Multiple Products, Community Forestry and Contract Design: The Case of Timber Harvesting and Resin Tapping in Honduras

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Abstract

In exchange for protecting the forest from theft and fire, communities in developing countries are sometimes granted sole rights to collect firewood and non-wood products such as medicinal plants, fruits and resins. State agencies, however, usually retain the right to harvest the mature timber. In this paper, production trades-offs and contracting problems presented by a combination of usufructuary rights to collect pine resin and the Honduran government's claim to charge for the right to harvest mature timber are analyzed. The analysis indicates the contract fails to establish as residual claimant the party with the greater ability to affect resource use, and therefore fails to maximize the rental value of the forest. This result has broader implications for community forest programs.

Keywords: contract choice, property rights, timber harvesting, resin production.

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Introduction

A popular response to deforestation and poor utilization of forests in developing countries is to increase the participation of local communities in managing the forests.[1] The lands in question belong to the state, but policing resource use has proven to be costly and ineffective. The alternative of community participation is seen as helping to improve forest productivity and alleviate poverty by fostering institutions capable of limiting uncontrolled access to the

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[1] Both the World Bank and the Food and Agricultural Organization of the United Nations have endorsed the principles of community forestry. A major report issued by the latter organization urges that "governments therefore should take special action in such cases to protect the interests of local communities, for example, by entering into long-term usufruct agreements with people who agree to live in harmony with the forest..." (Alexander, 1995, p.220).

forest resource. To encourage protection of the resource, local groups have been granted certain usufructuary rights to the forest. These include the right to collect firewood and non-wood products such as medicinal plants, fruits and resins, often free of charge. While state agencies have attempted to retain the right to harvest the mature timber, conflicts have arisen when harvesting interferes with the usufructuary rights of the community.[2] In response, a number of different contractual arrangements that offer the community either a share in the value of the timber harvested or the right to harvest at a predetermined charge have been tried.[3] In this paper, production trades-offs and contracting problems presented by a combination of usufructuary rights and a state's claim to charge for the right to harvest mature timber are analyzed.

While the extraction of non-wood forest products has often been viewed as having no impact on the production of saw timber, or even on the ecology of the forest, the commercial extraction of firewood, fruits, and especially the tapping of trees for latex and resins can have a large negative effect (Peters, 1996). To illustrate the trade-offs and contracting problems that production of multiple outputs can present, this study focuses on the interrelationship between resin production and the harvest of saw timber. After presenting the conceptual arguments, the analysis will focus on recent experiences in Honduras. Honduras has a number of contentious land tenure issues, and resin tapping on national forest lands administered by COHDEFOR (Corporación Hondurena de Desarrollo Forestal) offers an illustration of the problems that can arise when the allocation of property rights is not commensurate with the ability of the parties to affect the net income flows from the forest resource. This paper focuses on how various contractual arrangements affect behavior.

[2] For a general description of community forestry and tenure issues, see Bruce (1989) and Panayotou & Ashton (1992).

[3] Some countries share timber receipts with local communities that commit resources to planting and protecting the forest. But there is often considerable distrust of the state's promise to share revenues (Sarin, 1995). Occasionally, forests have been leased to community-based enterprises which then have the right to harvest mature timber. See Pardo (1995).

Contracts, whether they are formal or informal, govern the exchange of property rights to resources such as labor and land. The contract assigns to the various parties certain rights and obligations and designates how much of the residual each is to assume. Importantly, shirking and opportunistic behavior must be controlled if the rental value of the resource is to be maximized. The type of contract chosen and the assignment of the residual will depend on the costs of transacting.[4] *As a general rule, maximization requires that the greater a party's ability and inclination to affect the returns an asset can generate, the greater the share of the residual that individual should assume.*[5] In this paper it is argued that the contractual arrangement adopted by COHDEFOR for resin tapping operations violates this basic principle. The explanation for this seemingly non-wealth maximizing behavior is that COHDEFOR, like many state agencies, does not have a clearly defined residual claimant. Moreover, bureaucratic agencies have independent concerns, including the cultivation of political support. Thus, members of the agency, or others in the government, can lack the inclination to select the contractual form that would come closest to maximizing the rental value of the forest resource.

