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Economic Viability of Management Plants of *Stryphnodendron adstringens* (Mart.) Coville in North of Minas Gerais State

Viabilidade Econômica do Plano de Manejo do *Stryphnodendron adstringens* (Mart.) Coville no Norte de Minas Gerais

Viabilidad Económica Del Plan de Manejo de Stryphnodendron adstringens (Mart.) Coville en el Norte de Minas Gerais

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Abstract
This study aimed to assess the economic viability of managing the *Strypodendron adstringens* Mart. Coville in the Cerrado *sensu stricto* in North of Minas Gerais. To achieve this goal we analyzed the economic feasibility of four management plans under selective cuts with 40, 50, 60 and 70% of basal area removed (G). The method consisted of building a cash flow for the species with a planning horizon for ten years. After obtaining the cash flow, with the help of economic engineering resources, we evaluated the financial indicators. These indicators consisted of Net Present Value (NPV), Internal Rate of Return (IRR), Discounted *Payback period* (PP) and Break-even Point (BEP). The results presented economically viable for all plans analyzed. But the plan 70% of basal area removed, stood out from the rest. Therefore it is concluded that the production of barks of barbatimão is economically viable since the intervention takes place in the percentage of 70% basal area within a sustainable management system.
Keywords: Savannah; Conservation; Barbatimão.

Resumo
Objetivou-se avaliar a viabilidade econômica de manejar a *Strypodendron adstringens* Mart. Coville no cerrado *sensu stricto* do Norte de Minas Gerais. Para atingir esse objetivo analisou-se a viabilidade econômica de quatro planos de manejo sob cortes seletivos com 40, 50, 60 e 70% de área basal removida (G). O método consistiu da construção de um fluxo de caixa para a espécie com um horizonte de planejamento para dez anos. Após a obtenção do fluxo de caixa, com o auxilio dos recursos de engenharia econômica, avaliou-se os indicadores financeiros. Esses indicadores consistiram do Valor Presente Líquido (VPL), da Taxa Interna de Retorno (TIR), do *Payback period* descontado (Pbd) e do Ponto de Equilíbrio (PE). Os resultados apresentaram viáveis econômicamente para todos os planos analisados. Porém o plano de 70% de área basal removida, se destacaram dos demais. Portanto conclui-se que a produção de cascas do barbatimão é viável economicamente, desde que a intervenção ocorra no percentual de70% de área basal dentro de um regime de manejo sustentável.
Palavras-chave: Cerrado; Conservação; Barbatimão.

Resumen
El objetivo fue evaluar la viabilitad económica del manejo de *Stryphnodendron adstringens* Mart. Coville em el Cerrado sensu stricto del norte de Minas Gerais. Para lograr este objetivo se analizó la viabilidad económica de cuatro planes de manejo bajo cortes selectivos com 40, 50, 60 y 70% de área basal removida (G). El método consistió em construir um flujo de caja para la especie com un horizonte de planificación de diez años. Luego de obtener el flujo de caja, con la ajuda de recursos de ingeniería económica, se evaluaron los indicadores financieros. Estos indicadores consistieron em el Valor Presente Neto (VAN), la Tasa Interna de Retorno (TIR), el Periodo de Recuperación descontado (PBD) y el Punto de Equilibrio (PE). Los resultados fueron económicamente viables para todos los planes analizados. Sin embargo, el plan de remoción del 70% del área basal se destacó de los demás. Por lo tanto, se concluye que la producción de corteza de barbatimão es económicamente viable, siempre que la intervención se realice en el porcentaje del 70% del área basal dentro de un régimen de gestión sostenible.
Palabras clave: Cerrado; Conservación; Barbatimão.

1. Introduction

The Savanna presents great diversity of non-timber products potentially viable for economic exploitation. According to data of IBGE statistical yearbooks, the bark of barbatimão (*Stryphnodendron adstringens*) for the production of tannin is among the most produced non-timber forest products (NTFPs) occurring in the Savanna. Minas Gerais excels in producing barbatimão (*Stryphnodendron adstringens*) followed by Pará, Bahia and Goiás (Almeida et al., 1998). The economic valuation of non-timber forest products is in the market demand which grows currently. The advantages of the growing market of non timber forest products are mainly, the possibility of reconciling economic development coupled with environmental conservation and maintenance of populations in the original regions. However, with population growth and decrease of the basis of these forest resources, these products generally extractives, are under increasing pressure (Almeida et al., 2009).

