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IMPROVING INCENTIVES FOR SUSTAINABLE FOREST MANAGEMENT: AN ECUADORIAN CASE STUDY

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LIST OF ORGANIZATIONS

AID	U.S. Agency for International Development
BCE	Central Bank of Ecuador (Banco Central del Ecuador)
CORMADERA	Corporation for Forestry and Wood Products Development of Ecuador (Corporación de Desarrollo para el Sector Forestal y Maderero del Ecuador)
FONNIN	National Fund for the Protection of the Ecuadorian Infant Population (Fondo Nacional para la Protección de la Población Infantil Ecuatoriana)
IDEA	Agricultural Strategies Institute (Instituto de Estrategias Agropecuarias)
IERAC	Ecuadorian Institute for Agrarian Reform and Colonization (Instituto Ecuatoriano de Reforma Agraria y Colonización)
INEFAN	National Institute for Forestry and Natural Areas (Instituto Nacional Forestal y de Areas Naturales)
INFORDE	Initiative for Private Forestry Development (Iniciativa para el Desarrollo Forestal Privado)
JICA	Japanese International Cooperation Agency
LACTECH	Agricultural and Rural Development Technical Services Project
MAG	Ministry of Agriculture and Livestock (Ministerio de Agricultura y Ganadería)
MICIP	Ministry of Industry, International Commerce, and Fisheries (Ministerio de Industria, Comercio Internacional, y Pesca)
MOP	Ministry of Public Works (Ministerio de Obras Públicas)
PRONAREG	Programa Nacional de Regionalización Agraria (National Program for Agrarian Regionalization)
SUFOREN	Subsecretariat for Forestry and Natural Resources (Subsecretaría Forestal y de Recursos Naturales)
USDA	U.S. Department of Agriculture
WRI	World Resources Institute

I. INTRODUCTION

Tropical deforestation arouses widespread concern. Although they cover a small portion of the earth, moist forests near the equator harbor a large number of plant and animal species. The loss of that habitat, then, is a major threat to global biodiversity. Deforestation also causes carbon dioxide to be released into the atmosphere. As a result, warming of the planet is accelerated. Diminished tree cover also contributes to soil erosion, sedimentation, and flooding, which can create major local and national impacts.

To arrest the loss of tropical forests, several actions need to be taken. Unique habitats and areas where large numbers of threatened species are concentrated must be given some sort of protection. In addition, economic activities that cause little or no environmental damage need to be encouraged. Among those activities are limited extraction of non-timber forest products as well as properly managed ecotourism. Above all, halting the conversion of natural ecosystems into cropland and pasture depends on improving production, employment, and incomes in areas that have already been settled. As Southgate (1991) emphasizes, the conversion of Latin America's natural habitats into cropland and pasture is, in large part, a symptom of the poor performance of the region's agricultural economies.

This report addresses another aspect of tropical forest conservation, which is to improve the incentives for sustainable timber production. Implicitly, our analysis rests on the assumption that declaring all standing forests as parks is highly impractical. It can also be taken for granted that ecotourism and the production of non-timber commodities could be carried out even if there were a major reduction in total forest cover. [The recent success of ecotourism in the face of advanced cumulative deforestation in Costa Rica is instructive in this regard.] To save forests outside of designated nature reserves, sites visited by tourists, and "extractive reserves" (to use the term applied to the geographic sources of non-timber products), the returns to sustainable timber production will have to exceed the returns associated with agricultural land clearing.

In this report's analysis of timber production incentives, the geographic focus is Ecuador. As is explained in the second part of this report, the contribution of forestry and wood products manufacturing to the national economy is small and is jeopardized by the loss of tropical forests, which are the sector's source of raw materials. The history, current extent, and environmental consequences of agricultural land clearing are reviewed in the third part of the report. A comparison of agricultural earnings and potential forestry income in recently colonized areas is offered in the fourth part. That comparison reveals that deforestation has been an economic failure for colonists, who are the people most directly involved in deforestation. The disincentives for sustainable forestry development, including trade policies that drive down timber values, low forest fees, and

property arrangements that discourage forestry, are reviewed in the fifth part of the report and, in the sixth part, potential increases in stumpage prices that Ecuadorian loggers and wood products manufacturers are indicated.

As is emphasized at the end of this report, improved incentives for sustainable timber production should be a centerpiece of a strategy for the conservation of Ecuador's tropical forests.

II. THE FORESTRY SECTOR

2.1 Sector Composition, Employment, and Trade

Ecuador's forestry sector, conventionally defined, comprises three parts. The first sub-sector is timber production and harvesting and the second is the wood processing industry (defined to include plywood and particle board plants, small sawmills, furniture makers, and so forth). Pulp and paper manufacturing (which involves recycling of old paper and cardboard, more than anything else) is the third sub-sector. In terms of the value of annual output, the three parts of the forestry sector are all of comparable size.

The sector as a whole makes a relatively modest contribution to the national economy. Central Bank of Ecuador (BCE) data show that the value of forestry output (excluding fuelwood and other products exchanged mainly in the informal economy) has been around 1.0 of GDP since the early 1980s. The only major deviation from economy-wide trends occurred in 1982, when manufactured wood exports collapsed due to the adoption of trade restrictions in neighboring countries. Since then, growth in the wood processing industry has matched that of the other two sub-sectors and also that cf the national economy.

As of 1989, total sectoral employment was 75,000, which was a little more than 0.9 percent of the national labor force. About 5,000 worked in the pulp and paper sub-sector, 55,000 in wood processing, and 15,000 in timber production and harvesting (Laarman and Prestemon).

There are two principal marketing channels in the forestry sector. Much of the wood used by furniture manufacturers and artisans and also in construction is harvested by small-scale loggers (*motoserristas*), who use chainsaws to fell trees and cut them into large planks (*tablas* or *tablones*). That product is then sold to intermediaries, many of whom have trucks, who then sell to the end-user.

The marketing chain for industrial roundwood is simpler, with larger logging firms, which are often subsidiaries of an integrated enterprise, contracting directly with land owners. Logs are extracted and transported to plywood or veneer plants.

The collapse in manufactured wood exports that occurred in 1982 is reflected in trade data presented in Table 2.1. For many years afterward, shipments of balsa to foreign buyers accounted for

Table 2.1 The Forestry Sector's Trade Balance
(million 1990 US$)

	1982	1984	1986	1988	1990
Exports	48.7	16.1	20.4	28.3	29.0
- Paper and Cardboard	1.7	0.8	1.0	0.7	0.5
- Logs	0.3	0.0	0.0	0.1	0.0
- Wood and Furniture	46.7	15.3	18.4	24.4	24.6
- Tagua	0.0	0.0	1.0	3.1	3.9
Imports	140.0	115.6	84.0	79.2	73.4
- Pulp and Paper	138.3	114.8	83.7	78.8	73.1
- Wood	1.7	0.8	0.3	0.4	0.3
Balance	-91.3	-99.5	-63.6	-50.9	-44.4

Source: BCE data

practically all exports. Because of legal restrictions (Subsection 5.1.1), log exports during the 1980s were negligible (Table 2.1). However, foreign sales of plywood and other products recovered partially during the late 1980s. In 1990, balsa accounted for 48 percent of total forestry exports and plywood and particle board for another 34 percent. The United States purchases 80 percent of Ecuador's balsa exports and, along with Venezuela, is a major buyer of plywood. Peru and Colombia are the principal destinations for particle board exports.

Ecuador does not import logs and it is a net exporter of manufactured wood products. However, imports of pulp and paper are sizable. As a result, the country's balance of trade in forest products has long been negative (Table 2.1).

Timber is not the only product extracted from Ecuador's forests. In recent years, collection of tagua (*Phytelephas sp.*), a vegetable ivory used to make buttons and artwork, has increased dramatically in Manabí and Esmeraldas provinces. Export growth is indicated in Table 2.1.

2.2 Forest Resources

2.2.1 Natural Forests

Notwithstanding rapid tropical deforestation (Sections 3.1 and 3.2), natural forests continue to cover a large part of the country. As of the late 1980s, there were 11.47 million ha of tree-covered land (including a small amount of plantations -- Subsection 2.2.2), which was equivalent to 42 percent of continental Ecuador. As is indicated in Table 2.2, most of the

country's forests are east of the Andes.

