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Economic Analysis of the Forest Promotion, Forest-Saving Program, Installed in the Southern Half of Rio Grande do Sul State, Brazil

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Abstract

This study aimed to analyze economically the forest promotion, forest-saving program installed in the southern half of Rio do Grande do Sul State, Brazil, as an income alternative and potential supplier of raw material in the forest production segment. Cost data were calculated for the total of 269 projects per hectare and divided into Inputs and Services. The revenues were derived from the sale of standing timber at the end of the forest production cycle, not including harvesting costs. For economic analysis, criteria from Net Present Value (NPV), Benefit Cost Ratio (B/C), Internal Rate of Return (IRR), and Equivalent Annual Value (EAV) were used. The interest rate used was 7.0% per year according to the promotion program. The project presents at seven years a NPV of $542.90 and an IRR of 16.0%, showing to be feasible and attractive. The costs and revenues from the year seven planting were analyzed and with addenda at years 8, 9, and 10, demonstrated that greater project profitability gains are achieved between years 8 and 9 with an increase of $463.18 in relation to year 8. This represents a profitability of 49.0% which had an increase of $229.61 when compared to year 7. The sensitivity analysis demonstrated the inverse relationship trend that exists between the NPV and the interest rate.

The project's return capacity from the seventh year is precisely referenced by the freezing of the debt, which did not accrue an interest rate adjustment, as well as the price per cubic meter of timber, which remains readjusting as zero bases.

Keywords: costs, forest-saving, forestry, productivity, revenues

1. Introduction

Forests play an important role in society, providing a range of benefits, either through its timber or non-timber products, its multiple ecological and socioeconomic roles, protection of natural resources, and social welfare (Schettino, 2000). Thus, it is necessary to develop national and regional forest policies which combine timber production objectives, conservation, and generation of socio-economic benefits (Schjetman, 1998). Moreover, one of the great challenges of the forest sector is the establishment of foundations for a sustainable management of forest activities.

In this context, the Forest-saving program stands out, comprising an incentive policy for the planting of plantations of the eucalyptus genus for rural producers. According to Penido (2005), this program is founded on sustainable development and social responsibility, thus contributing to income generation, in addition to environmental preservation and sustainability. Thereby, the model opens a perspective of sustainable business for the rural producer, who has received incentives for planting since the first year of the program, with the provision of seedlings for reforestation, technical assistance, warranty of merchantability for the timber, and environmental education programs (Vidal, 2005; Kengen, 2002).

Among the positive aspects of the forest promotion program, the awareness-raising of the rural producer in relation to the benefits of reforestation and local development stands out, corroborating for a significant number of rural producers planting native species or practicing reforestation with eucalyptus due to forest benefits (Neves, 1994; Soares, 2007; Valverde, 2003).

With this, it becomes extremely important for the idealized program to produce results, such as the generation of regional income as well as to make it known as having great entrepreneurial potential, adding value to rural properties, and promoting social development. Because of this, it becomes essential the knowledge of actual data and facts to enable plans and guidelines to be drawn up, aimed at sustainable development. Among the works addressing this reality, the studies developed by (Gonçalves, 1959; Coelho, 2002) stand out.

In view of this, this work aimed to analyze economically the forest promotion, forest-saving program installed in the southern half of Rio do Grande do Sul State, Brazil, with regards to its costs for forest formation, productivity and the economic value added for the rural producer, as an income alternative and potential supplier of raw material in the forest production segment.

2. Material and Methods

2.1 Characterization of the Project Area

This study was performed in a forestry company called Fibria Celulose S.A. in the southern half of Rio do Grande do Sul State. According to the Köppen climate classification, the region's climate is of the "*Cfa*" and "*Cfb*" subtropical type, characterized by rain during all months of the year, featuring temperatures above 22 °C in the hottest month and around 3 °C in the coldest.

In 2004, the company adopted two paths for forest production. Among them, areas purchased and implementation carried out by the company and the Forest-saving program, which aims to encourage the region's producers to plant forests.

