REVERSING TROPICAL Deforestation:
SOME LESSONS FROM NORTHWESTERN ECUADOR

Douglas Southgate, Lisa Chase, and Michael Hanrahan¹

Abstract.—The option of establishing commercial timber plantations on land previously cleared for crop and livestock production is explored in this paper. The geographic focus of the study is northwestern Ecuador, which has experienced rapid agricultural colonization in recent years. We point out that land use conversion has been an economic failure; colonists are poverty-stricken and agricultural productivity is extremely low. Reforestation is demonstrated to be an economically viable alternative to depletive agriculture. Also, tree plantations are shown to be a cheaper source of timber than primary forests, where much logging continues to take place. The paper closes with a discussion of policy reforms needed to encourage reforestation.

INTRODUCTION

The conversion of South America’s tropical forests into pasture and cropland arouses worldwide concern. Habitat loss results in species extinction and the removal of tree cover causes atmospheric concentrations of CO₂ to increase, which in turn accelerates global warming. It is estimated that, when fire is used to clear land for crop or livestock production in the Amazon Basin, 91 to 223 m³/ha of CO₂ are emitted. Approximately 36,000 km² are cleared each year in the region and 326 to 800 million mt are released into the atmosphere (CDEA).

Unfortunately, the response to deforestation and its environmental impacts has been poorly balanced. In the Amazon Basin, for example, much attention is being devoted to parks, indigenous territories, and extractive reserves, which all together occupy less than a quarter of the region. By contrast, research and extension in support of sustainable agriculture have been modest. Perhaps the most glaring omission is that abandoned lands, which amount to 60 percent of Amazonia’s deforested area (Brack-Egg), are almost totally neglected.

The situation in northwestern Ecuador (Figure 1) is representative of what is taking place throughout the American tropics. Agricultural expansion is threatening the few primary forests that remain intact. Once covering 27,000 km², rainforests between the Andes and the Pacific Ocean have been reduced to 2,500 km² at most (Myers, 1988). Dodson and Gentry (1991) report that natural ecosystems can only be found in a few, inaccessible locations.

For the most part, trees cover has been destroyed to make way for agriculture. Deforestation in Western Ecuador accelerated rapidly in the 1960s, when a new highway passed through Santo Domingo to link Quito, the national capital, with Guayaquil, the country’s largest city and major port (Bromley). Still more colonists flocked to the region after the road connecting Santo Domingo with Esmeraldas, on the northwestern coast, was improved. The Ecuadorian Institute for Agrarian Reform and Colonization (IERAC) has legalized more land holdings flanking this highway than in any other frontier region (Barsky et al.).

This pattern of resource exploitation, which is typical of Latin America’s agricultural frontiers, cannot go on indefinitely. As Ecuador’s timber industry is fully aware, forests in the northwestern part of the country (which are a major source of logs) will be gone in twenty years or so if current rates of clearing continue. In addition, crop and livestock production has proven to be an economic disappointment. Paralleling the widespread underutilization of deforested land throughout the Western Hemisphere, a good deal of northwestern Ecuador’s agricultural land has been abandoned.

In this paper, an alternative to logging followed by agricultural settlement is examined. Specifically, establishing tree plantations on deforested land is evaluated. In addition to increasing timber supplies and rural income and employment, reforestation helps to mitigate the greenhouse effect because young trees consume significant quantities of carbon dioxide.

¹Associate Professor of Agricultural Economics at Ohio State University, former Research Assistant at Instituto de Estrategias Agropecuarias (Quito, Ecuador), and Senior Resource Economist at Development Alternatives Inc. (Bethesda, Maryland), respectively.
We begin by describing agricultural colonization, emphasizing that the process is leading to a degraded landscape and an impoverished population. Farm income, estimated with data collected in a survey of small holders, constitutes one point of reference for an analysis of the financial returns to tree plantations. Estimates of the expense of harvesting wood from those plantations are also compared with the cost of extracting timber from primary forests.

Our analysis shows that reforestation can be remunerative, both for the owners of deforested land and for the timber industry. The policy reforms needed to promote this option are identified at the end of the paper.