At best, inventories of standing timber are spotty in Ecuador. For example, no stand projection tables exist for the country. Neither are there any estimates of growth rates in natural forests. A summary of per-hectare estimates for different parts of the *Costa* and *Oriente*, which were obtained using various criteria and techniques, are presented in Table 2.2. The total volume of tropical timber for the nation as a whole is hundreds of times greater than the volume of wood used each year by industry during the middle and late 1980s: around 2.25 million m^3/year, according to the Initiative for Private Forestry Development (INFORDE).

It is important to keep in mind, however, that the ratio of standing timber to annual timber extraction in the northwest, which has been a relatively cheap source of logs (operations in the *Oriente* tend to be very expensive), is much less favorable. Dividing the 84.87 million m3 of timber that stood in Esmeraldas and northwestern Pichincha province a few years ago by the INFORDE estimate of industrial timber demand yields a ratio of 37.39. Of course, natural growth as well as regeneration after logging should be considered when timber resource "lifetimes" are being calculated. On the other hand, those lifetimes are being severely diminished in the northwest by accelerated agricultural land use conversion (Subsection 3.1).

2.2.2 Tree Plantations

One response to decreased natural stocks is the establishment of tree plantations. Unfortunately, cumulative reforestation in Ecuador, particularly in the tropics, is meager.

As is indicated in Table 2.3, practically all of the country's tree plantations are in the *Sierra*. The principal species used in highland reforestation projects has been eucalyptus (*Eucalyptus globulus*), which has limited industrial applications. It will be many years before most tropical plantations are ready to be harvested. The principal species used, laurel (*Cordia alliodora*) and pachaco (*Schizolobium parahybum*), take about twenty years to

Table 2.2 Standing Timber in Tropical Forests, Selected Areas

Province	Forested Area	Commercial Timber	Total Volume
Esmeraldas	1.06 million ha	66 m^3/ha	69.96 million m^3
NW Pichincha	0.21	71	14.91
Napo and Sucumbios	2.50	64	160.00
Pastaza	3.25	89	289.25
Morona Santiago	0.75	80	60.00
Zamora Chinchipe	0.30	117	35.10
			629.22 million m^3

Source: SUFOREN (1991), p. 43

Table 2.3 Tree Plantations in Ecuador in 1985

Region	Under 8 Years	Over 8 Years
Costa and *Oriente*	2,754 ha	919 ha
Sierra	20,754	29,798

Source: SUFOREN, p. 44

reach a diameter of 45 cm at chest height, which is the minimum size accepted by timber buyers (Montenegro, 1987a and 1987b). In 1985, less than 1,000 ha of tropical plantations were more than eight years old (Table 2.3).

III. EXTENT AND ENVIRONMENTAL CONSEQUENCES OF TROPICAL DEFORESTATION

Many years will pass before Ecuador is able to meet its timber demands with production from reforested areas. INFORDE reported that annual plantation output during the middle 1980s was 0.54 million m^3, or less than a fourth of the timber extracted from natural forests.

Supplies from the latter source are also in jeopardy because tree-covered land is being cleared to make way for crop and livestock production. As is explained in this section, some reports of deforestation in Ecuador are exaggerated. Nevertheless, rates of land use conversion are high. Furthermore, the environmental consequences of forest loss are serious.

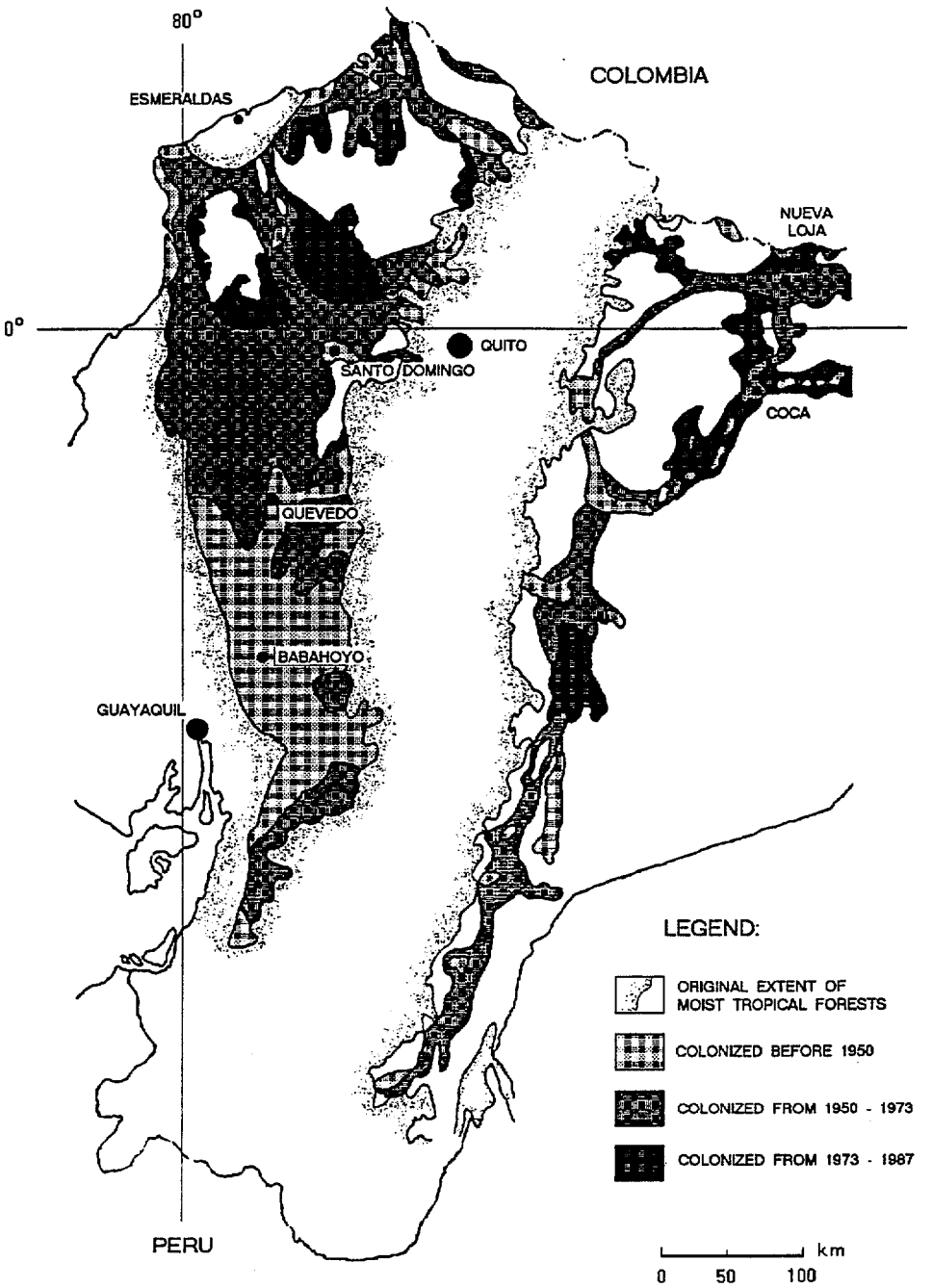
3.1 Historical Trends

Conversion of tropical moist forests into cropland and pasture began in Ecuador more than 125 years ago and has accelerated in recent decades (Figure 3.1). Completion of the highway running through Santo Domingo marked the initiation of rapid agricultural settlement in the northwestern part of the country. Deforestation in the Ecuadorian Amazon (or *Oriente*), which had few connections with the outside world until recent times, increased dramatically after 1967, when petroleum was discovered in the northeastern part of the country (Bromley).

Changes in land use in tropical Ecuador during the past twenty years are reported in Table 3.1. Between the early 1970s and the late 1980s, cropland west of the Andes increased by nearly a fifth, to more than 1.25 million ha. Meanwhile, the area planted to annual and perennial crops in the *Oriente* rose by 350 percent, from 30,000 to 135,000 ha.