2.2 Cost and Revenue Data Involved

Cost data were calculated for 269 projects and divided into Inputs and Services, which include implementation and maintenance costs, resulting in the cost per hectare. The revenues were derived from the sale of standing timber at the end of the forest production cycle, not including harvesting costs.

2.2.1 Services

Service costs comprised those activities performed prior to the planting, as well as planting and maintenance during the forest growth period up to harvest time, consisting of costs related to labor and machine-hour.

To combat ants, first, bulk insecticidal bait was systematically used in the entire area followed by its localized application. Next, mechanical, or manual mowing was planned for the areas of greatest weed infestation. According to evaluations performed and the determination of the type of infestation, herbicide was used.

The minimum cultivation tillage system was adopted, with subsoiling in the planting line using three-shank equipment. The subsoiled strip reaches a width of 0.80 m and a depth of up to 40.0 cm. In the same strip, two harrowing operations were performed to improve soil conditions for planting, whereupon fertilization can be applied at the same time.

The spacing used was 3.0 × 2.0 m and 4.0 × 1.5 m. In both cases, planting density was 1,667 plants ha^{-1}. Replanting was performed up to 30 days after planting. Activities including chemical weeding, firebreak maintenance and occasional mechanical mowing in certain projects were also performed. The details of service activities, as well as their costs, can be seen in Table 1.

Table 1. Detailing of service activities for project implementation

Year	Activities	Labor		Machines		Total cost $ ha^{-1}
		Daily rates	$ ha^{-1}	Hours	$ ha^{-1}	
1	Initial ant combat	1	7.85			7.85
	Mechanical chemical total area cleaning			1.88	23.56	23.56
	Mechanical cleaning and firebreaks			2.08	26.18	26.18
	Subsoiling with grid			4.40	55.24	55.24
	Harrowing + Fertilizing			2.29	28.80	28.80
	Ant combat repass	0.73	5.76			5.76
	1st Release		13.61		133.77	147.38
	Total financed area		13.61		133.77	147.38
	Manual planting	4	31.41	2.81	35.34	66.75
	2nd Release		31.41		35.34	66.75
	Total financed area		31.41		35.34	66.75
	Manual/chemical weeding on the line	7.8	61.26			61.26
	2 to 4 months fertilizing	2.84	22.30			22.30
	Manual/chemical weeding on the line	7.8	61.26			61.26
	Mechanical mowing between the lines			2.08	26.18	26.18
	6 to 9 months fertilizing	2.84	22.30			22.30
	Ant combat maintenance	1	7.85			7.85
	Mechanical mowing between the lines			2.08	26.18	26.18
	3rd Release		174.97		52.36	227.33
	Total financed area		174.97		52.36	227.33
2	Ant combat maintenance	0.53	4.19			4.19
	Firebreak maintenance			0.5	6.28	6.28
	4th Release		4.19		6.28	10.47
	Total financed area		4.19		6.28	10.47
3	Ant combat maintenance	0.53	4.19			4.19
	Firebreak maintenance			0.5	6.28	6.28
	5th Release		4.19		6.28	10.47
	Total financed area		4.19		6.28	10.47
4	Ant combat maintenance	0.53	4.19			4.19
	Firebreak maintenance			0.5	6.28	6.28
	6th Release		4.19		6.28	10.47
	Total financed area		4.19		6.28	10.47
	Total		232.57		240.31	472.88

2.2.2 Inputs

Inputs are factors used in the production process for forest forming, such as fertilizers, pesticides, and herbicides. In Table 2, activities with the description of the inputs are described (quantity ha^{-1} and total ha^{-1}).

