SCANDINAVIAN FOREST ECONOMICS
No. 40, 2004

Proceedings
of the Biennial Meeting of the
Scandinavian Society of Forest Economics
Vantaa, Finland, 12th-15th May, 2004

Heikki Pajuoja and Heimo Karppinen (eds.)

Vantaa

This on-line version differs from the printed Proceedings 2004.
Ragnar Jonsson's paper is included in this version, but is missing from the paper copy.

Evaluating Three Innovative Financial Instruments of the Costa Rican Plantation Forestry System.

Guillermo A. Navarro[1]

Introduction

Costa Rica has promoted reforestation and plantation forestry (RPF) for the last 24 years. At the beginning, RPF was used as an instrument for reducing the country's high deforestation rate, but later on it became a tool to ease fears of a possible timber famine (Navarro 1999). At that time the Costa Rican State promoted initially fast growing species with low prices or no-markets at all which yielded not very positive outcomes. Nowadays however, the Costa Rican State has accepted native, high-value timber species with longer rotation cycles, which could yield better social and private returns. These plantations are expected to generate a higher income but also an increased value of the forest asset itself. Nonetheless, theses long-rotation plantations need to solve problems associated with the lack of cash flow in the early years because forest owners require a cash flow to cover up plantation expenses and for their private income. Three innovative financial mechanism of the Costa Rica forest sector are evaluated in this paper in order to explore their effect on the profitability and the cutting decision. One of them is the pre-purchased timber (PPT) system implemented by the Foundation for the Central Volcanic Range (FUNDECOR), a non-governmental organization working in the protection and management of forest ecosystems in Costa Rica's central plateau. The other two are administrated by the Costa Rican National Forestry Fund (FONAFIFO). One is the payment of environmental services (PES), and the other is the timber loans (TL), which was derived from the PPT system.

Financial Instruments for Plantation Forestry

FUNDECOR's pre-purchase timber (PPT) fund was established with a World Bank's International Financing Corporation (IFC) loan. PPT funds are managed with an endowment fund set up at a Costa Rican private bank, which serves as an instrument for carrying out financial transactions and as a guarantor for annuity payments for the landowner; however, all procedures are supervised by FUNDECOR. Basically, landowner sells FUNDECOR 40m^3 of the total final harvest; in this way obtaining a financing option. FUNDECOR sets the rotation age using technical rather than financial criteria, usually around 15 years of age, the idea is that plantation owners do not need to wait until the rotation age for obtaining their income, rather they can receive a cash flow before the last thinning. This last thinning is assumed to bring an important positive net revenue that can help the landowner to wait for the rotation age. FUNDECOR guarantees annual payments in US dollars, based on plantation's age, rotation, location, and the timber price of the forest species. Amounts range between US$46.30 and US$232 per hectare per year, and are given in equal annual payments. A forest

[1] Professor and Researcher in Forestry Economics and Management at the Tropical Agricultural Research and Higher Education Center (CATIE). Tel.: +506-5582542; Fax: +506-556-8514. E-mail address: gnavarro@catie.ac.cr

[2] Carlos Herrera, 2003: Personal communication.

plantation is eligible at 3 years of age and with a maximum of 9 payments. The immature timber value calculation is done by discounting the timber value of the 40 m^3 from the rotation age at 11% annual interest rate using today's timber price, and a relationship between Costa Rican timber inches (pmt) and cubic meters of 300pmt/m^3. The final harvest value is discounted from a rotation age to the year before the last thinning, then the sinking fund factor formula is used to calculate the equal annual payments. To ensure the existence of the plantation and commitments assumed by the owner, a security guarantee figure was created by which the commitment is written in the margin of the ownership title for the property, at the Public Registry. This way, any third party will be aware of the timber contract existing between FUNDECOR and the owner. FUNDECOR's commitment is to guarantee the technical assistance and financial resources necessary for developing silviculture activities required by the plantation payments[2].

The forest law N°7575 introduced the concept of Payment for Environmental Services (PES), which a payment given to the forest owners for the services provided by their forest systems (CO_2 fixation, water quality and erosion prevention, scenic beauty and biodiversity). PES concept is aimed to increase the attractiveness of forestry compared to other competing land uses by recognizing the value of the environmental services that these systems provide to society. In this manner, PSA represents a payment that society, which demands and enjoys these environmental services, gives to the forest landowners for producing the environmental services coming from their forest systems. With the PSA program, landowners have to give the rights for CO2 fixation and other environmental services during the length of the contract to FONAFIFO. So, these environmental certificates may be negotiated in the international market. PES is about $450/ha in present value terms, and it is paid during a 5-year period in 50, 20, 15, 10 and 5% installments respectively. However, the land owner will loose between 15% and 20% of this funds in regency services and transaction costs. This system operates with funding coming form a fuel tax, and other agreements with local and national utility and water companies interested in the protection of forests for water production (Navarro, 1999).