As a rule, deforested land is dedicated to cattle production. Nearly 2.00 million ha of new pasture have been created in the five

Figure 3.1 Tropical Deforestation in Ecuador: An Historical View



Sources: Bromley and SUFOREN reports

Table 3.1 Agricultural Land Use Trends in Tropical Ecuador

Land Use	1972-73	1988-89	change
Cropland	1,090,000 ha	1,393,000 ha	28 %
- *Costa*	1,060,000	1,258,000	19
- *Oriente*	30,000	135,000	350
Pasture	1,217,000	3,672,000	202
- *Costa* provinces	833,000	2,792,000	235
- *Oriente* provinces	384,000	880,000	129

Source: Southgate and Whitaker

provinces of western Ecuador (El Oro, Guayas, Los Ríos, Manabí, and Esmeraldas) since 1972. Another 0.50 million ha were deforested to make way for livestock production in the five Amazonian provinces (Zamora Chinchipe, Morona Santiago, Pastaza, Napo, and Sucumbios). Table 3.1's data on pasture trends do not reflect agricultural colonization of the western lowlands of Pichincha, Cotopaxi, and other Andean provinces, which was under way by the 1960s and continues to this day. All told, at least 3.00 million ha of tropical forests have been converted into cattle pasture during the past twenty years.

3.2 Current Magnitude

The most widely cited estimate of annual deforestation in Ecuador is 340,000 ha a year, which is equivalent to 2.3 percent of standing forests (WRI, p. 42). This figure is difficult to reconcile with other estimates of land use conversion. According to a national government survey, deforestation in Ecuador's five eastern provinces averaged a little more than 100,000 ha per annum, or a little more than 1 percent a year, between the middle 1960s and the middle 1980s (SUFOREN, p. 42). This finding is generally consistent with FAO's most recent estimate of agricultural land clearing throughout the *Oriente*: 60,000 ha a year (Schmidt).

Representatives of the agency out of which INEFAN was created, the Subsecretariat for Forestry and Natural Resources (SUFOREN), indicated that annual deforestation during the late 1980s was roughly 200,000 ha. INEFAN officials now claim that the rate has fallen to 140,000, which is probably not far off the mark.

3.3 Environmental Consequences

The social costs of this land use change are considerable. Marketed or marketable forest commodities are lost. For example,

using land to produce crops or livestock implies a corresponding reduction in timber output. At the same time, supplies of fruit, medicinal plants, and other non-timber products are diminished.

Other costs of deforestation do not manifest themselves directly in the marketplace. The climatic impacts of land use change, for example, are "externalities." So is the species extinction that results from habitat destruction and the damage done to roads, reservoirs, and other infrastructure because of watershed deterioration.

Southgate and Macke (1989) have documented the costs of reservoir sedimentation associated with deforestation and depletive agriculture in the Ecuadorian Andes. Unfortunately, no such research has been carried out in tropical parts of the country. A brief assessment of agricultural land clearing's impacts on biodiversity and global warming follows.

3.3.1 Losses of Flora and Fauna

In all likelihood, the most serious consequence of land use change in Ecuador has to do with diminished biodiversity. Myers (1988) has identified ten "hot spots" around the world, where tropical moist forests inhabited by large numbers of rare plants and animals are under severe threat. The Amazonian lowlands of eastern Ecuador are the center of one of these ten zones, the Uplands of Western Amazonia. The same investigator considers Western Ecuador, where cumulative deforestation is very advanced, (Section 3.1), to be one of the world's three hottest hot spots.

Although diminished biological diversity defies economic evaluation, it is safe to say that humankind as a whole would probably pay a considerable amount to maintain the existence of rare species in Ecuador. Similarly, the world's scientific community would probably pay large sums to make sure that the country's stockpile of genetic information is not lost.

3.3.2. Global Warming

Using a dynamic model of climate change, damages resulting from global warming (e.g., rising sea levels and reduced agricultural production), and economic responses to those damages, Nordhaus (1992) has estimated that the present value of economic losses caused by carbon emissions will grow from a little more than $5/mt in the middle 1990s to $10/mt in 2025. In a study of global warming damages caused by deforestation in the Brazilian Amazon, Schneider et al. (1991) use a conservative estimate of costs: $5/mt. They also employ a measure of carbon released from deforested land originally published by Fearnside (1987): 120 mt/ha. The resulting estimate of global warming costs associated with land clearing is:

US$5/mt x 120 mt/ha = US$600/ha.

Deforestation in Ecuador might have less of an impact on the

world's climate than what is suggested by Schneider *et al.*'s (1991) analysis. Different from what tends to take place in Brazil, cleared land in, for example, the *Oriente* is not burned, mainly because conditions are usually too wet.

IV. THE ECONOMIC FAILURE OF AGRICULTURAL COLONIZATION

In addition to resulting in adverse environmental impacts, the conversion of tropical forests into cropland and pasture has proven not to be very beneficial for agricultural colonists, who are the people most directly involved.

Unfortunately, the state of forestry research in Ecuador does not permit estimation of the potential returns to managing natural forests for timber production. That is, not even rudimentary data exist on either natural growth or the regeneration that takes place after logging.

However, it is possible to compare tree plantations and agroforestry with the typical land use in recently deforested areas, which is extensive cattle ranching. Our analysis of these three options, reported in this section, suggests that many frontier land-holders with secure tenure and access to credit would choose either of the first two options over the third, even at current stumpage prices.

4.1 The Returns to Agriculture

The economic failure of recent agricultural colonization in northwestern Ecuador has been documented by Southgate *et al.* (1992), who surveyed 179 settlers in the region in 1991. Incomes among the sampled population are very low. More than 33 percent of the colonists reported having negative cash flows for their respective farms and ranches. Only 10 percent of the sample took in more than US$100/ha (at prevailing exchange rates) during the preceding twelve months. Most farmland generates less than US$25/ha.

A sure sign that agricultural land clearing has been unprofitable is the low current value of real estate in the northwestern Ecuador. Of the surveyed colonists who were willing to name a price, a third would sell out and move if offered US$100/ha. Three quarters indicated that they would give up their holdings if offered US$300/ha.

In response to the low profitability of crop and livestock production, an exit from agriculture is taking place. One cow per hectare is generally thought to be within land-use capabilities in northwestern Ecuador. When the stocking rate is below one cow per five hectares, that land is so under-utilized as to be considered abandoned. In the survey area, a full 37 percent of all pastures, or 29 percent of all deforested land, falls below this threshold (Southgate *et al.*).

4.2 Plantation Forestry Income

In addition to being low in their own right, agricultural colonists' earnings compare poorly with the income that could be generated by tree plantations, provided timber prices are not too low. In this section, the option of raising laurel, which is the principal species used in tropical reforestation projects in northwestern Ecuador, is examined.

Below 900 m in altitude, laurel reaches a diameter of 45 cm, which is the minimum diameter that a veneer plant will accept, about 23 years after planting. At this time, there are 160 to 175 harvestable trees on a typical hectare. Yields average 276 m^3/ha and range from 222 to 332 m^3/ha, depending on management (Montenegro, 1987a). In the analysis that follows, the lower bound on yields, 222 m^3/ha, is used. Inputs required for tree planting and maintenance have been obtained from Montenegro (1987a).

Net returns to land planted to commercial trees, defined as the present value of standing timber at the end of the rotation less the present value of planting and maintenance costs incurred during the rotation, have been converted into annuity equivalents. As is indicated in Table 4.1, laurel's profitability depends greatly on real interest rates, wages, and stumpage prices.

With the low yields used in this study, annual net returns are generally negative if real interest rates reach 10 percent. This is certainly discouraging since credit tends to be very scarce in northwestern Ecuador.