The high market demand for products contributed to greater appreciation of their prices by the market (izco; burneo, 2003). The economic analysis of a forestry investment involves the use of techniques and criteria of analysis that compares the costs and revenues associated with the production. It consists in verifying if these costs are surpass the needed revenue. Companies that produce material from management plans with economic and environmental viability are strong candidates to get a green stamp (Amaral et al., 1998).

To obtain certification, the company needs the production from the exploitation of Non-Timber Forest Resources (NTFRs) to be socially fair and economically viable. The production reliability is assessed by environmental and economic indicators. The main economic indicators consist of the Net Present Value (NPV), Internal Rate of Return (IRR), Payback and Break-even Point (BEP) (Souza et al., 2007 and Oliveira et al., 2002).

The economic value is directly related to the biodiversity of each site (Guerra et al., 2009) and the north of Minas Gerais is, as an example, one place that holds natural resources which can contribute to economic growth in the region (BRITO, 2005). To evaluate the harvest of the bark in this context, there was the objective of evaluating the economic viability of managing the *Stryphnodendron adstringens* (Mart.) Coville in Savannah in the North of Minas Gerais.

2. Methodology

The study was conducted at Bela Vista Farm in the municipality of Botumirim in the North of Minas Gerais state. The study area is located in the Cerrado *sensu stricto* coordinates: latitude: 16º96'82.563841343' South, Longitude 43º0'75.7193826139 West and 892.223 m altitude. The farm is a private estate of 170 ha, where the study area is 31.28 ha and it is in process of advanced regeneration, without the presence of domestic animals. This area was an inventory of forest species. To carry out the forest inventory, plots were distributed in 25 equally spaced transects at 80 m. The plots were 20 x 20 m (400 m^2) equally spaced 20 m apart. Within each plot all adults living with diameters at 1.30m (DAP) ≥ 3 cm from the soil were measured.

The obtained diameters were distributed by Spiegel formula (Felfili; Rezende, 2003). Finished the diameter distribution, the frequency data (*fi*) were fit to the model of Meyer $Lny_i = \beta 0 + \beta 1 * Lnx_i$ at an exponentia negative curve from the central value of the diameter classes (xi) (SCOLFORO, 1998). The 'xi' led to the total basal area (G), the precursor of the equations developed by Da Gama (2012) used to estimate the production. Where $LnPsc = -3{,}71840864 + 0{,}896190311\ Ln(dap^2 ht)$ for dry weight of bark (kg) with coefficient of determination (R^2) and residual standard error (Syx) of 96,67% and ± 26,45% and $LnV = -10{,}1745813 + 1{,}005891616\ Ln(dap^2 ht)$ for the timber volume (m³) with a coefficient of determination (R^2) and residual standard error (Syx) of 97.25% and ± 27.87%, respectively.

After preliminary study of the data parameters were defined to assess the technical feasibility of the management plan for the species. In which the horizon of cutting cycle was ten years for the replacement of the basal area in the Cerrado *sensu stricto*; one plot was randomly removed per year, according to the IEF-MG No. 054, of August 25th, 1997, repealed by Ordinance Nº. 87 of May 17th, 2005, Annex III, Chapter 4, Article 4.4.2 and 4.5. 3. The definition of the viable plans was technically according to Meira (2012), based on the ability of the study area to meet the demand of annual production of barks of the species in 7000 $kg.ano^{-1}$ under the management plans between 40 to 70% basal area removed. These plans were defined so as to respect the support mechanisms of the ecosystem through a BDq modified approach which consists in removing the basal area (G) while the maximum diameter (D) and the De Liocourt quotient (*q*) remain unchanged (RANGEL et al., 2006). Such technical and environmental analyzes supported the study of economic feasibility.