Likewise, timber loans (TL) are aimed not only at making plantation forestry more competitive in regard to other land uses, but also to improve the cash flow distribution in the typical forest plantation project, and to bring sustainability elements in the commercial plantation forestry. The expected impact of this program is to improve the landowner liquidity, avoid the anticipated harvest of forest plantations in order to obtain forest products with desired dimensions and qualities, and to maintained a positive commercial reforestation rate. Timber loans are financed with the emission of medium term bonds. These TL bonds have not only the immature timber as a guarantee, but also a solidarity guarantee of the Global Environmental Facility (GEF), and FONAFIFO patrimonial fund. A timber loan is given based on the value of 50m^3 at rotation age; however, 100% of the inventory is used as loan guarantee. It is a requirement that the forest plantation has at least 250 high quality trees, a minimum of 10 hectares, growth rates are above the national average, free from pests and diseases, good access all year round, and farms must bare a title in the National Property Register. A forest plantation is eligible at the age of 4 with a maximum of 8 payments. The immature timber value is calculated by discounting at 11.9% real annual interest rate the projected stumpage revenue from the rotation age to the year before the last thinning, using today's timber price, and with a scaling relation of 325pmt/m^3. Similar to FUNDECOR's system, once the discounted value is at the year before the programmed thinning, the sinking fund factor formula is applied for calculating the annual payments[3].

A Case Study Calculation

In order to evaluate the three financial systems described above it is necessary to introduce a case study calculation using the land expectation value (LEV) o willingness to pay for land (WPL) model for analyzing the investor behavior for choosing the rotation age that maximizes benefits in monetary terms in presence of these financial mechanisms. The optimal rotation age is determined by the plantation age that maximizes the WPL value. Moreover, the reference land price is used as a criteria guideline for accepting or rejecting these investments. The case study calculation uses a *Cedrella odorata* stand. Cedar, as it is commonly known, is a highly valued endanger native forest species used in plantation forestry and agroforestry systems in the region. Despite the problems associated with the *Hypsipilla grandela* attacks, it is possible to implement a plantation under close supervision and management. In any case, there is no harm to use such an example in an experiment of this nature. It is important to know that the first drawback to the models implemented by FUNDECOR and FONAFIFO is that there is no scientific evidence for using investment criteria for selecting the optimal stand's rotation age. The question is, how does the policy instrument designer know that a "silvicultural" rotation yields the optimal rotation for production of environmental services and maximizing the landowner benefits? This experiment will prove how important for landowners and society is to estimate an investment-efficient rotation age rather than a technical o a silvicultural rotation for implementing financing mechanisms. In this exercise, it is assumed that the financial mechanisms are accessed independently to better understand their effect on profitability and optimum rotation age.

Table 1. Cedrella odorata timber harvest options.

(a) Age (yr)	(b) Diameter (cm)	(c) Volume (m^3/ha)	(d) Harvest US$/ha	(e) Capitalized cash flow US$/ha	(f) WPL US$/ha
13	31.5	75.40	$6,511.2	$5,370.3	$3,123.0
14	33.5	90.09	$7,779.4	$6,532.3	$3,372.0
15	35.4	105.94	$9,148.0	$7,786.1	$3,584.5
16	37.2	122.88	$10,610.3	$9,124.5	$3,761.2
17	39.0	140.82	$12,159.4	$10,539.7	$3,903.6
18	40.7	159.67	$13,787.9	$12,023.7	$4,013.2
19	42.3	179.37	$15,488.6	$13,568.2	$4,092.1
20	43.9	199.82	$17,254.1	$15,165.0	$4,142.4
21	45.5	220.93	$19,066.2	$16,794.9	$4,163.5
22	**47**	**242.63**	**$20,950.8**	**$18,483.0**	**$4,166.1**
23	48.5	264.83	$22,868.1	$20,187.9	$4,144.1
24	49.9	287.46	$24,822.5	$21,912.8	$4,102.6
25	51.3	310.45	$26,807.7	$23,650.2	$4,043.8
26	52.6	333.73	$28,817.7	$25,392.6	$3,969.9
27	53.9	357.23	$30,846.7	$27,132.6	$3,882.7
28	55.2	380.89	$32,889.5	$28,863.2	$3,784.3
29	56.4	404.64	$34,940.9	$30,577.6	$3,676.4
30	57.6	428.45	$36,996.4	$32,269.1	$3,560.7

[3] Edgar Ortiz Malavassi, 2003: Personal communication

The case study calculation used a biological growth model for *Cedrella odorata* adjusted for a average site of the CATIE´s farm. It was assumed an initial acceptable mortality of 10% of the original planting density (1111/trees/ha), and 3 thinning. Prior to the third thinning, the average tree diameter is still below 30cm, which is assumed to be the minimum acceptable diameter for the plantation timber production. In addition, the typical investor was defined with a minimum acceptable rate of return (MAR) equal to 8% in US$.