AGRICULTURAL COLONIZATION IN NORTHEASTERN ECUADOR

In a recent analysis of land use change in the Brazilian Amazon, Schneider et al. (1990) argue that agents of deforestation are engaged in the extraction of nutrients, loosely defined, from natural ecosystems. "Mining" often begins with logging. Burning the remaining forest reduces pest incidence and converts biomass to ash. This enhances the availability of soil minerals (other than the nitrogen lost during combustion) needed for crop production. Typically, cattle ranching represents the last phase of nutrient mining.

On most of the holdings carved out of tropical moist forests in northeastern Ecuador, the last stage of ecosystem depletion has been reached. In a 1991 survey of 179 agriculturalists who have settled in the area (Southgate et al.), we found that slightly more than a third of the typical parcel still retains tree cover. Around 20 percent of all cleared land is planted to crops, mainly coffee, plantains, cacao, and bananas. The remaining four fifths, equivalent to half the land owned or occupied by the survey sample, is in pasture.

Incomes among agricultural colonists are very low. More than 33 percent of the surveyed group reported having negative cash flows for their respective farms. Only 10 percent of the sample took in more than $100/ha (at prevailing exchange rates) during the preceding twelve months. Most farmland generates less than $25/ha.

A sure sign that the clearing of tropical moist forests for agriculture has been a failure in northeastern Ecuador is the low current value of real estate in the region. Of the interviewed farmers who were willing to name a price, a third would sell out and move if offered $100/ha. Three quarters indicated that they would give up their holdings if offered $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.

Land abandonment is even more widespread in other parts of the Western Hemisphere. For example, Brack-Egg (1992) contends that, of all the deforested area in the Amazon Basin, 60 percent is no longer being used for crop or livestock production.

COMMERCIAL TREE PLANTATIONS

Throughout Latin America, the national and international institutions involved, directly or indirectly, with agricultural land clearing are aware that deforestation has not worked for the vast majority of colonists. As a result, alternative modes of resource development are receiving substantial attention.

In northwestern Ecuador, establishing plantations of pachaco (Schizolobium parahyba) and laurel (Cordia alliodora) on colonized parcels appears to hold considerable promise (McCormick). The two species are used primarily in the manufacture of veneer and plywood. They also share the advantage of reaching a harvestable size fairly quickly.

Below 600 m in altitude, pachaco reaches a diameter of 45 cm, which industrial buyers favor, about 18 years after planting. At this time, there are 110 harvestable trees on a typical hectare. Yields average 350 m³/ha and range from 280 to 420 m³/ha, depending on management. Nearly 90 percent of the harvest is suitable for the production of veneer. The remainder is used for posts and other miscellaneous purposes (Montenegro, 1987b).

Laurel has three advantages over pachaco. First, whereas the latter species should not be planted at elevations exceeding 600 m above sea level, the former does well up to 900 m. This is important in the Western Ecuador hot spot, where agricultural frontiers have already advanced up into the Andean foothills. A second advantage is that maintaining a laurel plantation is less labor-intensive. Third, the species is more versatile, used in furniture making in addition to veneer and plywood manufacture.

Balanced against laurel’s three merits are two important disadvantages. First, it takes 23 years to grow to a diameter of 45 cm, whereas pachaco reaches that size in just 18 years. Second, there is a smaller harvest at the end of the rotation. Although 160 to 175 trees are felled on
each hectare, on average only 276 m³/ha of wood are extracted, yields ranging from 222 to 332 m³/ha (Montenegro, 1987a).

FINANCIAL ANALYSIS OF REFORESTATION

We have evaluated pachaco and laurel rotations from two perspectives, that of the owner of deforested land and that of the timber industry. An owner, of course, is interested in reforestation if higher net returns to land can be captured. Wood products firms will establish tree plantations if they promise to yield cheaper timber than the current source, which is often a primary forest.

Net returns per hectare planted to laurel and pachaco as well as the costs of producing timber on plantations have been determined for various real interest rates and local wages. Net returns are estimated for a range of stumpage values while production cost estimates reflect land price assumptions. The results of our analysis rest on conservative yield projections (280 m³/ha after 18 years in the case of pachaco plantations and 222 m³/ha after 23 years for laurel stands). Inputs required for tree planting and maintenance have been obtained from Montenegro (1987a and 1987b).