Table 2. Detailing of inputs used for project activities

Year	Activities	Inputs		Total cost $ ha^{-1}
		Description	Quantity ha^{-1}	
1	Initial ant combat (kg)	Granulated bait	3.0	6.28
	Mechanical chemical cleaning (kg)	Scout/Glyphosate herbicide	2.0	14.66
	Harrowing + Fertilizing (kg)	NPK 6,30,6 Fertilizer	218.0	97.02
	Ant combat repass (kg)	Granulated bait	2.0	4.19
	1st Release			122.15
	Total Financed Area			122.15
	Manual/chemical weeding on the line (kg)	Scout/Glyphosate herbicide		3.66
	2 to 4 months fertilizing (kg)	Ammonium Sulfate + 1% Bo	190.0	69.63
	Manual/chemical weeding on the line (kg)	Scout/Glyphosate herbicide	0.5	3.66
	6 to 9 months fertilizing (kg)	Ammonium Sulphate + 1% Bo	190.0	69.63
	Ant combat maintenance (kg)	Granulated bait	2.0	4.19
	3rd Release			150.79
	Total Financed Area			150.79
2	Ant combat maintenance (kg)	Granulated bait	2.0	4.19
	4th Release			4.19
	Total Financed Area			4.19
3	Ant combat maintenance (kg)	Granulated bait	1.0	2.09
	5th Release			2.09
	Total Financed Area			2.09
4	Ant combat maintenance (kg)	Granulated bait	1.0	2.09
	6th Release			2.09
	Total Financed Area			2.09
	Total			281.31

From the total service costs, which added to $472.88 per hectare for the 269 projects, $232.57 in labor and $240.31 in machine-hours was obtained (Table 1). The total services and inputs costs totaled $754.19 per hectare. For the region, this cost proved to be very attractive, since the disbursement by the producer was over the years.

2.3 Data Organization

A search was performed in the company's database, whereby the number of producers who are part of the program was analyzed, listing the costs for implementation, services, financed amounts, the forest inventory results of properties with an average of 7 years as well as the amount paid to the producer per m³ ha^{-1} of standing timber from the forest inventory results, in general terms for the project.

For economic analysis, the interest rate of 7% per year was used, which is the same rate adopted in the promotion program. For costs and revenues, the actual values at the time of the implementation were considered, being later adjusted according to the interest rate. Implementation costs were considered as taking place in the zero-period and the maintenance costs (inputs) as taking place from year zero to the end of the 7-year rotation.

The forest-saving program aimed the purchase of standing timber from the producers, in which case the tool used to measure the volume of existing timber in the project was through the pre-harvest forest inventory for the quantitative understanding of the plantation, whereby all existing individuals in the demarcated area were measured, with a tolerated sampling error of 5%.

2.4 Financial Evaluation Criteria

At first, a partnership was established with Banco, who founded the initiative with fixed interest rates, without annual amortization and without collateral to subsidize the forest implementation costs, standing the forest as collateral. The organization, in the other hand, guaranteed the purchase of 95% of the timber produced, leaving the remaining 5% at the discretion of the producer to sell the timber to the company or use it in his or her property. For financial evaluation, methods that consider capital variation over time were adopted, since they are long-term investments, as Rezende and Oliveira (2001) mention.

Net Present Value (NPV): Able to determine the current value of future payments discounted at an interest rate subtracting the original cost of the investment. According to Silva et al. (2005), the NPV is the difference between the current value of revenues and the current value of costs. Thus, the project that presents an NPV greater than zero is considered as being economically feasible. This indicator is calculated by the following equation:

$$NPV = \sum_{j=0}^{N} R_j \,(1 + i)^{-j} - \sum_{j=0}^{n} C_j \,(1 + i)^{-j} \quad (1)$$

Where, *Rj* = revenue in the period *j*; *Cj* = cost in the period *j*; *i* = interest rate; *j* = period of occurrence of the revenue or the cost (0, … *n*); *n* = maximum number of project duration periods.