The following section commences with a description of gum resin collecting and then discusses the factors that are likely to influence the choice of contracts for organizing the production of the multiple products saw timber and gum resin. To aid the discussion, a standard model of optimal forest rotation is employed. Section three discusses the situation in Honduras, and the forest cooperative Villa Santa is used to illustrate the problems presented by the current contractual arrangement between forest cooperatives engaged in resin production and COHDEFOR.

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[4] Transaction costs include the costs associated with reaching agreements, measuring the attributes of the commodity being exchanged, and monitoring to reduce shirking or opportunistic behavior. While descriptive, this entire litany of costs can be placed under a single rubric, the cost of establishing and maintaining property rights. For a discussion of what constitutes transaction costs, see Allen (1991).

[5] The study of contracts is at the heart of property rights analysis, and the general rule stated in the text is one of the key implications that follows when transaction costs are considered. See Barzel (1989).

Resin Production and Contract Choice

The Gum Resin Industry

In addition to providing building materials, paper products, and fuels, trees of the forest also furnish a large array of silvichemicals and other products. These include cork, vanillin, fruits, medicinals, rubber, and a wide variety of gums and resins. Within the latter group are "naval stores," an inclusive term used to denote the products obtained from the resin of pine trees (see Zinkel & Russell, 1989). The term originated in the days when wooden sailing vessels were waterproofed and preserved using pitch and tar obtained from pine trees. Today, the crude resin from pine trees is converted into turpentine and rosin, the latter being the major product. Rosin is the material that remains behind as an involatile residue after distillation of the turpentine and is a brittle, glassy solid. Uses for rosin include sizing for paper and paperboard, soaps and disinfectants, protective coatings, adhesives, and an intermediate chemical in numerous processes such as the making of perfumes.

There are three established methods for obtaining rosin and turpentine from pine trees. Gum resin, or gum naval stores, is obtained directly from live pine trees by tapping and collecting the resin. Sulphate naval stores are obtained as a by-product when pine wood chips are converted into pulp using a sulphate pulping process. The third method utilizes old resin-saturated pine stumps and solvents to extract the resin. Resin tapping of live pine trees is labor intensive and utilizes fairly simple equipment. In contrast, the other two methods are capital intensive.

Historically, the United States has been the world's leading producer of resins, relinquishing that lead in the 1980s to China.[6] Today, collection of substantial quantities of crude resin or gum resin can be found only in countries or areas with relatively low wages, including China, Indonesia, Russia and a number of Latin America countries. Total world crude resin production in 1994 was approximately 1

[6] In the late 1950s the United States accounted for about half of the world's production of rosin. By the late 1980s, its share had been reduced to one fourth of world output. Currently, sulphate pulping processing is the prevailing method for producing naval stores in the U.S. (Zinkel & Russell, 1989, p. 41).

million tons, with a market value of just under a half billion dollars.[7]

Although production is world wide, there is considerable variation in resin yields depending upon temperature, length of season, rainfall and pine species. The genus *Pinus* consists of 94 species, and 31 of those have been tapped for resin. The bulk of production, however, is accounted for by 7 species (Zinkel & Russell, 1989, pp. 114–15). *Pinus caribaea* and *Pinus oocarpa* are the two species of pine utilized for resin in Honduras. Warm temperatures, long seasons and ample but not excessive rainfall increase yields. The collection of resin involves wounding the pines by chipping away a section of the bark to expose the wood.[8] Tapping generally commences when the tree is 20 to 25 centimetres diameter at breast height. The most common method involves making an initial exposure that covers about a third of the circumference of the tree. After the tree face has been prepared, a resin collection system composed of metal aprons is installed at the bottom of the exposed face. A collector or cup is then placed under the apron to catch the resin flow. The flow of resin is slow, but can be increased by applying a diluted sulphuric acid spray or paste to the exposed face. The resin is generally collected every 7 to 14 days. Since the pine will eventually heal itself, stopping the flow of resin, chipping must be repeated. The frequency of chipping depends on the amount of the chemical stimulant applied and the number of years the tree is to be used for naval stores production prior to harvest. The size of the face will gradually be expanded over time and trees can be doubled and occasionally triple-faced to increase yields. Yields typically increase with diameter, but eventually decline with age and condition of the tree.