Reforestation from a Land Owner’s Perspective

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. The latter, which are reported in Tables 1 and 2, can be compared with the annual net returns to agriculture in northwestern Ecuador, which average $25/ha, in order to determine whether the opportunity costs of land used in tree plantations can be covered.

As is indicated in Table 1, pachaco’s profitability is very sensitive to real interest rates. When wages are low, an increase in the interest rate from 5.0 to 7.5 percent causes net returns to decline by 40 percent or more. As labor costs rise, the effect of real interest rates on profitability grows even stronger.

Likewise, the net returns to pachaco production depend greatly on stumpage prices. At a price of $10/m³, for example, land inputs are fully compensated only if real interest rates are below 7.5 percent. Currently, however, stumpage prices in those places with all-weather road access can reach $20/m³. At that price, a pachaco plantation is profitable for a land owner even at the upper range of interest rates and wages considered in this study.

As with pachaco, a laurel plantation’s profitability varies with market conditions (Table 2). More importantly though, the disadvantages of a later and smaller harvest are crucial. For any given combination of prices, real interest rates, and wages, the net returns to laurel production are considerably lower than those for pachaco. Indeed, the opportunity costs of land are covered only if yields are substantial, stumpage prices are relatively high, and wages and real interest rates are relatively low. Although laurel is potentially more valuable than pachaco (see above), stumpage prices for the two species are fairly close. During the middle 1980s, for example, values for laurel were $12 to $17/m³ (Montenegro, 1987a), as opposed to $12 to $15/m³ (Montenegro, 1987b).

Financial analysis reveals that raising pachaco is profitable for a land owner, provided that stumpage prices stay above the lower range of reference values used in this study. By contrast, laurel production is profitable only if real interest rates are below 7.5 percent and if stumpage prices are high. Notably, industry sources expect those prices to increase, perhaps reaching $40/m³ a few years from now (Durini).

Reforestation from Industry’s Perspective

For tree plantations to be established, they must not only be profitable for land owners. They must also be an economical source of raw materials for the forest products industry.

One test of industry interest involves a comparison of timber production costs and recent stumpage values. The latter comprise a conservative benchmark since forest depletion can be expected to push up the price of standing timber over time. As has already been mentioned, precisely this trend is being anticipated in Ecuador.

Production costs have been estimated for the same yield assumptions, interest rates, and wages used in the evaluation of net returns to land and also for a land price of $300/ha. The latter figure is more than the minimal value at which most colonists would sell their holdings (see above). The cost estimates reported in Table 3 were obtained by capitalizing all spending on land, planting, and maintenance forward to the end of the rotation and then dividing the investment by timber yield.

Even if the price paid for standing pachaco does not rise, establishing plantations of that species would be profitable. The only two cost estimates above $15/m³ are for the case of high real interest rates. Even a modest increase in timber values would be enough to cover the highest costs reported in Table 3. At prices below $17/m³, which is the maximum value reported in the middle 1980s (see above), reforestation with laurel appears to be worthwhile only
when interest rates are low. Stumpage values will need to double for laurel plantations to break even at high interest
rates.

Another benchmark for evaluating tree plantations is the expense of harvesting logs in primary forests and delivering
them to processing facilities (e.g., veneer plants). As indicated in Table 4, that expense is considerable. Timber
must be skidded over rough terrain to the end of an access road, which the logging firm, itself, must build.
Significant overhead and management inputs are involved in all this. By contrast, government stumpage fees are
negligible, amounting to roughly $0.75/m³ at current exchange rates. Given the high cost of extracting logs
from primary forests, the stumpage prices paid to locals (i.e., settlers who tend to establish themselves before
logging enterprises arrive on the scene) are similarly low. [Settlers also receive compensation from loggers in the
form of roads and partial land clearing.]

As is also reported in Table 4, it is less expensive to obtain raw materials from tree plantations, where less skidding
needs to be done and where roads are already in place. Except for the case where laurel production is financed
with loans carrying a 10 percent real interest rate, plantations can out-compete primary forests as a source of
timber.

As time goes on, plantation investments will become even more attractive. Once the timber stocks of northwestern
Ecuador are fully depleted, the country’s forest products industry will have to turn to the Amazon Basin, which is
more remote. It costs approximately $20 to take a m³ of timber from that region to processing facilities clustered
west of the Andes. Adding that expense to felling, skidding, and other costs listed in the first column of Table
4, one arrives at a figure of $55/m³. Using this cost, which does not include stumpage prices that might be
collected by resource owners, one can see that even laurel production will be profitable under a wide range of market
conditions.