Internal Rate of Return (IRR): It considers the project as feasible in which the IRR is higher than the interest rate used in the calculation and, for project comparison, the one that is considered the best is the one that presents the highest IRR. Thus, this rate equals the NPV of a project equal to zero, *i.e.*, it is when the current value of revenues becomes equal to the current values of costs (Rezende & Oliveira, 2013). Its equation is given by:

$$\sum_{j=0}^{n} R_j \,(1 + TIR)^{-j} = \sum_{j=0}^{n} C_j \,(1 + TIR)^{-j} \quad (2)$$

Benefit Cost Ratio (B/C): It is based on dividing the revenues by the costs which may occur during the lifetime of the project, *i.e.*, it establishes the relation between the current value of revenues and the current value of costs (Dossa et al., 2000). It is calculated by the following equation:

$$\frac{B}{C} = \frac{\sum_{j=0}^{n} R_j (1 + i)^{-j}}{\sum_{j=0}^{n} C_j (1 + i)^{-j}} \quad (3)$$

Equivalent Annual Value (EAV): It is also called Value Periodic Equivalent (VPE). It is the periodic and constant portion required for the payment of an amount equal to the NPV of the investment option undergoing analysis, over its lifetime. It consists in determining the income or benefit - in case it is positive or the cost - in case it is negative, equivalent to the project's lifetime (Casarotto Filho, 2010). It is calculated by the equation:

$$VPE = \frac{VPL \times (1 + I)^{t}}{1 - \frac{1}{(1 + I)^{nt}}} \quad (4)$$

Attracting new producers to the Forest-saving program did not feature a minimum or maximum area; however, some factors were taken into consideration for their eligibility. The aspects that were analyzed for this type of business are related to the producer's profile, as a producer of wood for pulp. Subsequently, the project's economic analysis was performed, adjusting the costs and revenues for the zero moment, in addition to structuring the project's cash flow. With the base value of the cubic meter in the year zero set at \$5.27, the revenue at the end of year 7 was obtained.

The forest promotion project was funded for 7 years, with the endorsement of the company holding the guarantee of purchasing the product. In the seventh year, upon its implementation, the payment of the debt to the bank was made by the company and converted into cubic meters for the producer. From this, the option was presented of either selling the standing timber or renegotiating the contract for another 3 years, *i.e.*, up to ten years, with the value of the debt frozen from the time of the end date of the contract, by means of an addendum to the original contract, considering annual increase data provided by the forest inventory. Thus, following the same sequence, in the eighth year, the price per cubic meter was adjusted to \$9.06, by the productivity of 285.5 m^3 ha^{-1} as inventory. In the ninth year, the price per cubic meter was adjusted to \$9.69, by the productivity of 373.34 m^3 ha^{-1} and, therefore, in the tenth year, the price per cubic meter was set at \$10.37, by the productivity of 453.25 m^3 ha^{-1}. It should be noted that as productivity increased, prices were adjusted with the reality of the year under analysis according to an interest rate.

Then, due to the uncertainty, a sensitivity analysis was performed, which is a technique used in situations where there is no information about probability distribution, *i.e.*, when there are uncertainties and lack of control on the form and intensity that certain future events will influence the project. Thus, it is possible to examine possible changes in values, such as in IRR and in NPV, produced by cash flow component parameters variations (entries and exits).

3. Results and Discussions

3.1 Economic Analysis

The economic analysis of the project was accomplished by correcting the costs and revenues for the zero moment and constructing the cash flow of the project. With the base value of the cubic meter in year zero of \$8.47, revenue was obtained at the end of year 7. Thus, in the seventh year, based on revenue, the price per cubic meter corrected at 7% per year from of the zero base, is \$8.47, for the productivity of 241.96 m^3 ha^{-1}, according to inventory, the total revenue, was \$2074.90.

Table 3. Costs, Revenues and Cash Flow for the seventh year

Year	Costs (\$)		Total Costs (\$)	Revenues (\$)	Cash Flow (\$)
	Inputs	Services			
0	272.9	441.5	714.4		-714.4
1	4.2	10.5	14.7		-14.7
2	2.1	10.5	12.6		-12.6
3	2.1	10.5	12.6		-12.6
4					
5					
6					
7				2074.9	2074.9

Economic feasibility indicators of the project—NPV, IRR, EAV and B/C Ratio are presented in Table 4.