The Trade-offs

The chipping of the tree, unless done carefully, can lead to substantial damage to the butt log and loss in saw timber value. In extreme cases, tapping can kill the tree. The box

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[7] The average world price for crude resin was about $300 per ton in 1995 (Coppen & Hone, 1995)

[8] The description of resin tapping operations is based on the author's own field visits and discussions contained in Zinkel & Russell (1989) and Coppen & Hone (1995).

method of chopping a cavity into the base of the pine to catch the resin is still used in some areas and results in reduced vigor of the tree, making it susceptible to wind breakage and attack by insect and disease. Even with the newer methods of chipping and use of chemical stimulants, trade-offs remain. Deeper and wider incisions induce a greater flow of resin, but can reduce growth of the tree and the quality of the saw timber. But if care is exercised in preparing the face, there appears to be little reduction in the amount of wood volume over most conventional harvesting cycles.[9]

In addition to considering the cost and returns to exercising due care in the tapping of pines, production of the multiple products resin and saw timber involves the determination of an optimal time to harvest the timber. To examine the trade-offs, consider the standard Faustmann model for maximizing soil rent for an even-aged stand.[10] The value of the timber in this stand, net of harvesting costs, at age t is denoted by the function $G(t)$. The rotation length or age of the stand when harvested is defined by the variable T. As noted above, the amount of gum resin that can be extracted from a stand typically increases with age of the tree, but eventually declines. When trees are young, however, they do not produce sufficient amounts of resin to justify tapping operations. Accordingly, assume that the periodic net value of resin collected, $R(t)$, is a function of the age of the stand, becoming positive at some age $t_i > t_{0,}$ and eventually becomes zero at some advanced age. The discounted net return, where r is the rate of discount, from an infinite series of rotations that includes both the returns to timber and resin production is given by

$$V = \frac{G(T)e^{-rt} + \int_{t_0}^{T} R(X)e^{-rx}dx}{1 - e^{-rT}}. \tag{1}$$

[9] See Zinkel & Russell (1989, p. 106). There are a number of other methods for gum resin production, such as the borehole technique that appears to cause even less damage than the standard chipping technique. See Hodges (1995).

[10] For a discussion of the basic Faustmann model and implications pertaining to optimal rotation age, see Deacon (1985). Montgomery & Adams (1995) also present the standard model, and consider the impact of joint products on optimal rotation age. Papers that deal explicitly with joint products and optimal rotation are Hartman (1976) and van Kooten, Binkley & Delcourt (1995).

Assuming that resin production is positive at T, the first order condition is

$$\frac{G'(T)}{G(T)} = r - \frac{R(T)}{G(T)} + \frac{rV}{G(T)\left(1 - e^{-rT}\right)}. \tag{2}$$

Here, $G'(T)$ is the partial derivative of $G(T)$ with respect to T.[11] The optimal rotation age occurs when the rate of growth in the value of the timber, $G'(T)/G(T)$, is equal to the rate of discount less $R(T)/G(T)$, plus the last term in Eq. (2). This latter term reflects the opportunity cost of the site. Now consider the effect resin production can have on optimal rotation age. With $R(T)$ positive, the second term on the right hand side of Eq (2) is negative and its effect is to increase rotation age. But, since V must increase with resin production, the opportunity cost of the site has also increased. This secondary effect will operate to reduce rotation age. Accordingly, there can be offsetting factors and in general, whether the production of gum resin increases or decreases optimal rotation is an empirical question (see Montgomery & Adams, 1995, p. 385). Importantly, optimization of V requires that the contribution of both products be taken into consideration when determining rotation age.