Montenegro (1987a) reported that, during the middle 1980s, stumpage prices for laurel were US$12 to US$17/m^3 in areas that could be reached by trucks. Elsewhere, values were lower. A laurel plantation cannot be justified if only US$10 is received for a cubic meter of standing timber (Table 4.1). But if prices rise,

Table 4.1 Annual Net Returns per Hectare for a 23-Year Laurel Rotation

	Real Interest Rates		
	5.0 %	7.5 %	10.0 %
Daily Wage = US$3.00			
Price = US$10/$m^3$	US$14.81	-US$5.18	-US$21.47
Price = US$15/$m^3$	41.60	14.28	-7.52
Price = US$20/$m^3$	68.40	33.75	6.44
Daily Wage = US$3.50			
Price = $10/$m^3$	$9.58	-$11.04	-$27.94
Price = $15/$m^3$	36.37	8.42	-13.99
Price = $20/$m^3$	63.16	27.89	-0.03

Source: Southgate, Chase, and Hanrahan (1993)

either because policies are reformed or because of resource depletion, then the rotation begins to look financially attractive, even if workers are paid US$4.00/day (which is above current wages in most rural areas).

At a low real interest and at stumpage values that are comparable to or a little higher than those prevailing in the middle 1980s and which continue to hold to this day, reforestation with laurel is competitive with agricultural land clearing. As is indicated above, the average colonist is earning around US$25/ha and many would be willing to sell their holdings for less than $300/ha. Even at the low yields assumed in the preceding analysis, the opportunity cost of land planted to laurel is covered.

4.3 Agroforestry Income

Financial markets function very poorly in rural Ecuador, largely because of past attempts by the government to maintain negative real interest rates and also because of inflation (Ramos and Robison). As a result, rural credit is artificially scarce, which discourages the adoption of land uses, like reforestation, that yield returns only after the passage of many years.

Agroforestry (i.e., the inter-planting of agricultural and tree crops) is a response to this problem. In eastern Ecuador, for example, it is quite common for farmers to allow laurel and other commercial timber species to grow back in fields planted to coffee (Uquillas, Ramirez, and Seré). Research conducted under the auspices of the AID-funded Forestry Support Project for approximately six years beginning in 1984 has yielded several recommendations for the refinement of this practice (Peck).

Drawing on technical coefficients identified during the course of that research, Southgate *et al.* (1992) have evaluated the improved agroforestry system. Net present values have been estimated for the two daily wage rates (US$3.00 and US$3.50), three standing timber values (US$10, US$15, and US$20/$m^3$), and three interest rates (5.0, 7.5, and 10 percent) used in financial analyses of the laurel rotation (Section 4.2). In addition, financial analysis has been conducted using two alternative coffee prices (US$0.10 and US$0.15/kg), that are within the range of current farm-gate prices.

The results of financial analysis, expressed in annuity value equivalents, appear in Table 4.2. Comparing the annual profitability of agroforestry (Table 4.2) with that associated with reforestation with laurel (Table 4.1) reveals that the former land use holds a number of potential advantages. Net returns are not affected as much by fluctuations in the discount rate because the bulk of revenues (associated with coffee sales) are captured earlier in the rotation. In addition, agroforestry is less risky than establishing and managing a commercial forest because multiple outputs, rather than a single commodity, are produced.

By contrast, agroforestry's profitability is relatively more sensitive to wage levels since the system is more labor-intensive

Table 4.2 Annual Net Returns per Hectare for Agroforestry

	Real Interest Rates		
	r = 5.0 %	r = 7.5 %	r = 10.0 %
Daily Wage = US$3.00			
lau p = US$10/$m^3$ & cof p = US$0.10/kg	US$61.17	US$48.40	US$36.32
lau p = US$10/$m^3$ & cof p = US$0.15/kg	172.54	164.19	154.83
lau p = US$15/$m^3$ & cof p = US$0.10/kg	77.97	61.01	45.69
lau p = US$15/$m^3$ & cof p = US$0.15/kg	189.84	176.81	164.20
lau p = US$20/$m^3$ & cof p = US$0.10/kg	94.77	73.68	55.06
lau p = US$20/$m^3$ & cof p = US$0.15/kg	206.13	189.42	173.57
Daily Wage = US$3.50			
lau p = US$10/$m^3$ & cof p = US$0.10/kg	US$30.51	US$15.76	US$2.07
lau p = US$10/$m^3$ & cof p = US$0.15/kg	141.87	131.55	120.58
lau p = US$15/$m^3$ & cof p = US$0.10/kg	47.80	28.88	11.45
lau p = US$15/$m^3$ & cof p = US$0.15/kg	158.67	144.17	129.96
lau p = US$20/$m^3$ & cof p = US$0.10/kg	64.10	41.00	20.82
lau p = US$20/$m^3$ & cof p = US$0.15/kg	175.47	156.79	139.33

Source: Southgate *et al.* (1992)

than is establishment and management of a laurel plantation. Of even greater importance is the farm-gate value of agroforestry's principal product, which is coffee. Since the break down of the international quota system, in July of 1989, world prices for that commodity have fallen to low levels. In addition, farm-gate values have been depressed in many parts of Ecuador by disease problems. Disease also diminishes yields, which of course lowers profitability.

Regardless, it is safe to conclude that agroforestry, like laurel production, is more remunerative than extensive cattle production, which, to repeat, is the prevailing land use in deforested areas in northwestern Ecuador.

V. THE CAUSES OF INEFFICIENT FOREST LOSS

The evidence is very strong that the costs associated with converting tropical forests into pasture and cropland far outweigh its benefits. Humankind as a whole suffers the impacts of global warming and species extinction. Downstream populations are adversely affected by changes in stream-flow regimes brought about by the deforestation of upper watersheds. Furthermore, it seems that the gains to farmers and ranchers in recently cleared areas do not exceed by very much the income that could be generated by timber production.

All of this begs the question of why deforestation rates in Ecuador remain stubbornly high. "Market failure" is part of the problem; environmental costs are externalities as far as most agricultural colonists are concerned and, so, are not taken into account when a decision about whether or not to clear a patch of jungle is being made.

In addition, basic socioeconomic forces contribute substantially to the conversion of tropical forests into cropland and pasture in Ecuador. Income distribution has always been highly skewed and per capita GNP, which is not much more than US$1,000, is stagnating. In spite of recent declines in fertility, the country's population is still growing by around 2 percent a year. Migration to agricultural frontiers is a response to the grim realities underlying these national statistics.

Land use change must also be understood in the context of what is taking place in the agricultural economy. As Southgate and Whitaker (1994) stress, development and dissemination of improved technologies for crop and livestock production have been deficient in Ecuador for years. As a result, agricultural yields are low, even by the standards of neighboring countries. This means that encroachment on natural ecosystems is an inevitable response to increasing commodity demand, driven by urban population growth, increased exports, and rising incomes. In an econometric analysis, Southgate (1991) has demonstrated that a strong, inverse relationship between crop yield trends and frontier expansion holds throughout Latin America and the Caribbean. Among the twenty-three countries included in his sample, Ecuador has low levels of agricultural productivity and a high rate of frontier expansion.

Another set of factors contributing to inefficient agricultural land clearing has to do with the disincentives for timber production and forest conservation. Trade restrictions of various types diminish the value of standing timber, thereby encouraging people to clear it away. The low fees paid by those extracting timber from natural forests tend to cause people to under-value resources and also reduce financial support for forestry research, extension, and management. In addition, weak property rights in tree-covered land constitute an incentive for land clearing.

Each of these three reasons why forests tend to be mismanaged and destroyed is examined in the pages that follow.

5.1 Trade Policies

Among others, Repetto and Gillis (1988) have examined the impacts of bans on the export of unprocessed timber, exchange rate distortions, and direct export taxes and subsidies, most of which have been implemented to stimulate more domestic processing. In general, these measures foster deforestation by reducing the profitability of primary forestry activities and diminishing stumpage values.

In this section, trade policies influencing the forestry

sector are described and estimates of the impacts on the private and social profitability of forestry activities and the value of timber resources are presented. In general, Ecuadorian trade restrictions have tended to drive down domestic timber values and to augment the domestic value of plywood and other wood products. These arrangements, of course, have benefitted industrial users of timber, but have diminished the incentives for forestry management.

5.1.1 Description

Exchange Rate Distortions. Over the years, exporters of forest products (and other goods and services) have paid an implicit tax because of chronic over-valuation of the Ecuadorian sucre. During the four years that preceded the structural adjustment package introduced on 3 September 1992, exporters had to turn in all foreign exchange earnings to the Central Bank at the official intervention rate, which consistently over-stated the value of the national currency by around 10 percent. Differences between market and official exchange rates were eliminated on 25 November 1992, when the sucre was floated. Since then, exporters have been able to exchange all their foreign currency earnings on the free market.