Summary

This section’s analysis suggests that establishing tree plantations on deforested land can be a financially attractive
alternative to current patterns of renewable resource development in northwestern Ecuador. Even under
conservative assumptions regarding harvests, producing timber can be more profitable than extensive cattle
ranching, which is the predominant use of deforested land. At the same time, tree plantations are an economical
investment for the wood products industry, which currently depends on raw materials extracted from primary forests.

Actual economic behavior in the study area validates our findings. For example, Ecuador’s major forest products
firm has bought several thousand hectares in the Northwest, much of it old colonized land, for $300 to $500/ha. It is
planting pachaco, laurel, and other species that, in a few years, will fully supply its veneer plant.

POLICY IMPEDIMENTS TO FORESTRY DEVELOPMENT

To say that reforestation can benefit land owners as well as the wood products industry in areas through which the
agricultural frontier has recently passed begs a question. Why does nutrient mining, rather than renewal of timber
stocks and other natural capital, continue to be the norm? More than anything else, the answer has to do with public
policy.

There are two salient features of the policy environment in northwestern Ecuador and other parts of Latin America
undergoing agricultural colonization. First, human capital and other “non-environmental assets” are scarce. Second,
property rights in natural wealth are weak.

In several ways, the small farmer survey described earlier in this paper reveals that formation of non-environmental
assets, which substitute for natural resources in the production of crops, livestock, and other goods and
services, has been deficient. Most adults in the study area have had less than six years of formal schooling. More
than 85 percent of the sampled population is receiving no technical assistance. Likewise, the institutions required
for financial intermediation are at an incipient stage of development, primarily because of the Ecuadorian
government’s long-standing policy of pegging the interest rates below the rate of inflation. As a result of financial
sector repression, most respondents must get along without formal credit, less than 23 percent having received a loan
during the preceding twelve months (Southgate et al.).

Since human capital, knowledge of improved technology, and credit are all very scarce, economic activity in the
study area revolves around renewable resource extraction. Some of the survey respondents log high-valued timber in
primary forests. Many more raise crops and livestock in a depleting fashion (e.g., by not using soil conservation
measures).

The performance of northwestern Ecuador’s extractive economy also has much to do with the second characteristic
of the frontier policy environment: weak property rights. As is the case in many other parts of Latin America
undergoing agricultural colonization, land and forests are nominally in the hands of the state, which does little or
nothing to control access to its “properties.” Consequently, resources are free for the taking. Private claims are
legitimized by public agencies, but only when individuals making the claims exercise visible use rights. Clearing away natural vegetation is typically a prerequisite for land tenure (Southgate and Whitaker).

The response of northwestern Ecuador's frontier economy (comprising, specifically, a large number of price-taking colonists) to these property arrangements is entirely consistent with the predictions of economic theory concerning competitive exploitation of open access resources. That is, prices for natural resource commodities gravitate toward the opportunity cost of labor and other factors used to extract those commodities. For example, the payments colonists receive for fine tropical hardwoods average $33 per harvested m³, which is a small fraction of domestic and international prices but is roughly equivalent to the value of time spent felling and transporting timber as well as wear and tear on chain saws and draft animals.

By no means does this market equilibrium represent a sustainable steady state. Since labor and other inputs employed in resource extraction are barely compensated from the sales of timber and other commodities, wealth tends to accumulate very slowly. That is, there is very little surplus (in the form of resource rents) that can be channeled into education and the dissemination of new technology. Nutrient miners, then, are on a treadmill that will continue to turn as long as environmental wealth can be exploited.

Needless to say, investing in tree plantations is very difficult under these circumstances. The need for credit, which (to repeat) is scarce because of policies that repress financial intermediation, can be reduced somewhat by opting for agroforestry systems. Insofar as trees can be planted on land that is used simultaneously for agricultural production, then land owners need not wait 18 to 23 years before having a product to sell.

However, the problem of human capital scarcity must still be addressed. In particular, experience in northeastern Ecuador (where is laurel being inter-planted with coffee) demonstrates that the success of agroforestry projects depends heavily on management inputs and know-how (Peck). Formation of non-environmental assets, it is fair to say, is essential for the renewal of natural wealth.