If a single individual owned the land and carried out all the activities associated with resin collecting and timber harvesting, the costs and benefits would be internalized. But consider a situation where one party has the right to the resin production while a second party holds the rights to the saw timber. If the first party can effectively determine the age at which the timber is harvested, T will be chosen to maximize the value of resin production, not the value of the joint products that contribute to V. If the net returns from resin production remain positive, the incentive can be to delay the harvest well beyond the joint product optimal rotation age. Indeed, if the contract is tenuous or the time period covered does not extent to multiple ro-

[11] Note that if there were no production of resin, $R(t) = 0$, Eq. (2) would reduce to the standard multi-period harvesting model where the first order condition is simply,

$$\frac{G'(T)}{G(T)} = \frac{r}{1 - e^{-rT}}.$$

tations, the timber will be harvested only after the net returns from resin production are no longer positive. One could, of course, imagine a long term agreement that utilizes side payments to solve this problem. But in the real world transaction costs are positive and can preclude such an arrangement, especially if one of the parties involved is a government agency. In the following section, the case of resin tapping in Honduras is examined. There, the government has essentially granted rights to the residual income generated by resin tapping while denying the same party similar rights to the residual income from timber.

RESIN TAPPING COOPERATIVES AND USUFRUCTUARY CONTRACTS IN HONDURAS

National Forest Policy

Honduras is a heavily forested country with over half its territory in commercial forest lands: 2.8 million hectares of pine forests and 2.9 million hectares of hardwood forests (COHDEFOR, 1996). Approximately 50 percent of the pine forested lands belongs to the national government. Honduras has a long history of conflict over forest and land tenure, but it is the more recent era that is relevant to this analysis. In response to perceived over-exploitation of Honduran forests in the 1970s, the national government began active management of the country's forests. In 1974, legislation was passed that created the national forestry corporation, COHDEFOR.[12] This agency was initially given exclusive control over all of the nation's forests, both private and public. While the right to determine how private, municipal and communal lands were used remained with the nominal owner, the right to harvest timber on those lands belonged to COHDEFOR. Importantly, this agency was also granted discretionary powers to work with communities that were engaged in forest-based resource activities on national forest lands, such as resin tapping. Under the 1974 law, cooperatives could be assigned usufructuary rights to areas of the national forests. Initially, the cooperatives were allowed to tap resin and extract firewood free of charge. Although legally the rights to harvest timber after

[12] El Decreto Ley 103-74, Ley de COHDEFOR.

it had been used for extracting resin remained with COHDEFOR, the cooperatives have from time to time pressed the claim that harvesting rights should be theirs by virtue of the fact that they are the parties directly engaged in protecting the woods from fire, guarding against timber theft, and controlling forest diseases and insect plagues.[13]

In the 1990s, the government's forest management policy underwent another series of transformations.[14] Although the timber on privately owned land now belongs to the landowner, COHDEFOR requires a detailed management plan for all forested lands, specifying inventories and sustainable yield harvest levels, before issuing a permit to harvest. The requirement that a management plan be approved before logging is allowed is currently COHDEFOR's main mechanism for controlling use of the forest resources of Honduras. The development of a forest management plan is also a precondition for the long-term harvest and utilization agreement, referred to as a *convenio*, between COHDEFOR and communities utilizing the national forests. In addition, COHDEFOR is now charging a fee for each barrel of resin extracted from the national forests and requires cooperatives to pay a negotiated stumpage price for timber harvested by them.[15] The stumpage price paid by the cooperatives is based on bid prices obtained by COHDEFOR in auctions of national forest timber in comparable areas, but where resin tapping is supposedly not occurring.

COHDEFOR's current policy of utilizing auctions to sell rights to harvest timber on the national forest is in many respects an attempt to mimic the management techniques employed by the U.S. Forest Service. Once environmental constraints have been satisfied, large tracts of land are designated for harvest, with rights going to the highest bidder. The role of the forestry agency is largely that of a moni-

[13] Confrontations between resin tappers and the government are discussed in Stanley (1991).

[14] El Decreto Legislativo 31–92, Ley para la Modernización y el Desarrollo del Sector Agrícola.