Export and Import Taxes. The forestry sector is subject to a nominal (0.5 percent) ad valorem tax on all exports. The tax was created by Regulation No. 132 of 20 February 1989 to support the National Fund for Protection of the Ecuadorian Infant Population (FONNIN). Otherwise, shipments of forest products to foreign markets have been exempt from taxes since November 22, 1965, when Decree Number 2527-A was issued.

A 2 percent fee is assessed on the CIF value of all imports to raise money for the FONNIN. The duty on wood imports, which used to range up to 70 percent, was reduced from 20 to 7 percent in May of 1992. Tariffs on veneer imports range from 2 to 7 percent.

Export Bans and Quotas. The 1981 Forestry Law gave the Ministry of Agriculture and Livestock (MAG) and the Ministry of Industry, International Commerce and Fisheries (MICIP) the authority to regulate exports of forest products. Exports of tree species that were in danger of extinction were prohibited. Other species could be shipped out of the country, but only if the products met minimum processing requirements set by MAG. Those requirements were set forth in Decree No. 0694, of 4 January 1991. Timber that was only cut into pieces with a chainsaw was not eligible for export. Mine poles and electric power poles had to come from plantations or sites where natural regeneration was managed and also had to be dried and treated with chemicals. Also set forth were the characteristics that boards, veneer, plywood and other industrial products had to have before they could be exported. Sawmills, veneer plants, and other facilities had to satisfy minimal technological requirements before being awarded an operating and export license.

The Export Facilitation Law (No. 147), of 23 March 1992, removed all export licenses as well as all special requirements for exporting. However, the same legislation also states that the government can establish quotas or temporary bans in order to avoid domestic shortages of basic-needs articles. In addition, Article 10 of the Law reads: "All products are exportable except (a) those declared part of the national patrimony or of artistic, cultural, archeological or historic value and (b) indigenous flora and fauna in danger of extinction."

Seizing on the latter clause, government officials continue to regulate the forest product trade. In particular, a list of more than thirty species that cannot be exported that was presented by MAG on 19 December 1990 remains in effect. The list includes types of trees that are relatively abundant and consumed in great quantities domestically, like chanul (*Humiriastrum procerum*) and sande (*Brosimunn sp.*). INEFAN officials confirm that maintaining (cheap) raw material supplies for Ecuadorian industry was a major criterion guiding preparation of the list.

5.1.2 Measures of Trade Protection

Currency distortions, export taxes, and regulatory controls on exports all tend to drive down the domestic value of commodities shipped to foreign markets. At the same time, import tariffs and trade restrictions augment domestic prices for goods and services that could be supplied by producers in other countries. In this section, the protection (negative or positive) given to various traded or tradable forest products is documented.

Estimates of nominal as well as effective rates of protection (NRPs and ERPs) are presented. A NRP simply indicates the percentage gap between domestic and border prices (P_d and P_b, respectively) for the product in question:

$$NRP = 100\ (P_d - P_b)\ /\ P_b\ .$$

A large positive or negative NRP is a good first indicator of the presence of policy-induced distortions in markets for timber and wood products. A more robust indicator is the ERP, which takes into account distortions in the prices of tradable factors of production:

$$ERP = 100\ \{[(P_d - A\ W_d)\ /\ (P_b - A\ W_b)] - 1\}\ ,$$

where W_d and W_b are domestic and border prices, respectively, for the tradable input and A is the amount of tradable input contained in a unit of the final product (Scandizzo and Bruce; Tsakok). Border prices, and therefore NRPs and ERPs, are calculated using official exchange rates and also correcting for over-valued currencies.

In this study, NRPs are estimated for logs as well as plywood. The ERP for plywood, which is the most important product made from timber extracted from natural forests in the northwestern part of

the country, is also estimated in order to show that profits depend greatly on the artificially low prices that manufacturers pay for timber as well as the artificially high price they receive for their output in the protected domestic market.

Negative Nominal Protection for Logs. A major controversy over the costs suffered by timber producers erupted in 1989, when an Italian firm was prepared to buy eucalyptus for US$15/m^3 or more. The domestic price at that time was US$2 to US$4/m^3.

Some Ecuadorian environmentalists saw fit to oppose this trade. From the standpoint of forest conservation, this position is difficult to understand because eucalyptus coppices immediately after cutting. All that the environmentalists accomplished was to keep intact nominal protection amounting to -73 to -87 percent. Unwittingly or not, they served the interests of the Ecuadorian wood products industry, which is primarily interested in keeping raw materials cheap.

In 1988 and 1989, Ecuador exported balsa (*Myroxylon balsamum*), sande, and virola (*Dialyanthera sp.*) logs to plywood manufacturers in Mexico and the United States. As is indicated in Table 5.1, the negative NRPs for those commodities were, if anything, higher than the contemporary negative NRP for eucalyptus.

A comprehensive ban on log exports was in place from 1990 until early 1993. Although it is not possible to determine NRPs precisely during that period, it is virtually certain that there continued to be an 80 to 90 percent gap between border and domestic prices for unprocessed timber.

Positive Nominal Protection for Plywood. Although Ecuador has been a net exporter of plywood, it would be preferable to use CIF import prices to estimate NRPs since imports have been discouraged by tariffs (Subsection 5.1.1). However, it was not possible to do this because prices of imported plywood cannot be disaggregated from published data.

Since tariffs are the most important policy influencing domestic plywood prices, tariff rates can be used as a proxy for

Table 5.1 Nominal Protection of Logs

Year	Product	Bor. Price[1]	Bor. Price[2]	Dom. Price	NRP[1]	NRP[2]
1988	Balsa	US$340.7/m^3	US$296.4/m^3	US$17.9/m^3	-94.7%	-93.9%
	Sande	250.0	217.5	13.8	-94.5	-93.7
	Virola	251.6	218.9	13.8	-94.5	-93.7
1988	Virola	274.4	238.7	38.8	-85.9	-83.7

[1] FOB price corrected for currency distortions.
[2] FOB price not corrected for currency distortions.

Source: CORMADERA (1988) and (1992)

the NRP. Before 1991, for example, the rate for plywood (and therefore the proxy NRP) was 70 percent. That year, the tariff rate was cut to 30 percent. After an additional reduction, in 1992, the NRP fell to just 12 percent.

Another option for NRP estimation is to consider the country a net exporter and to use FOB values as border prices, with the understanding that those values represent upper bounds on true border prices. Using this approach, we have determined that the plywood industry has received substantial positive protection, with NRPs ranging from 5 to 18 percent when exchange rate distortions are ignored and from 13 to 31 percent when they were taken into account (Table 5.2). Since we are, if anything, exaggerating border prices, our NRP estimates are on the low side.

Highly Positive Effective Protection for Plywood. An ERP was estimated for plywood on the basis of cost structure and NRPs for logs and plywood in the late 1980s. The results, presented in the second column of Table 5.3, indicate that the plywood industry received an effective rate of protection of at least 1,222 percent. This means that the returns to capital, management, and other domestic factors (other than timber) used in manufacturing were inflated by 1,222 percent. To say the same thing, industry profits under a free trade regime would have been 92 percent lower.

5.2 Timber Charges

In many parts of the developing world, tree-covered land is, by and large, a government property. Typically, the fees paid by firms and individuals extracting timber from those areas fall well short of stumpage values. As a result, governments lack the means to provide research, extension, and other "public-good" support for the forestry sector. Furthermore, the imbalance between fees and

Table 5.2 Nominal Protection of Plywood

Year	Product	Bor. Price[1]	Bor. Price[2]	Dom. Price	NRP[1]	NRP[2]
1988	Common	US$385.8/m^3	US$347.2/m^3	US$413.0/m^3	7.1%	19.0%
	Lumber	342.2	308.0	413.0	20.7	34.1
	Sande	353.9	318.5	413.0	16.7	29.7
	Virola	324.7	292.2	413.0	27.2	41.3
1989	Lumber	346.0	321.8	389.6	12.6	21.1
	Sande	372.8	346.7	389.8	4.6	12.4
	Virola	368.8	343.0	358.9	-2.7	4.6

[1] FOB price corrected for currency distortions.
[2] FOB price not corrected for currency distortions.