Economic parameters used were structured in effective operational cost (EOC) that includes all expenses and investment and total operational cost (TOC), which included the sum of EOC and taxes charged by the State Forest Institute. With these values and obtaining all necessary inputs for the implementation of the management plan, we evaluated the return on investment and profitability indicators. In this analysis, physical and financial investment were based on the production from the conversion of total values of the cutting cycle in annual, with the investment fully implemented in the first year (assuming zero year) (Martin et al., 1998). To support these analyzes, we adopted the following economic indicators: Gross income (GI): amount of bark (kg) and timber (m³) extracted from barbatimão multiplied by the selling price in the product market, Gross Operational Profit (GOP) : difference between GI and TOC. This indicator measures the profitability in the short term, showing the financial condition and operational activity. Thus we have the GOP = GI - TOC (Martin et al., 1998).

Cash Flow (CF) allows identifying a net flow at each financial year. This is the algebraic sum of the inputs (GI) and the expenses incurred during the project cycle (Henriques et al., 2010). To calculate the cash flow, we considered all economic parameters, disbursements and taxes and social as well as the annual interest on capital for the investment. Estimates were made based on the sale price of barks, charged by barbatimão in the region.

The viability of the investment was assessed from economic indicators such as net present value (NPV) analysis based on sensitivity and variation in basal area removal. This is indicated by the positive difference between revenues and costs updated according to the discount rate determined (Souza et al., 2007). Besides NPV it was used the internal rate of return (IRR). This indicator takes into account the variation of capital over time, ie, indicates how high you can reach the interest margin for the project to continue viable. The minimum rate considered in the project was 10% per year to be considered as the most common rate in forestry (Oliveira et al., 2002). We also evaluated the discounted *Payback period* (PP), which defines the number of years required for investors to recover the initial capital invested in the project. It is obtained by a calculation that divides the initial costs of a project by the annual savings expected. Finally, it was examined a cost indicator, called Break-even Point (BEP). In this analysis it was found the production of bark to a NPV of zero. This factor determines which is the minimum necessary to cover production costs, given a selling price according to the formula: $BEP = TOC / Bark_{kg}$.

3. Results and Discussion

The choice of silvicultural system of selective cutting allowed the ease of access in the intervention area (Guedes et al., 2011). Therefore, due to the architecture of the species to be easily removed, it was not considered the opening of roads. This way, we decided by the slaughter of trees with ax and by manual loading the timber with the aid of wagoner. The operating costs for the production of barks are shown in Table I. The cut-and post cut as peeling and loading may change due to the variation in the number of individuals within the unit of annual production (UAP) to be harvested and obstacles affected by the topography of the area (Oliveira et al., 2009).

Table 1: Value of physical investment to finance the production of bark of *Stryphnodendron adstringens* Mart. Coville in Botumirim municipality in North Minas Gerais.

Cost items (EOC + charges)	Ocurrence year	Price (R$)	Specification
Implementation			
Annotation	0	11.76	ha
Topography	0	4.71	ha
Forest Inventory	0	11.76	ha
Licensing	0	11.76	ha
Preparation of the plan	0	159.85	ha
Implementing the Plan	0	319.70	ha
Purchase of land			
Value of the land	-	1,500.00	ha
Cost of land	Annual	150.00	(1.500)*i
Costs and expenses			
Cut	Years of cut	8.00	m³
Peeling	Years of cut	6.00	m³
Loading	Years of cut	6.00	m³
IFC	Years of cut	0.0062	Kg
IFM	Years of cut	3.261	m³
PPE	Years of cut	68.00	Kit
Grinder (lima)	Years of cut	2.50	Unity
Ax	Years of cut	33.63	Unity
Machete	Years of cut	10.41	Unity
Canvas w/bark	Years of cut	0.31	Kg
Sledgehammer	Years of cut	4.28	Unity
Sickle	Years of cut	16.12	Unity
Tapes for bark	Years of cut	0.05	Kg
Cardboard Box	Years of cut	0.10	Kg

Notes: EOC = Effective operational cost, IFC (Portuguese acronym) = Bark forest tax, IFM (Portuguese acronym) = Timber Forest Tax, PPE = Personal Protective Equipment. Source: Authors.

As the opportunity cost of land use it was considered based on the interest on the capital invested to purchase the same. This cost was due to land being a factor of production and not a free good in nature, because the land can be used to other purposes such as maintenance of domestic animals or remuneration obtained from applications of money in financial investments (Correa Júnior et al., 2008). However investments in land for forestry purposes are high and must be considered in economic evaluation (Table 1) (Oliveira et al., 2002).