[15] Título VI de la Ley para la Modernización y el Desarrollo del Sector Agrícola de 1995 agosto 22.

tor. While this approach has its merits on lands that can be adequately protected from intrusion and are not being heavily utilized for other purposes, it is potentially troublesome when those conditions are not met.

In principle, of course, the state agency could charge for resin and saw timber separately and require that the contractor harvest timber at the optimal rotation age in a manner that minimizes damage to the understory and protects against erosion. The agency could also hire separate parties to regenerate the stand and patrol the forest to protect against fire and disease. Indeed, the agency seems to have that approach in mind. Under current policy, the forest cooperatives are to pay separately for resin and saw timber harvested, while COHDEFOR is to pay cooperatives or other entities to take care of the forest.[16] In a world of zero transaction costs, such an agreement would pose no problem. But transaction costs are positive, and this approach entails charging the same group of people who are to take care of the forest the full stumpage value of the timber. This arrangement does not offer the cooperatives much of an incentive to take due care of the saw timber. There is much room for shirking and opportunism on both sides. To be successful in maximizing the rental value of the resource would require considerable monitoring, something COHDEFOR has not shown much of an inclination to do. Although the national forests of Honduras contain large quantities of commercial timber, COHDEFOR consistently operates at a substantial loss.[17] Not surprisingly, the cooperatives report that COHDEFOR cannot be relied upon to make payment for regeneration and forest management practices. The essential problem with the current arrangement is that COHDEFOR has selected a contract form that denotes it as the residual claimant, yet the forest cooperatives are in a better position to affect the income stream.

Exactly why COHDEFOR would select such an arrangement is not entirely clear. But this is a state agency, not a private party. There is no clearly defined residual claimant and, thus, there is no clear objective function that can be

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[6] The terms of the long-term contractual arrangements with forest cooperatives or other community entities are contained in a standard COHDEFOR contract entitled, “Convenio de Usufructo y Manejo Forestal de un Bosque Nacional.”

[17] Based on data supplied by COHDEFOF, revenues from the sale of timber were only 43 percent of total costs in 1995.

assigned to the agency. While individuals within the agency look to their own interests, contracts selected in that environment do not resemble contracts that would maximize the rental value of the site. Of course, one should not label an outcome as inefficient without having taken into consideration all of the costs of transacting, a difficult if not impossible feat. Nevertheless, there are implications about resource use that follow when two or more individuals own different elements of the same commodity and ownership among the contracting parties is not based on their ability to affect the income flow generated by the asset.

Under the current arrangement with cooperatives, COHDEFOR collects fees for resin and timber harvested but does not directly control the timing of the harvests. The decision of when to harvest is largely left to the cooperative. But from the standpoint of the cooperative, charging a stumpage fee is equivalent to a reduction in price and will cause rotation age to increase (see Montgomery & Adams, 1995). Indeed, if the stumpage fee is set equal to the value of the standing timber, its value to the cooperative would be zero and rotation age would be determined on the basis of the net value of resin. If COHDEFOR consistently paid regeneration costs, the cooperative would have an incentive to harvest earlier. But as mentioned above, the government can not be relied upon to make these payments. The following section examines the case of the resin tapping cooperative Villa Santa. Utilizing data from the cooperative's accounts and other sources, the rental value of the site that accrues to the cooperative is calculated. The analysis shows that the terms of the contract have induced the cooperative to emphasize resin production over timber. That results in an excessively high rotation age and lower returns to the site than appear possible under alternative contractual arrangements.

The Villa Santa Cooperative.

Honduras is a relatively small player in world production of crude resin, accounting for only about one percent of total output (Coopen & Hone, 1995, p. 16). But for the forest communities involved in the collection of resin, it is often a major source of income. There are over twenty forest cooperatives actively engaged in the collection of resin, and they vary in membership size from as few as 12 to over

800.[18] The cooperative Villa Santa, although considered to be one of the better organized forest cooperatives, is chosen for analysis because of the availability of data on timber harvesting, resin collection and costs involved.