Table 4. Economic feasibility indicators calculated for the project in year 7

Economic indicators	
Minimum Hurdle Rate (%)	7
Net Present Value (\$ ha^{-1})	542.9
Internal Rate of Return (%)	16.0
Equivalent Annual Value (\$ ha^{-1} year)	100.7
Benefit Cost Ratio (B/C)	1.72

As per the economic indicators calculated for the interest rate of 7% per year, it is possible to see that the project presented an attractive economic feasibility for the rural producer. With an Internal Rate of Return (IRR) of 16%, the project has good attractiveness when compared to other hurdle rates, since the IRR represents the project's profitability, *i.e.*, it is the rate that summarizes the project's return. Subsequently, the value found for the Net Present Value (NPV) of \$542.90 represents the product covered the entire investment and it still had a financial surplus gain. According to Rezende (2006), in an economic analysis performed for the promotion program in the Estate of Minas Gerais, a NPV of \$521.14 ha^{-1} for standing timber was obtained at 7 years, which represents a value 3% lower than the one found for the promotion program in the South of Rio Grande do Sul State, for the same 7-year period.

As for the Equivalent Annual Value and Benefit Cost Ratio indicators, the project shows economic effectiveness, since for all years, from the amount invested, the producer received \$100.70 and a B/C Ratio greater than 1.

Subsequently, for years 8, 9 and 10, the total revenue obtained was \$2619.70, \$3665.40, and \$4761.40, respectively. Table 5 shows the costs, revenues, and the cash flow for years 8, 9 and 10.

Table 5. Costs, Revenue and Cash Flow for years 8, 9 and 10

Year	Total Costs ($)			Revenues ($)			Cash Flow ($)		
				Year			Year		
	Inputs	Services	Total	8	9	10	8	9	10
0	272.9	441.5	714.4				-714.4	-714.4	-714.4
1	4.2	10.5	14.7				-14.7	-14.7	-14.7
2	2.1	10.5	12.6				-12.6	-12.6	-12.6
3	2.1	10.5	12.6				-12.6	-12.6	-12.6
4									
5									
6									
7									
8				2619.7			2619.7		
9					3665.4			3665.4	
10						4761.4			4761.4

Considering the same economic indicators for different years of project conclusion and the same interest rate, the following results were achieved, as per Table 6.

Table 6. Economic feasibility indicators calculated for the project in years 8, 9 and 10

Year	Economic indicators			
	NPV ($/ha)	IRR (%)	EAV ($/ha/year)	B/C Ratio
8	775.3	17	129.8	2.03
9	1244.4	19	191.0	2.66
10	1671.1	20	237.9	3.23

Analyzing the data, the biggest gain in the project's profitability takes place between years 8 and 9, with an increase of $469.18 in relation to year 8. This represents a profitability of 49% in relation to year 8, which had an increase of $232.40 in relation to year 7. The project's return capacity from the seventh year is precisely referenced by the freezing of the debt, which did not accrue an interest rate adjustment, concurrent with the price per cubic meter of timber continuing being readjusted as zero-base until the time of accounts meeting, this takes place close to the harvest. Thus, there is greater representativeness of the increase in cubic meter volume of timber per h^{-1} year. Hence, the producer who has chosen to extend the term of his or her project, ended up having a more attractive return due to good forest production, which provided higher-profit return.

Based on forest inventory surveys, forest productivity from the fifth year showed growth up to the tenth year, reaching 56 m^3 ha^{-1} year (Figure 1). The results of economic indicators after the seventh year are directly linked to forest growth, increasing project productivity.