Table 1 presents the maximum WPL calculated assuming different final harvesting options for a one hectare stand of *Cedrella odorata* after it reached 30cm dbh. Columns (a), (b) and (c) present possible clear-cutting ages, average diameter of the stand in cm, and commercial harvested timber volumes in m^3. The commercial volume determination was done taking into account the growth and yield models, the relationship between total and commercial volume, and Smalian and the traditional rope scaling systems. Based on the land value system developed for the area of study (Turrialba, Costa Rica), the market value of land for a fertile soil was reported to have a price of US$4000/ha. Planting, site preparation and maintenance cost for the first year was estimated in $661/ha. Maintenance cost per hectare for years 2 to 6 are $312, $228, $132, $129 and $190 respectively. First, and second-third thinning have a cost of $147 and $70/ha each. Pruning costs are estimated at 29.37/ha the year after thinning. The annual administrative costs are set at $15/ha. Column (d) presents the harvest income in US$/ha, and it is actually the potential clear-cut revenue. The stumpage prices with an average tree dimension bigger or equal than 30cm dbh were set at US$86.35/$m^3$ (¢110/pmt). Column (e) totals the establishment and maintenance revenues and costs compounded to each potential final harvest age in a per hectare basis.

Finally, column (f) in Table 1 shows the WPL, which is equal to column (d) plus column (e). Then, the result is discounted to year 0, considering all future rotations. Thus, the maximum WPL option, as a measure of the landowner's investment net benefit, defines the preferred age for cutting the stand, and also gives information on whether to accept of reject the project. The maximum WPL for *Cedrella odorata* is US$4,166.1/ha at rotation age 22-years at a MAR of 8%. Since the maximum WPL is higher than the US$4,000/ha land price, then the investment is accepted. The WPL maximization is the process of estimating the correct land holding value which is the investor's maximum bidding price for farmland to be used in a *Cedrella odorata* plantation investment in Turrialba region.

Economic Analysis

This case study is used as a reference to evaluate the effect that the 3 financial mechanisms have on the profitability of the investment and investor rotation age choice that maximizes the investment. FONAFIFO´s PES is a payment that society makes for the environmental services provided by plantation forestry. PES reduces establishment and maintenance costs in the first 5 years of the investment. This reduction on production costs rises the asset value (WPL) to $4651/ha, but decreases the rotation age to 21-years in relation to the reference case. Such behavior is suggested by the economic theory, and it is shown in Table 2 (Johansson and Löfgren, 1985). However, from the policy standpoint, such payment scheme produces a contrary effect on the provision of environmental services. If the PES, as a policy instrument, decreases the rotation age; it also reduces the life span for providing environmental services, and reduces the expected social benefits paid for. Society's expected benefit is to maximize environmental services, not to increase profits for the landowner. In this sense, a good economic concept such as the market for environmental services may have negative effects if it is

implemented with the wrong financial instrument.

FONAFIFO´s timber loan (TL) produces a decrease in the WPL to $3754/ha below the land price rejecting the investment, and it also decreases the optimal rotation age to from 22 to 20-years. The TL interest rate is 4 points higher than the reference case. Therefore, it should produce a reduction in the WPL and the optimal rotation age (Johansson and Löfgren, 1985). One of the aims of a timber loan was to increase the rotation age and to improve profitability. The financial instrument used for the TL produced a contrary effect in respect for its objectives. FONAFIFO's two financial instruments fails to meet society goals on enhancing the provision of environmental services from plantation forestry.

Table 2. Three official financing mechanisms for plantation forestry and their effect in the profitability and optimal rotation age for *Cedrella odorata*

Institution	Financial Mechanism	Interest Rate	Volume m^3/ha	Number of Payments	Amounts US$/ha	WPFL US$/ha		Optimal Rotation Age	
Reference Case Study	Self-funded Investment	8%				$4166.3	ref	22	ref
FONAFIFO	Payment of environmental services (PES)	None		5 decreasing payments	$243.9 (50%) $89.6 (20%) $61.7 (15%) $37.7 (10%) $17.3 (5%)	$4,651.8 (+$488.4)	↑	21 (-1)	↓
FONAFIFO	Timber Loan (TL)	11.90%	50 (325pmt/m3)	8 equal payments (age 4-11)	$114.72 / year	3754.6 (-$411.70)	↓	20 (-2)	↓
FUNDECOR	Pre-purchase timber (PPT)	11%	40 (43.3 with 300pmt/m3)	9 equal payments (age 3-11)	$79.28 / year	$3,906.1 (-$260.12)	↓	24 (+2)	↑

According to Table 2, FUNDECOR´s PPT system also results in a decrease in the WPL below market price, $3906.1/ha. However, PPT increases rotation age in respect to the reference case to 24-years. The PPT reduces the harvest income by taking 43m^3 out of the final commercial volume, which reduces investor revenues; decreasing WPL and increasing the optimal rotation age (Johansson and Löfgren, 1985). FUNDECOR's PPT is the financial mechanism which reduces less the WPL in comparison with the base case and the PES option, but increases the optimal rotation age in two years in comparison to the base case.