The Villa Santa community is located in the southeastern part of Honduras, which is highland pine (*Pinus oocarpa*) country with steep terrain. The site quality of most of the forested areas within this community is fairly high, 2s and 3s, with 1 being the highest and 5 the lowest (Cooperativa Agro-Forestal Villa Santa, 1995). The cooperative focuses primarily on the production of resin and, to a lesser extent, timber. It also has its own small circular sawmill and is engaged in the harvesting of fire wood. The cooperative operates primarily within national forest land and has a forest management plan approved by COHDEFOR covering 4,914 hectares. The forests under the care of the cooperative have a wide distribution of age classes and are managed on an annual sustainable yield basis that could conceivably continue to produce current quantities of resin and timber indefinitely.

Members of the cooperative have divided the resin-harvesting area into parcels, which they recognize as private property and, on occasion, trade these parcels within the cooperative. The parcels vary in size and some members have more than one parcel. The 216 active members of the cooperative have on average 1,000 trees each that are used for resin, but there is considerable variation. Resin is collected by the parcel owner or someone who has share contracted with the owner. It is then brought by mules or horses to various collection points in the forest where it is poured into 60 gallon barrels. The road system within the Villa Santa area is extensive, and the cooperative has a truck that picks up the barrels and brings them to a central collection point controlled by the country's three resin processing plants. Because the amount paid to the resin collector depends on the quality of the resin, each barrel is marked with the individual resin collector's identification number.

[18] Information pertaining to membership in forest cooperatives was obtained from FEHCAFOR (Federacion Hondureña de Cooperativas Agroforestales). Also, see Stanley (1991).

Although technically illegal, the practice of dividing areas of national forest lands into parcels for resin collection is common practice throughout Honduras. The cooperative structure offers a means by which members can collectively protect their areas from outsiders and benefit from economies of scale in the transportation of resin.[19] By assigning parcels within the group, cooperatives have adopted a system that largely internalizes the costs and benefits of resin production. Moreover, ownership of a parcel is the basis for membership in the cooperative. While members of the cooperative are paid for each barrel of resin produced, surpluses generated through the logging and milling operation must also be distributed among members. In the past, when the cooperative has experienced a surplus, it has typically been distributed on the basis of resin production, but occasionally equal shares have been given. In 1995 the cooperative also paid members 60 Lempiras (Lps.) per m^3 for timber cut on a member's parcel.[20] To obtain an estimate of the rental value of the land under current practices, net returns from resin and timber production were calculated for the most recent full year, 1995.

In 1995 the cooperative sold 2,314 barrels of resin, about 10 percent of the total crude resin production in Honduras. The resin provided a gross income of Lps. 1,223,726.49, giving the typical member a part time source of income close to the national per capita income level.[21] The cooperative also harvested 2,723.42 m^3 of pine and sold finished lumber products for Lps. 1,222,157.68. Although it is difficult to determine from the accounts how much, if any, net earnings the cooperative has diverted into other activities, the by-laws require that surpluses be distributed to the members. Since there are numerous other small sawmills in the vicinity and the cooperative also sells logs to these mills, it seems unlikely that the mill at Villa Santa is capa-

[19] This pattern of establishing quasi rights through collective action can be found in other natural resource settings such as fisheries and grazing (Ostrom, 1990). However, these rights structures can be tenuous and often do not survive major shocks (Johnson & Libecap, 1982).

[20] The exchange rate in 1995 was around 10 Lps. to the US dollar. By the summer of 1996 it was 12.2 Lps. to the dollar.

[21] The data on production and revenues are from the accounts of the cooperative (Cooperativa Agroforestal Villa Santa Los Trozos Ltd., Estado de Excedentes o Perdidas al 31 de Diciembre de 1995). The World Bank estimates that in 1995 per capita income in Honduras was around $600, or 6,000 Lempiras.

ble of generating significant rents. Accordingly, it is assumed that any net earnings generated by the sawmill are reflected in payments to the members for their timber.