Costs and expenses were all necessary inputs for forest harvesting, including labor and material for the storage of the product (Table 1 and 2). The freight for delivery of the product has not been estimated by the fact that this is proportional to the amount of charge produced and enterprise demand per period. So in this analysis, this cost is responsibility of the buyer. It was observed that the cost of implementing the plans was low, ranging from R$ 2,249.94 to R$ 2,508.25 between the simulated plans for hectare (Table 2). From the cost of physical investment and finance, we obtained the cash flow.

Table 2: Specification of cost / expenses and financial investment for the physical production of bark of *Stryphnodendron adstringens* Mart. Coville Botumirim in North of Minas Gerais.

Cost items	Basal area (G) removed			
	40%	50%	60%	70%
Gross investment				
Price of the land for cutting cycle of 10 years	1,500.00	1,500.00	1,500.00	1,500.00
Registration, inventory, topography, project design and execution	519.54	519.54	519.54	519.54
Subtotal	2,019.54	2,019.54	2,019.54	2,019.54
Expenses				
PPE (Personal Protective Equipment)	227.70	227.70	227.70	227.70
Axeman	5.04	6.02	7.34	8.50
Wagoner	3.78	4.64	5.51	6.37
General services	3.78	4.64	5.51	6.37
Grinder (lima)	2.50	2.50	2.50	2.50
Ax	33.63	33.63	33.63	33.63
Machete	10.41	10.41	10.41	10.41
Canvas	69.91	85.87	101.84	117.81
Sledgehammer	4.28	4.28	4.28	4.28
Sickle	16.12	16.12	16.32	18.88
Tapes	11.20	13.76	15.71	18.04
Cardboard Box	22.05	26.74	31.44	36.14
Subtotal	410.40	436.31	462.60	488.71
Total	2,429.94	2,455.85	2,482.14	2,508.25

Source: Authors.

The cash flow for the different percentages of basal area removed was built from the survey of inputs and investment needed to achieve the harvest barks of barbatimão (Table 2). The gross investment was constant for all simulated plans, not suffering variation in the amount paid. This was the highest investment management plan, considered of great importance for the calculation of economic indicators. Despite the variables have the same planning horizon, the costs of labor per year are different (Table 3). In the management of the candle (*Eremanthus erythropappus* DC.), the higher costs were the transport and exploration (Oliveira et al., 2010). Comparing the cash flow of the present study with the cash flow for the implementation of eucalyptus forests, we found that the cost was lower because in planted forests is greater demand for infrastructure as opening and maintenance of roads as well as pre-treatment and post cultural (Guedes et al., 2011).

Table 3: Cash flow for the production of bark *Stryphnodendron adstringens* Mart. Coville Botumirim in North of Minas Gerais

Variables	Basal area removed			
	40%	50%	60%	70%
GI	-2,019.54	-2,019.54	-2,019.54	-2,019.54
GOR	1,138.90	1,381.84	1,624.75	1,867.67
TOC	-410.40	-436.31	-462.60	-488.71
Forest rates	-166.31	-167.07	-167.84	-168.60
NI	972.60	1,214.77	1,456.91	1,699.06
GOP	562.20	778.43	994.31	1,210.35

Notes: GI = Gross Investment, GOR = Gross operating revenue, NI = Net income, TOC = Total operating costs and expenses, GOP = Gross operational profit. Source: Authors.

We considered as gross investment, the initial exploration before effectiveness as shown in Table 2. The gross operating revenue (GOR) was paid by the market value of R$ 5.00/kg for bark and R$ 30.00/m³ for timber cut from the plans simulated. This revenue was considered sufficient to characterize the economic viability of the production activity of forest resources under management regime according to legislation. The net income (NI) was obtained from discounted rates of forest and taxes on the GOR. Operating profit (GOP) was obtained from NI less operating cost (TOC).

In the amount of fees, it was included in the rate for forest logging in m³ and bark in kg. This tax was 12% referring to ICMS (Portuguese acronym) = Tax for circulation of goods and services and 2.3% for the Fund of assistance and welfare of rural workers (former FUNRURAL) (Martin et al., 1998). Other taxes were not considered, since the producer has an individual exemption on presentation of farmer card. However, there is no record of the sale of such products by a legal entity. And the marketing of products derived from sustainable forestry is legalized and registered by the issuance of invoice farmer (Azevedo, 2011).