Source: CORMADERA (1988) and (1992)

Table 5.3 Effective Protection of Plywood in 1988

Item	Private	Social
Factory-Gate Price	US$420.4/$m^3$	US$331.3/$m^3$
Tradable Input Costs	105.6	297.2
- Logs	63.6	258.2
- Other	42.0	39.0
Value Added	314.8	23.8
Effective Rate of Protection		1,222.0 percent

Note: The private factory-gate price is obtained by multiplying the social price by 130 percent, 30 percent being a representative NPR for plywood.

Sources: Tables 5.1, 5.2, and 5.4

resource values creates strong incentives to increase logging beyond efficient levels. Deforestation, then, is a visible manifestation of depletive "rent capture" (Repetto and Gillis; Grut, Gray, and Egli).

Without a doubt, the fees paid by loggers in Ecuador have been very low. Before the law creating INEFAN was passed, in 1992, there were two charges: a stumpage tax (*pie de monte*) amounting to S/. 750/m^3 and a reforestation deposit of S/. 600/m^3. At exchange rates prevailing at the time of the law, the combined fees were worth less than US$1.00/$m^3$.

Collection of the stumpage tax and reforestation deposit was always haphazard, at best. Loggers were supposed to get a cutting permit (*guía de movilización*) and then to make a deposit in the National Development Bank (BNF) equal to the expected harvest multiplied by S/. 1350. But control of logging was so lax that very few individuals bothered with permits.

Other problems arose as well. Pleading lack of funds, some firms were able to pay their fees in installments. In light of the chronic inflation of recent years, this meant that the real value of what the public sector receives was diminished. Also, the rules and procedures governing the return of reforestation deposits were so restrictive that they were really a tax, albeit a negligible one.

In February of 1993, INEFAN reformed its timber charges. Recognizing that it has no capacity to supervise tree planting or regeneration in logged-over areas, the agency abolished the reforestation deposit. At the same time, it raised the stumpage tax to S/. 4,000/m^3, which is nearly equal to $2.00 at current exchange rates. The fee for sawn timber removed from native forests was set at S/. 8,000/m^3, or a little less than $4.00.

Even this increased charge is small relative to timber values. In addition, the collection problems described above remain largely unresolved. Insofar as logging continues in uncolonized areas, which are putative state property, then the adverse impacts of low government fees on resource use and management described by Repetto and Gillis (1988) remain a concern.

5.3 Forest Tenure

Without a doubt, raising forest fees could help to finance forestry research and extension, which receive meager support in Ecuador. In addition, low fees cause loggers to under-value timber resources. As a cause of resource waste mismanagement, though, tenurial arrangements are a much more influential policy.

5.3.1 The Legal Context of Spontaneous Colonization

Most of the private holdings in tropical Ecuador were originally created as a result of colonization of "idle lands" (*tierras baldias*). Supervision of this process, which dates back to the colonial era, became the responsibility of the Ecuadorian Institute for Agrarian Reform and Colonization (IERAC) in 1964, when the first land reform law was passed.

Consistent with common practice among agrarian reform agencies throughout the Hemisphere, IERAC has required that colonized parcels be "occupied" before being "adjudicated" (i.e., recognized by the institution). For many years, the vague standard of occupied was taken by the parties involved (settlers, indigenous forest dwellers, as well as IERAC) to be equivalent to agricultural land clearing.

In recent years, top officials of the institution have protested that deforestation is no longer a prerequisite for adjudication. However, 42 percent of the 179 colonists that Southgate *et al.* (1992) surveyed in northwestern Ecuador in 1991 expressed the opinion that it is wise to reenforce a claim on land by exercising agricultural use rights.

The only direct fiscal check on land clearing is an adjudication fee. Traditionally low, the minimum fee (paid by most colonists) was raised in 1989 from S/. 1,000/ha (equivalent at the time to US$2.00/ha) to S/. 10,000/ha. At current exchange rates, the latter is equal to US$5.40/ha.

Colonists are not the only people who respond to legal incentives for land clearing. Macdonald (1981) reports that the indigenous community of Pasu Urcu, located in the Ecuadorian Amazon, abandoned the environmentally sound practice of periodic fallowing during the 1970s after IERAC agents informed members of the community that fallow lands could be claimed by agricultural colonists, who were 50 km away at the time.

5.3.2 The Problem of Insecure and Circumscribed Tenure

The deforestation requirement, insofar as it continues to exist either formally or informally, is not the only form of property rights attenuation along Ecuador's agricultural frontiers. It usually takes IERAC many years to adjudicate a colonized holding, during which time the settler-applicant is bound to feel that his property rights are tenuous. In a statistical analysis, Southgate, Sierra, and Brown (1991) have found that many colonists in the *Oriente* have responded to insecurity by asserting claims in the traditional manner: by converting forests into crop land and pasture as soon as they can. Pichón and Bilsborrow (1992), who have conducted a survey of agricultural colonists in northeastern Ecuador, have arrived at similar conclusions regarding the linkage between land clearing and tenure insecurity.

Economists generally agree that secure property rights for resource users is, like equivalence between prices and scarcity values, a prerequisite for the efficient use and management of natural resources. Since this prerequisite is not met in most parts of northwestern and eastern Ecuador, individuals doubt that they can capture the benefits of conservation. Furthermore, property rights attenuation reduces access to formal credit, which makes it hard to finance the adoption of conservation measures while at the same time diminishing the present value of those measures' long-term benefits.

5.3.3 Forest Concessions

The environmental damage caused by the deforestation requirement and also by insecurity tenure for colonists is widely recognized. Mechanisms have existed for giving firms and individuals property rights in tree-covered land. Unfortunately, those mechanisms are largely ineffective.

The 1958 Forestry Law allowed MAG to grant concessions for forest management and exploitation. Up to 1981, when a new law was passed, thirteen concessions were created around the country. Concession-holders had to pay a stumpage fee on the harvest as well as a charge (*derecho superficiario*) related to area. They also had to replant after logging.

The experience with this regime was disappointing. Some firms' compliance with replanting requirements was spotty. Others ignored the requirements completely. There remains some debate about causes. Firms engaged in timber extraction at the time argue that logging sites were invaded quickly by colonists (often with IERAC support), and so reforestation was impossible. By contrast, critics charge that the industry was simply inclined "to cut and run."

Regardless, the 1981 Forestry Law abolished all concessions. In principle, each of the thirteen sites reverted to the state. But since none of them had ever been marked off as Forest Patrimony, formerly administered by MAG and now by INEFAN, local officials of IERAC often regarded the sites as *tierras baldias*.

Many places were colonized in short order.

The 1981 Law created a new way to allocate forests for timber production. For each of the parcels in question, a resource inventory would be carried out as a prelude to an auction of harvesting rights (*licencia de aprovechamiento*). Winning firms would have to pay forest fees and also to reforest logged-over areas. This scheme was never implemented, apparently because few firms found it worth their while to participate in any bidding process. Apparently, most loggers have preferred to deal with colonists, which involves no reforestation obligation and negligible payments for standing timber.

INEFAN is still preparing the regulations needed to implement the 1992 Forestry Law. A current proposal is to enable individuals, firms, or cooperatives to acquire a forested parcel once a management plan has been submitted and approved. An applicant will have to show either that the parcel in question is unoccupied or that negotiations to relocate colonists have been concluded. [Some small holders with limited resources will be able to stay where they are if they switch to agroforestry or silvopastoril systems.] In addition, new owners will have to pay mapping charges (*derecho de linderación*) as well as the value of the land. Except for the prerogative reserved by the state to reclaim land where forest management plans are not being followed, this new form of tenure is tantamount to full private ownership.

The proposed scheme could be implemented in the 1.60 million ha in Napo and Sucumbios and 0.33 million ha in Esmeraldas that were identified and delimited as Forest Patrimony more than five years ago (MAG). Serious complications will arise because some of those lands were settled during the late 1980s and early 1990s.