The data in Table 1 show the net returns per 60 gallon barrel of resin. The gross price received in 1995 for each barrel was Lps. 528.83, and collection of resin is labor intensive with non-labor costs accounting for only Lps. 12 per barrel. These minor costs are for purchases of special tools for cutting the bark, sheet metal for directing the flow of resin, cups for collecting the resin, and sulfuric acid. Discussions with members of the cooperative indicated that it takes the equivalent of six days to collect one barrel. The process of collecting a single barrel from an average stand, containing about 1000 trees under resin production, is often spread out over a month or more. When not collecting resin, these same individuals normally work at other jobs, such as tending their corn fields. The members of the cooperative felt that a correct measure of the opportunity cost of a resin collector's time was Lps. 30 per day. After deducting taxes, transportation, equipment, labor, and other costs, there is a residual of Lps. 241.99. Multiplying that figure by the number of barrels produced in 1995 yields a value of Lps. 559,964. The above residual represents part of the return to the land and forest base. To arrive at the residual value of land, the stumpage value of the timber harvested must be added and the costs of fire protection, regeneration, and road maintenance must be deducted.

COHDEFOR charged the cooperative Lps. 151.03 per m^3 for harvesting 2,723.42 m^3 of pine in 1995. This price is based on auction market results from comparable sites. It would reflect the market value of stumpage if the auctions had been highly competitive or the reservation prices set by government were close to the correct market price. While there is some question as to whether COHDEFOR is obtaining prices that reflect aggressive competitive bidding, the conclusions drawn here are not altered by use of a higher stumpage price. Since the cooperative also paid parcel owners Lps. 60 per m^3 for timber harvested on their plots, a residual clearly accrued to members of the cooperative. Utilizing payment to parcel owners as a measure of net returns to the members of the cooperative, the total net return from harvesting saw timber was Lps. 163,404. Although there are items in the cooperative's accounting

TABLE 1 REVENUES AND COSTS PER BARREL OF RESIN, VILLA SANTA 1995.

Total Revenues Lps./barrel		
Sale price per barrel[i]		528.83
Costs Lps./barrel		
Municipal taxes[ii]	5.29	
Per barrel fee collected by COHDEFOR[ii]	16.05	
Management fee payable to COHDEFOR[ii]	3.50	
Administration fee charged by the cooperative[ii]	20.00	
Membership payment to FEHCAFOR[ii]	5.00	
Transportation to Tegucigalpa[ii]	45.00	
Labor cost (6 man days per barrel at Lps. 30 per day)[ii]	180.00	
Amortization of material and equipment[iii]	12.00	
Total costs Lps./barrel	286.84	
Net returns Lps./barrel		*241.99*

[i] Source, Cooperativa Villa Santa, Estados financieros a diciembre 1995.

[ii] Source, General management, Cooperativa Villa Santa.

[iii] Source, FINACOOP, "Diagnóstico Empresarial Coopertiva Villa Santa,"(Tegucigalpa: FINACOOP, 1995).

records indicating certain expenditures for forest protection, regeneration and maintenance, much of the labor input is that of the cooperative's members and is often unpriced. Thus, a separate estimate of the opportunity cost of forest protection and maintenance was undertaken, one that included an imputed cost of labor.[22] The estimated costs for 1995 were Lps. 448,680. Accordingly, the net returns to the cooperative from the land and forest base in 1995 were as follows:

Return to Resin Production	Lps. 559,964
Value of Stumpage	160,404
Less Forest Protection & Maintenance	(448,680)
Net Return	Lps. 271,688

[22] The following itemized annual cost estimates for Villa Santa are from Cannon (1996):

Forest Management Plan	Lps. 42,000
Forest Protection	160,800
Timber Stand Improvement	9,600
Reforestation	61,320
Road maintenance	174,960
Total costs	448,680

While positive, the comparison offered below indicates that net returns to the land and forest base appear low compared to its potential.