It has been proved that PES and TL decrease the period of environmental services, and TL and PPT make the investment not profitable for this case study. Could it be possible to solve the optimal rotation problem of the PES and the profitability problem of the PPT? Table 3 presents three theoretical models designed, one to improve the problems with the PES and two evaluate more in depth the PPT. In one hand, PES by definition is a payment for services

coming from the forest ecosystem, and these services are provided in a continuous way until the final harvest. PES should be associated with an income or production capital, and not as investment capital for afforestation. Therefore, a theoretical PES has been designed by establishing a annual equal payment of $35/ha from the first year to the final harvest year. This theoretical PES increases the WPL, $4,603.8/ha, and maintains the optimal rotation age at the same level compared with the reference case. On the other hand, two theoretical PPT models were designed improving several things: Scaling method (325pmt/m^3), lower the interest rate (8%), and the introduction of annual purchase method for the immature timber with a progressive payment method, which pays more for the wood as it get closer to maturity. PPT Model 1 was similar to the FUNDECOR's PPT where they purchased 40m^3 in 9 payments. This model was implemented by buying 4.4 m^3/ha/year from age 3 to age 11, and every year the amount paid was higher as the timber got closer to maturity. The result was an increase on the WPL making the investment profitable at 4123/ha, and it kept the optimal rotation of the original PPT (24-years). On the other hand, a second model of the PPT used conditions similar to the FONAFIFO's TL with 50m^3 in 8 payments. The result for Model 2 also increased the WPL to a profitable conditions just above the land price, but increase the optimal rotation age to 25-years. From society point of view, PPT Model 2, in this exploratory analysis, is the desired financial system because maintains the profitability of the investment, a bit lower from the reference case, but increases the rotation age in three years, which provides society more environmental services and also will provide to the market bigger round wood.

Table 3. Three theoretical models for plantation forestry and their effect in profitability and the optimal rotation age for a hectare of Cedrella odorata

Institution	Financial Mechanism	Interest Rate	Volume m^3/ha	Number of Payments	Amounts US$/ha	WPFL US$ / ha		Optimal Rotation Age	
PES Theoretical	Payment of environmental service (PES) in annual payments	None		Annual equal payments	$35.00	$4,603.8 +$437.50	↑	22 0	-
PPT Theoretical model 1	Pre-purchase timber (PPT)	8%	4.4m3 / yr 40 (325pmt/m3)	9 progressive payments (age 3-11)	$78.65 (age 3) $84.9 (age 4) $91.7 (age 5) $99.1 (age 6) $107.0 (age 7) $115.5 (age 8) $124.8 (age 9) $134.7 (age 10) $145.5 (age 11)	$4,123.0 (-$43.1)	↓	24 +2	↑
PPT Theoretical model 2	Pre-purchase timber (PPT)	8%	6.3m3 / yr 50 (325pmt/m3)	8 progressive payments (age 4-11)	$112.8 (age 4) $121.8 (age 5) $131.6 (age 6) $142.1 (age 7) $153.5 (age 8) $165.8 (age 9) $179.8 (age 10) $193.4 (age 11)	$4,082.65 (-$83.61)	↓	25 +3	↑

Concluding remarks

The economic model for a "market" of environmental services where those who enjoy such services must pay for those who produce them is a strong concept that could help to preserve and enhance the quality of the natural environment and reduce the pressure of other competing uses on forestry investments. However, It is important to evaluate the effect that

a financial instruments will have in the behavior of the forest investor to make sure that the financial instrument achieved positive financial and environmental goals. Finally, it has been proved that the analysis with microeconomic models, such a the WPL, are helpful tools for evaluating and designing monetary policy instruments for promoting plantation forestry as a competitive investment and also as a way to compensate for the provision of environmental services.

References:

Johansson, P.-O. & Löfgren, K.-G. [1985]: The Economics of Forestry and Natural Resources. Basil Blackwell Ltd., U.K. 292p.

Navarro, G. 1999. Valuation Techniques and Investment Decision Model for Private Timber-oriented Even Aged Plantation Forestry under Monetary Incentive Instruments in Costa Rica. M. Sc. Thesis Faculty of Forest- Geo- Hydro- Sciences. Dresden University of Technology. 115p