Another problem has to do with the several million hectares of tree-covered land that has not been formally designated as Forest Patrimony. Much of that area is still open to agricultural colonization, under the policy regime criticized in this subsection of the report.

VI. HOW MUCH COULD THE ECUADORIAN WOOD PRODUCTS INDUSTRY PAY FOR UNPROCESSED TIMBER?

As is stressed in the preceding section, various policies discourage sustainable forestry development in Ecuador. Forest fees are low and tenurial arrangements continue to favor agricultural land use over forestry. In addition, log prices have been depressed by export restrictions and other distortionary trade policies.

To gain an idea of potential increases in the price of standing timber, economic analysis of roundwood production and industrial timber processing was undertaken. Data on the prices of selected outputs and also on production costs were collected from selected firms in late 1992 and early 1993. Subsequently, those data were analyzed to determine the residual value of stumpage:

price per unit of output (m^3 in most cases)

less per-unit expenditures on other inputs

less per-unit overhead and management costs and "normal profits" (equal to 25 % of per-unit expenditures on other inputs)

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residual value for logs

times utilized portion of stumpage

---

residual value of stumpage.

6.1 Residual Stumpage Values in Roundwood Production

Estimates of residual stumpage values for two modes of roundwood production -- *motoserristas*' plank (*tablas* or *tablones*) output and mechanized logging (Section 2.1) -- are presented in Table 6.1.

The estimate reported in the first column is probably on the low side for two reasons. First, it is based on reports from industry sources that it costs US$51 to fell, saw, and deliver a m^3 of timber to a concentration point. This figure is probably a fair reflection of the expense of obtaining raw materials from the *Oriente*, where operating conditions are difficult. By contrast, a firm engaged in mechanized harvesting in northwestern Ecuador reports that its costs up to the concentration point range from US$41 to US$47/m^3, including fees paid to the government and the local land owner.

Second, the estimate of residual stumpage value for a mechanized harvesting operation is low because $55/$m^3$ is a representative administered price reported by integrated logging and wood products manufacturing companies. Since that price is lower than true market values, those companies are choosing to show their profits in their factories rather than in logging operations. Of course, market prices would rise if timber trade is completely liberalized, thereby allowing foreigners to compete for Ecuadorian timber.

Having lower costs of production than mechanized loggers, *motoserristas* can pay more for standing timber. This is particularly true for species of higher value used in the furniture trade, which command a premium over the semi-dense species used to make plywood.

There are opportunities to increase residual values of stumpage used to make planks. In particular, output could be dimensioned, graded, and sorted to fit the preferences of furniture makers and other industrial users better. Also, raising stumpage recovery from, say, 25 to 35 percent would increase the residual value of logs by US$1.40/$m^3$.

Table 6.1 Residual Stumpage Values in Roundwood Production

	Mechanized Logging	Chainsawn Planks
Delivered Price at Concentration Point*	US$55/m^3	US$40/m^3
Transport to Point	- 11	
Loading and Handling	- 1	
Skidding or Moving to Road	- 8	- 3
Falling, Bucking, and Chainsawing	- 10	- 15
Tree Marking and Permits	- 2	
Road Building and Maintenance	- 11	
Equipment Depreciation and Maintenance	- 6	- 3
Inventory Costs	- 2	
Margin for Stumpage and Profit	US$4/m^3	US$19/m^3
Logging Profit (25% of Costs)	13	5
Residual Value for Logs	- US$9/m^3	US$14/m^3
Recovered Portion of Stumpage	80%	25%
Residual Value for Logs	- US$7.2/m^3	US$3.5/m^3

* Where logs are loaded on truck or delivered to rural plant or reloading yard.

Source: Industry interviews

6.2 Residual Stumpage Values in Wood Products Manufacturing

To obtain price and cost data for industrial wood processing in Ecuador, ten firms were interviewed: three manufacturers of hardwood plywood, a rotary hardwood veneer plant, a factory producing sliced hardwood veneer, three producers of solid doors, and two plants that make blanks and moldings.

To maintain confidentiality, results are not reported for the rotary and sliced veneer factories. In addition, the cost figures reported in Table 6.2 do not reflect simple averages for the interviewed firms since some companies have fully depreciated manufacturing capacity. Also, some of the figures reflect internal pricing within integrated firms more than true opportunity costs.

Molding and blank production is marginal in Ecuador. Planks purchased from *motoserristas* are the main input. Integration with more efficient mechanized logging operations could reduce raw material expenses. In addition, potential synergies with plywood plants exist. For example, good log grading at a complex where

Table 6.2 Estimated Profitability of Wood Products Manufacturing

	Hardwood Plywood	Solid Doors	Moldings and Blanks
Ex-Factory Price	US$359/$m^3$	US$64/door	US$250/$m^3$
Raw Material Cost*	106	16	130
Other Variable Costs	41	17	38
Fixed Costs	39	8	13
Current Profit	US$173/$m^3$	US$23/door	US$69/$m^3$

* The rates at which timber is converted into final product are 52 percent for hardwood plywood, five doors per m^3 of timber, and 50 percent for molding and blanks.

Source: Industry interviews

molding and blanks as well as plywood are produced could reduce input costs.

Solid door production in Ecuador is not very efficient by international standards, in part because custom production runs for local clients make up a large share of the business. Supplying foreign buyers with a standard product would lower costs. Also, it might be possible to obtain higher prices outside the country. With current prices and manufacturing technology, firms that make doors could pay 64 percent more for wood and still earn profits equal to 25 percent of raw material, variable, and fixed costs.

As recent investment indicates, hardwood plywood production can be profitable in Ecuador, particularly since trade policies protect domestic manufacturers from international competition (Section 5.1). If protection were continued, they could pay 95 percent more for wood and still collect the 25 percent profit margin. Obviously, trade liberalization would diminish output prices and drive up raw material values.

VII. AN INTEGRATED STRATEGY FOR TROPICAL FOREST CONSERVATION

By Latin American standards, Ecuadorians are converting natural ecosystems into farms and ranches very rapidly. Between 1982 and 1987, the area dedicated to crop and livestock production increased by 2.0 percent a year. The only country in the Western Hemisphere experiencing higher growth was Surinam, where the initial base of cropland and pasture was very small (Southgate, 1991).

Ecuador has reached the point where geographic expansion of the agricultural economy is no longer a viable response to mounting

commodity demands. As of the late 1980s, farmland already amounted to 93 percent of the area that the National Program for Agrarian Regionalization (PRONAREG) has determined is suitable for farming or ranching (Southgate and Whitaker, pp. 19-24). Due to adverse natural conditions, only a small portion of the *Oriente* is suitable for agriculture; that portion has already been occupied by colonists (MAG).

Recent agricultural land clearing has been a resounding economic failure for the individuals most directly involved. Southgate *et al.* (1992) have found that incomes among colonists in northwestern Ecuador are meager and that some of them would give up their holdings if offered as little as US$100/ha.

The income generated by crop and livestock production in recently deforested areas also compares very poorly with the costs of agricultural land clearing. Earnings generated by commercial forestry, the collection of non-timber products, or both are foregone. Almost certainly, the present value of those earnings amounts to several hundred dollars a hectare, which is greater than the present value of agricultural income (as indicated by land prices). To the marketable portion of the costs of deforestation must be added a non-market share, which has to do with environmental impacts. No monetary value has yet been placed on diminished biodiversity. However, global warming damage associated with tropical deforestation could amount to several hundred dollars a hectare.

Inefficient deforestation continues to occur largely because agricultural colonists and other agents of deforestation do not internalize the costs of that process. Clearly, they regard adverse environmental impacts as an externality. But in addition, they fail to receive the full social value of lost timber production because trade policies diminish the incentives for timber production and also because of frontier property arrangements that reward those who clear land for agriculture.

To arrest deforestation, then, a thorough reform of public policy is required. Five actions are required.

1. <u>Allow free trade in timber and wood products</u>. Remaining restrictions on exports and imports should be done away with and the process of driving down tariffs should not be reversed. For example, the list of species that can be used by domestic industry but cannot be exported in an unprocessed form needs re-thinking. If a species is truly threatened with extinction, it should not be used by anybody. If not, it should be traded freely. As exports are liberalized, stumpage values should rise.

