauchdünne Chocoladen "Feather-Thin Bitter Chocolate," net weight 100 grams.

Beyond Cocoa

1. Except for the mention of Guyana, below, our description of the conservation concession approach follows Jared Hardner and Richard Rice, "Rethinking Green Consumerism," *Scientific American*, May 2002, pp. 89–95. For Guyana, see the Conservation International press release, "Guyana Establishes Its First Conservation Concession," 19 July 2002, at www.conservation.org/xp/news/press_releases/2002/071802.xml, viewed 11 September 2003.

2. The lead author was introduced to this "utility" concept by Mark Winstein of the Ecostructure Corporation, which is developing a comprehensive ecosystem utility. A full account is available at www.ecostructure.us, viewed 11 September 2003.

Index

Other Worldwatch Papers

On Climate Change, Energy, and Materials

160: Reading the Weathervane: Climate Policy From Rio to Johannesburg, 2002
157: Hydrogen Futures: Toward a Sustainable Energy System, 2001
151: Micropower: The Next Electrical Era, 2000
149: Paper Cuts: Recovering the Paper Landscape, 1999
144: Mind Over Matter: Recasting the Role of Materials in Our Lives, 1998
138: Rising Sun, Gathering Winds: Policies To Stabilize the Climate and Strengthen Economies, 1997
130: Climate of Hope: New Strategies for Stabilizing the World's Atmosphere, 1996

On Ecological and Human Health

165: Winged Messengers: The Decline of Birds, 2003
153: Why Poison Ourselves: A Precautionary Approach to Synthetic Chemicals, 2000
148: Nature's Cornucopia: Our Stakes in Plant Diversity, 1999
145: Safeguarding the Health of Oceans, 1999
142: Rocking the Boat: Conserving Fisheries and Protecting Jobs, 1998
141: Losing Strands in the Web of Life: Vertebrate Declines and the Conservation of Biological Diversity, 1998
140: Taking a Stand: Cultivating a New Relationship With the World's Forests, 1998

On Economics, Institutions, and Security

167: Sustainable Development for the Second World: Ukraine and the Nations in Transition, 2003
166: Purchasing Power: Harnessing Institutional Procurement for People and the Planet, 2003
164: Invoking the Spirit: Religion and Spirituality in the Quest for a Sustainable World, 2002
162: The Anatomy of Resource Wars, 2002
159: Traveling Light: New Paths for International Tourism, 2001
158: Unnatural Disasters, 2001
155: Still Waiting for the Jubilee: Pragmatic Solutions for the Third World Debt Crisis, 2001

On Food, Water, Population, and Urbanization

163: Home Grown: The Case for Local Food in a Global Market, 2002
161: Correcting Gender Myopia: Gender Equity, Women's Welfare, and the Environment, 2002
156: City Limits: Putting the Brakes on Sprawl, 2001
154: Deep Trouble: The Hidden Threat of Groundwater Pollution, 2000
150: Underfed and Overfed: The Global Epidemic of Malnutrition, 2000
147: Reinventing Cities for People and the Planet, 1999
136: The Agricultural Link: How Environmental Deterioration Could Disrupt Economic Progress, 1997

Other Publications from the Worldwatch Institute

State of the World 2004 **AVAILABLE JANUARY 2004**
Worldwatch's flagship annual is used by government officials, corporate planners, journalists, development specialists, professors, students, and concerned citizens in over 120 countries. Published in more than 20 different languages, it is one of the most widely used resources for analysis.

Signposts 2003
This CD-ROM provides instant, searchable access to over 1365 pages of full text from the last three editions of *State of the World* and *Vital Signs*, comprehensive datasets going back as far as 50 years, various historical timelines, and easy-to-understand graphs and tables. Fully indexed, *Signposts 2003* contains a powerful search engine for effortless search and retrieval. Plus, it is platform independent and fully compatible with all Windows (3.1 and up), Macintosh, and Unix/Linux operating systems.

Vital Signs 2003
Written by Worldwatch's team of researchers, this annual provides comprehensive, user-friendly information on key trends and includes tables and graphs that help readers assess the developments that are changing their lives for better or for worse.

State of the World Library 2003
Subscribe to the *State of the World Library* and join thousands of decisionmakers and concerned citizens who stay current on emerging environmental issues. The *State of the World Library* includes Worldwatch's flagship annuals, *State of the World* and *Vital Signs*, plus all four of the highly readable, up-to-date, and authoritative *Worldwatch Papers* as they are published throughout the calendar year.

World Watch
This award-winning bimonthly magazine is internationally recognized for the clarity and comprehensiveness of its articles on global trends. Keep up-to-speed on the latest developments in population growth, climate change, species extinction, and the rise of new forms of human behavior and governance.

To make a tax-deductible contribution or to order any of Worldwatch's publications, call us toll-free at 888-544-2303 (or 570-320-2076 outside the U.S.), fax us at 570-320-2079, e-mail us at wwpub@worldwatch.org, or visit our website at www.worldwatch.org.