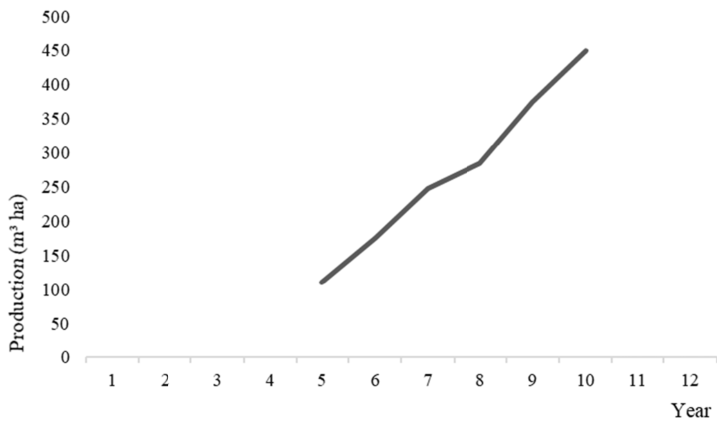

Figure 1. Project's general productivity

A study performed by Magnante (2015) for the same promotion program reports that the results for the early years of the project were positive, representing an average annual gain of $201.09 per cubic meter of timber with bark. The same study also reports that, when compared to beef cattle production and soybeans in the same year, the return per hectare and year for eucalyptus was 74% and 38% higher than for beef cattle production and soybeans, respectively.

3.2 Sensitivity Analysis

In the sensitivity analysis for the seventh year of the project, with an interest rate variation ranging from 1% to 20%, it is possible to logarithmically verify the behavior of the parameter that indicates the feasibility in relation to interest rate variation, as Figure 2.

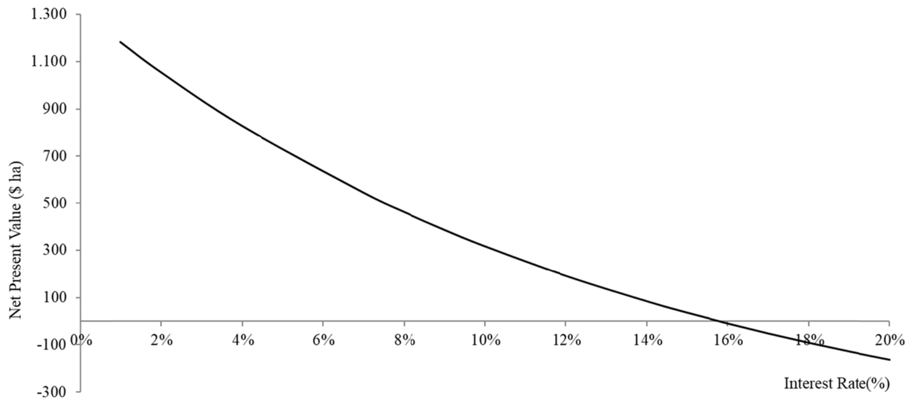

Figure 2. Feasibility indicator in relation to interest rate variation

Through the sensitivity analysis, it has been noted that with a 15.5% interest rate, an NPV lower than zero is achieved, which represents economic unfeasibility for the project in the presence of interest rates above 15%, demonstrating the inverse relationship between interest rates and the Net Present Value (NPV). Thus, it is possible to check the results summary according to the different cash flow values, such as variations in input costs, product prices, discount rates, etc.

4. Conclusions

The Forest-saving program, as a strategic model, enables the supply of raw material to the industry, generating income for rural producers and, consequently, contributing to regional forest development. The guarantee by part of the contracting party in relation to the purchase of timber from the time the contract is signed conveys negotiation security since the producer knows that he or she will produce the product and that, upon the contracted harvest, he or she is already aware of the price per cubic meter to be received from the sale of timber, regardless of any economic variable.

The breakdown of cultural barriers with the consortium of annual crops together with the planting of forests, providing income alternative beyond eucalyptus, strengthening diversity and the local productive chain, are positive aspects that the program has provided for producers in the region. Moreover, based on forest inventories, productivity is proven to be satisfactory in the seventh year and over the period up to its deadline, as the forest continues to evolve exponentially reaching important production gains that will presume profit. Thus, the developed forest saving promotion program complied with the analysis, verifying the economic viability for the rural producer, being a major supplier of wood for pulp, which has guarantees and incentives for forest production within the Forest Savings Program, reaching the economic superiority and attractiveness in the seventh, eighth, ninth and tenth years.

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