SUMMARY AND CONCLUSIONS

Analysis of the data collected in our survey of small farmers who have settled in northwestern Ecuador reveals that only a very small minority is doing well in agriculture. After having raised cattle or crops for several years on their respective parcels, most interviewees would sell out for $300/ha or less. This price is well below the present value of what can be earned from timber production, as our financial evaluation of laurel and pachaco plantations demonstrates.

Admittedly, this study does not prove that reforestation is the best use of partially and fully abandoned land in northwestern Ecuador. If rural financial markets were allowed to function efficiently, if extension services were expanded, and if other policy failures were remedied, crop or livestock production might well be the most economical use of some land.

In addition, the importance of strong local markets for timber cannot be exaggerated. Almost without exception, reforestation projects undertaken in Latin America with little regard to who will purchase the output have failed. By contrast, reforestation is starting to take place in northwestern Ecuador precisely because industrial demand in that region is strong.

It must also be recognized that plantations of the type described in this paper might not be the most efficient way to produce timber in the humid tropics. As Sedjo (in press) shows, managed regeneration in natural forests may be cheaper than establishing and maintaining new stands of trees.

Nevertheless, the results presented in this study do suggest that forestry is a remunerative use of cleared land in northwestern Ecuador. If policy impediments can be overcome, much of the region's under-utilized land can be dedicated to timber production, thereby providing an alternative to nutrient mining for colonists and out-competing the species-rich tropical forests that continue to be the major source of timber for the wood products industry.

This alternative merits more study, both in the area that is the geographic focus of our analysis and in other parts of Latin America where deforestation is followed quickly by land abandonment.

ACKNOWLEDGMENTS

Initial support for the research on which this paper is based came in the form of a grant from the Biodiversity Support Program, which involves the Worldwide Fund for Nature, The Nature Conservancy, and U.S. Agency for International Development (AID). Matching funds were provided by another AID initiative, the Development Strategies for Fragile Lands (DESFL) Project, for which DAI was the prime contractor. Salary support has also been provided by a third AID project, Environmental Policy Analysis and Training (EPAT), for which the Midwest Universities' Consortium for International
Activities (MUCIA) is the prime contractor.

Other IDEA research assistants played an instrumental role in data collection and processing. They are Manuel Bonifaz, Marc Carey, Maríá Arguello, Miguel Camacho, and Doris Ortiz. We have also benefitted greatly from advice provided by Manuel Durini and Fernando Montenegro, of the Fundación Forestal J.M. Durini.

All errors and omissions are, of course, the exclusive responsibility of the authors. Also, none of the aforementioned institutions and projects is responsible for any of the opinions expressed in the paper.

LITERATURE CITED


Sedjo, R. in press. Can tropical forest management systems be economic? Journal of Business Administration.


Table 1--Annual net returns per hectare to an 18-year pachaco rotation

<table>
<thead>
<tr>
<th>Wages and Stumpage Prices</th>
<th>5.0%</th>
<th>7.5%</th>
<th>10.0%</th>
</tr>
</thead>
<tbody>
<tr>
<td>When Daily Wage = $3.00</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Price = $10/m³</td>
<td>$48.72</td>
<td>$23.82</td>
<td>$2.89</td>
</tr>
<tr>
<td>Price = $15/m³</td>
<td>98.48</td>
<td>63.06</td>
<td>33.59</td>
</tr>
<tr>
<td>Price = $20/m³</td>
<td>148.25</td>
<td>102.30</td>
<td>54.29</td>
</tr>
<tr>
<td>When Daily Wage = $3.50</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Price = $10/m³</td>
<td>$41.66</td>
<td>$16.36</td>
<td>$-4.97</td>
</tr>
<tr>
<td>Price = $15/m³</td>
<td>91.42</td>
<td>55.60</td>
<td>25.73</td>
</tr>
<tr>
<td>Price = $20/m³</td>
<td>141.19</td>
<td>94.84</td>
<td>58.44</td>
</tr>
<tr>
<td>When Daily Wage = $4.00</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Price = $10/m³</td>
<td>$34.60</td>
<td>$8.89</td>
<td>$-12.83</td>
</tr>
<tr>
<td>Price = $15/m³</td>
<td>84.36</td>
<td>48.13</td>
<td>17.88</td>
</tr>
<tr>
<td>Price = $20/m³</td>
<td>134.13</td>
<td>87.37</td>
<td>48.58</td>
</tr>
</tbody>
</table>