   Unfortunately, the oligopolistic structure of Ecuadorian timber markets seems to be preventing producers from benefiting from trade liberalization. The reasons why the legal system does not offer relief for those victimized by non-competitive pricing should be investigated.

2. Strengthen forest tenure. Legal recognition of the *de facto* ownership rights of forest dwellers should be a first priority. Dislodging individuals and communities that are living in what the state considers to be Forest Patrimony would be socially unjust since many communities and individuals have been on the scene for years or even generations. It could also lead to environmental depletion as "trespassers" mine timber and other resources before being evicted. Furthermore, attempting to depopulate the Forest Patrimony might prove to be futile if, as seems likely, the people affected are able to defend their interest successfully through legal or political means.

   Under the circumstances, the best alternative is speedy adjudication of all forest dwellers' property rights, which involves resolution of conflicting land claims in many cases. Full property rights (*inscrituras*) should only be awarded after INEFAN has approved a forest management plan for the land involved.

   Any Forest Patrimony lands that are both unsettled and outside of parks and reserves should be sold to private parties through competitive auctions.

3. Invest in the forestry research and extension. As stumpage values rise and as property rights in tree-covered land are strengthened, firms, individuals, and communities will grow more interested in timber production. Currently, the scientific base for sustainable forest management is very weak. To date, plantation research has been carried out principally by one or two private firms and there is little or no forestry extension in the country.

   In order for improved incentives to lead to sustainable production (and not just to renewable resource mining), funding for research and extension must increase and new mechanisms for carrying out those activities (e.g., through competitive grants schemes, contracts for technology transfer, etc.) must be developed. Extension should be targeted largely on small holders.

4. Improve technology for wood products industries. Our analysis suggests that the profitability of plywood manufacturing has depended largely on trade policies that depress raw material prices and keep out cheap imports. Further research is needed to identify precisely where Ecuador's comparative advantages in the production of wood products lie. A strategy for improving technology so as to exploit those strengths must then be developed and implemented.

5. Reduce the shortage of long-term credit. Along with other parts of the rural economy, the forestry sector is hampered by

credit shortages. In particular, there is virtually no long-term credit in the countryside, which is a problem for activities, like timber production, that yield output only after many years have passed.

The most effective response is to reduce inflation and also the transactions costs involved in financial intermediation (e.g., those associated with poorly defined property rights). Targeted credit for forestry should be regarded as a "second-best" approach.

The five-point reform program we propose is a challenge insofar as special interests may object to some proposals. For example, companies that have benefitted from trade protection will be reluctant to see log exports totally liberalized. In addition, reform is a challenge because piecemeal changes in policy are likely to be ineffective. The development and dissemination of improved tree species and forest management techniques, for example, will have modest results if the tenurial incentives to clear tree-covered land remain in place. Conversely, reform of tenurial incentives and making cheap credit available for reforestation will do little good if timber markets remain distorted. Integrated policy change is essential.

REFERENCES

Bromley, R. 1981. "The Colonization of Humid Tropical Areas in Ecuador" Singapore Journal of Tropical Geography 2:1, pp. 15-26.

Corporación de Desarrollo para el Sector Forestal y Maderero del Ecuador (CORMADERA). 1988. "Boletín Informativo de Precios de Productos Madereros, Número 3," Quito.

Corporación de Desarrollo para el Sector Forestal y Maderero del Ecuador (CORMADERA). 1992. "Estadísticas del Sector Forestal y Maderero del Ecuador, 1991," Quito.

Grut, M., J. Gray, and N. Egli. 1991. "Forest Pricing and Concession Policies: Managing the High Forests of West and Central Africa" (Technical Paper No. 143), International Bank for Reconstruction and Development, Washington.

Japanese International Cooperation Agency (JICA) and Ministerio de Agricultura y Ganadería (MAG). 1988. Estudio Forestal de la Región Noreste de la República del Ecuador. Quito.

Macdonald, T. 1981. "Indigenous Responses to an Expanding Frontier: Jungle Quichua Economic Conversion to Cattle Ranching" in N. Whitten (ed.) Cultural Transformations and Ethnicity in Modern Ecuador. Urbana: University of Illinois Press.

Ministerio de Agricultura y Ganadería (MAG). 1987. Informe Final de la Limitación del Patrimonio Forestal del Estado. Quito.

Montenegro, F. 1987a. "Plantaciones Forestales Productivas en los Trópicos del Ecuador con Laurel" in I. McCormick (ed.) Análisis Económico de Inversiones en Plantaciones Forestales en Ecuador. Quito: Asociación de Industrias Madereras.

Montenegro, F. 1987b. "Plantaciones Forestales Productivas en los Trópicos del Ecuador con Pachaco" in I. McCormick (ed.) Análisis Económico de Inversiones en Plantaciones Forestales en Ecuador. Quito: Asociación de Industrias Madereras.

Myers, N. 1988. "Threatened Biotas: Hotspots in Tropical Forests" Environmentalist 8:3, pp. 1-20.

Nordhaus, W. 1992. "An Optimal Transition Path for Controlling Greenhouse Gases" Science 225, 1315-1319.

Peck, R. 1990. "Promoting Agroforestry Practices among Small Producers: The Case of the Coca Agroforestry Project in Amazonian Ecuador" in A. Anderson (ed.) Alternatives to Deforestation: Steps toward Sustainable Use of the Amazon Rain Forest. New York: Columbia University Press.

Pichón, F. and R. Bilsborrow. 1992. "Land Use Systems, Deforestation, and Associated Demographic Factors in the Humid Tropics: Farm-Level Evidence from Ecuador," International Union for the Scientific Study of Population Seminar on Population and Deforestation in the Humid Tropics, Campinas.

Ramos, H. and L. Robison. 1990. "Credit and Credit Policies" in M. Whitaker and D. Colyer (eds.) Agriculture and Economic Survival: The Role of Agriculture in Ecuador's Economic Development. Boulder: Westview Press.

Repetto R. and M. Gillis (eds.). 1988. Public Policies and the Misuse of Forest Resources. Cambridge: Cambridge University Press.

Scandizzo, P. and C. Bruce. 1980. "Methodologies for Measuring Agricultural Price Intervention Effects" (Staff Working No. 494), International Bank for Reconstruction and Development, Washington.

Schneider, R., J. McKenna, C. Dejou, J. Butler, and R. Barrows. 1991. "Brazil: An Analysis of Environmental Problems in the Amazon" (Report to Latin America and Caribbean Region), International Bank for Reconstruction and Development, Washington.

Southgate, D. 1991. "Tropical Deforestation and Agricultural Development in Latin America" (Discussion Paper No. 91-01), London Environmental Economics Centre.

Southgate, D. with M. Hanrahan, M. Bonifaz, M. Camacho, M. Carey, and L. Chase. 1992. "The Economics of Agricultural Land Clearing in Northwestern Ecuador," IDEA, Quito.

Southgate, D. and R. Macke. 1989. "The Downstream Benefits of Soil Conservation in Third World Hydroelectric Watersheds," Land Economics 65:1, 38-48.

Southgate, D., R. Sierra, and L. Brown. 1991. "A Statistical Analysis of the Causes of Deforestation in Eastern Ecuador" World Development 19:9, pp. 1145-1151.

Southgate, D. and M. Whitaker. 1994. Economic Progress and the Environment in Latin America: One Country's Policy Crisis. New York: Oxford University Press.

Tsakok, I. 1990. Agricultural Price Policy: A Practitioner's Guide to Partial Equilibrium Analysis. Ithaca: Cornell University Press.

Uquillas, J., A. Ramirez, and C. Seré. 1991. "Are Modern Agroforestry Practices Economically Viable? A Case Study in the Ecuadorian Amazon," Workshop on the Economics of Agroforestry Systems, the Nitrogen Tree Fixing Association, Honolulu.

Subsecretaría Forestal y de Recursos Naturales (SUFOREN). 1991. Diagnóstico: Plan de Acción Forestal, 1991-1995. Quito: MAG.

World Resources Institute (WRI). 1990. World Resources 1990-91. Washington.