Based on observations during field visits and examination of inventory data in the management plan, it is clear that Villa Santa has a considerable amount of over-mature timber. The maximum sustainable yield rotation age for pine in this area is generally around 40 years, but the cooperative regularly taps trees 50 to 60 years of age.[23] The butt log on many of these older trees exhibited a triangular shape due to having been faced on three sides for resin production. While the damage did not appear excessive, it was also clearly present. Moreover, the cooperative's management plan, as approved by COHDEFOR, allows Villa Santa to harvest up to 12,000 m^3 annually on a sustainable basis. Instead, they harvested substantially less in recent years, averaging around 3,000 m^3 per year. The fact that rotation age is higher where there is a secondary non-wood product is not inconsistent with the standard model of optimal forest rotation presented in Section II, nor empirical evidence (see, e.g., van Kooten, Binkley & Delcourt, 1995). Moreover, it could be argued that timber harvesting involves negative externalities such as erosion, and COHDEFOR attempts to correct for that by charging a high stumpage fee to deliberately increase rotation age. But on other government timber lands where resin is not tapped, COHDEFOR uses shorter rotations. While one can always assert the presence of externalities, they would have to be substantial to offset the findings presented below because in the Villa Santa case, the value of the timber not being harvested appears large relative to current returns.

For the sake of comparison, assume there was no resin production so that all forest protection and maintenance costs are applied against timber and let Villa Santa cut its full allowable harvest. Further assume that the cooperative receives the full value of the stumpage, the Lps. 151.03 COHDEFOR had charged the cooperative plus the Lps. 60

[23] On Villa Santa, the maximum sustainable yield rotation age is 40 years (*Pinus oocarpa*, average site class 2). Inventory data contained in the cooperative's management plan reveals substantial quantities of timber in the 50 to 60 year category. Financial maturity is generally shorter than the maximum sustainable yield rotation age and is likely to be somewhere in the range of 34 to 38 years.

per m^3 distributed to the parcel owners. Multiplying by 12,000 m^3 and subtracting the forest protection and maintenance costs yields a net return of Lps. 2,083,680. This figure is over seven times the current net return to the cooperative. Since resin tapping usually begins when trees are 30 cm in diameter, or around 30 years of age, and timber is harvested at 40 years, the optimal solution is likely to include both resin production and timber, but it would not be the current mix.

Why is Villa Santa not operating in manner that would maximize the rental value of the resource? Clearly, the contract used by COHDEFOR is a contributing factor.[24] Given the transaction costs, the agency is charging too high a stumpage price. Accordingly, Villa Santa emphasizes resin production because that maximizes their net returns.

CONCLUDING REMARKS

The general principle for determining the optimal allocation of ownership among contracting parties is that the party who is in the best position to affect the income flow generated by the asset be assigned the role of residual claimant. The arrangements between COHDEFOR and the cooperatives in Honduras appear to violate that general principle. While it may be tempting to suggest that COHDEFOR, or some other state agency similarly situated, act more like a residual claimant and enforce timely harvesting, that would ignore the constraints faced by the agency. The agency, for example, is not prohibited from auctioning off the rights to harvest timber to some party other than the cooperative. But if timber rights were sold to outside parties, the agency would lose the support of the local community for protecting the forest. Not only would the agency have to carefully monitor resin tapping operations, but many of the parcels on Villa Santa, as elsewhere in Honduras, are used for grazing. Fire is used to generate the growth of grass, and while quick fires may have little effect on standing timber, they can destroy new

[24] Rent maximization would likely reduce employment in resin collecting and increase it in timber harvesting and saw milling activities. While the net effect may be to reduce total employment in the area and cause some displacement, there are alternatives and the analysis has been carried out using the opportunity cost of labor within the area.

seedlings. If trees are worth little or nothing to members of the community, fires will be more frequent and regeneration more costly. It is important to emphasize that despite insecure tenure rights on national forest lands in Honduras, resin tappers have collectively been able to establish a system of quasi property rights. Operating as a cooperative, groups of resin tappers have divided forested areas into parcels and have assigned areas among their members. The boundaries of these parcels are recognized and treated as private property by members of the cooperative, and they protect these areas from intrusion. Thus, it appears that the individual parcel owners are the better candidates for the position of residual claimant, and structuring a contract that more fully allows them to internalize benefits and costs would not only increase their incomes, but provide higher incomes for the country as a whole.

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