Table 2--Annual net returns per hectare to a 23-year laurel rotation

<table>
<thead>
<tr>
<th>Wages and Stumpage Prices</th>
<th>5.0%</th>
<th>7.5%</th>
<th>10.0%</th>
</tr>
</thead>
<tbody>
<tr>
<td>When Daily Wage = $3.00</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Price = $10/m³</td>
<td>$14.81</td>
<td>$-5.18</td>
<td>$-21.47</td>
</tr>
<tr>
<td>Price = $15/m³</td>
<td>41.60</td>
<td>14.28</td>
<td>-7.52</td>
</tr>
<tr>
<td>Price = $20/m³</td>
<td>68.40</td>
<td>33.75</td>
<td>6.44</td>
</tr>
<tr>
<td>When Daily Wage = $3.50</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Price = $10/m³</td>
<td>$9.58</td>
<td>$-11.04</td>
<td>$-27.94</td>
</tr>
<tr>
<td>Price = $15/m³</td>
<td>36.37</td>
<td>8.42</td>
<td>$-13.99</td>
</tr>
<tr>
<td>Price = $20/m³</td>
<td>63.16</td>
<td>27.89</td>
<td>$-6.03</td>
</tr>
<tr>
<td>When Daily Wage = $4.00</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Price = $10/m³</td>
<td>$4.35</td>
<td>$-16.90</td>
<td>$-34.41</td>
</tr>
<tr>
<td>Price = $15/m³</td>
<td>31.14</td>
<td>2.56</td>
<td>$-20.45</td>
</tr>
<tr>
<td>Price = $20/m³</td>
<td>57.93</td>
<td>22.03</td>
<td>$-6.30</td>
</tr>
</tbody>
</table>
### Table 3—Imputed timber prices per cubic meter

<table>
<thead>
<tr>
<th>Species and Daily Wage</th>
<th>Real Interest Rates:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>5.0 %</td>
</tr>
<tr>
<td><strong>Pachaco Rotation:</strong></td>
<td></td>
</tr>
<tr>
<td>Daily Wage = $3.00</td>
<td>$7.56</td>
</tr>
<tr>
<td>Daily Wage = $3.50</td>
<td>8.27</td>
</tr>
<tr>
<td>Daily Wage = $4.00</td>
<td>8.98</td>
</tr>
<tr>
<td><strong>Laurel Rotation:</strong></td>
<td></td>
</tr>
<tr>
<td>Daily Wage = $3.00</td>
<td>$12.19</td>
</tr>
<tr>
<td>Daily Wage = $3.50</td>
<td>12.17</td>
</tr>
<tr>
<td>Daily Wage = $4.00</td>
<td>13.14</td>
</tr>
</tbody>
</table>

### Table 4—Harvesting and log transport costs in northwestern Ecuador

<table>
<thead>
<tr>
<th>Expenditures</th>
<th>In Primary Forests</th>
<th>On Tree Plantations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Felling</td>
<td>$2/m³</td>
<td>$2/m³</td>
</tr>
<tr>
<td>Skidding</td>
<td>12</td>
<td>4</td>
</tr>
<tr>
<td>Loading</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Road construction</td>
<td>6</td>
<td>0</td>
</tr>
<tr>
<td>Transportation</td>
<td>5-10</td>
<td>5-10</td>
</tr>
<tr>
<td>Overhead/management</td>
<td>10</td>
<td>2</td>
</tr>
<tr>
<td>Government charge</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Sub-total</td>
<td>$40-45/m³</td>
<td>$15-20/m³</td>
</tr>
<tr>
<td>Stumpage prices</td>
<td>$1-2/m³</td>
<td>$6-13/m³</td>
</tr>
<tr>
<td>Total</td>
<td>$41-47/m³</td>
<td>$23-53/m³</td>
</tr>
</tbody>
</table>

Sources: Durini (1992) and Table 3 (for stumpage values of timber harvested from plantations);