From the cash flow, economic indicators for economic viability analysis of management plans technically feasible were determined. As the timber generated although the production was negligible (Table 4), it was considered that the production costs and market price paid for, once to obtain the product of interest that is the bark, it is inevitable tree felling. However, aiming at sustainability and conservation of the biome, the timber obtained in management plans was considered as a byproduct of the extraction of the bark which will be used legally for use as energy.

Tabela 4: Indicadores econômicos para comercialização de cascas (kg) e madeira (m³) do barbatimão em um horizonte de planejamento de 10 anos.

Variables	Basal area removed			
	40%	50%	60%	70%
Bark (Kg)	224.00	271.72	319.44	367.16
Timber (m³)	0.63	0.75	0.88	1.06
NPV R$/ha	1,434.94	2,763.60	4,090.06	5,417.55
IRR (%)	24.80	37.00	48.00	59.00
PAYBACK (%)	4.70	3.20	2.40	1.90
BEP (%)*	25.00	34.00	43.00	49.00

Notes: NPV = Net present value, IRR = Internal Rate of Return, PAYBACK Time = return on invested capital, BEP = Break-even Point. Source: Authors.

The financial analysis for the NPV method was chosen because it is a technique known and widely used in investment analysis of forest management. This method indicates the value of output in current terms considering an interest rate with less risk (Souza et al., 2007). The NPV values showed that the result obtained with the management of barbatimão was present in all plans evaluated, since all of them had positive NPV regardless of the percentage removed. For plans with greater reductions in basal area, it was observed that the NPV was proportionally higher. This implies that the higher the NPV, the more attractive the investment project (Medina; Pokorny, 2011; Rezende; Oliveira, 1999). The profit discounted from NPV ranged from R$ 1,434.94 in the plan 40% and R$ 5,417.55 in the plan 70%. It was observed that the lowest NPV is much higher than the minimum economically viable greater than 1 (> 1). According to Oliveira et al. (2002) this behavior was expected and is quite natural. The reason that the NPV was positive was that the costs of expenses have been raised in order to cause the least possible damage to the managed area.

The most important investment that influenced the value of the NPV was the acquisition of the land. Oliveira et al. (2002) state that the land price greatly affects the NPV and this becomes more attractive in operations where the land cost is significantly lower, favoring the exploitation of NTFPs of the Savannah vegetation. One should take into consideration that the cost of land in North of Minas Gerais is more accessible because it is located in an area of transition between Cerrado *sensu stricto* and Caatinga, poor soils and shallow, inhospitable to agriculture.

As the NPV, the internal rate of return (IRR) also showed increasing profitability, ranging from 24.80 to 59% between the percentage removal of basal area (Table 4). The variation in capital over time evaluated by (IRR) of the project indicated the attractiveness highly satisfactory, having been much higher than 10% per year, minimum rate prevailing in the market. This value was equivalent to the interest that could be received on investments and superior to the available by the government aiming this type of activity (Souza et al. 2007). Azevedo (2011) in economic evaluation of the bark and wood of black acacia (*Acacia Mearnsii de Wild*) produced in planted forest, obtained an IRR of 24.81%; this was close to the percentage shown for the lowest proposed plan for the extracts. According to the author, the higher cost of the project was the planting, equivalent to the cost of land invested in the present study. In particular, the rate of return achieved by the author was calculated based on the overcharging timber production since the planted forest promotes this production. However the costs of implementing the planting of acacia were much higher than the cost of barbatimão under selective cuts in natural environment. But even though, the author claims that, for more complex the production is, the financial return is guaranteed. This fact shows the importance of economic production of bark under selective cutting. Thus it is suggested that the result surplus to the capital invested in the barbatimão project, were reinvested in seedling production. This way, it increases the production area and generates employment and income for the community, ensuring the sustainability of the settlement in order to maintain the genetic resources of the species (Vinha; Verissimo, 2006).

The *Payback period* consisted of discounting cash flows at a rate that reflects the value of money in time. This indicator of the level of risk was very important in the analysis, because it showed the time required to the plan to recover the capital invested, because in this period the project has paid all expenses (Ponciano et al., 2004). This variable should be analyzed along with the IRR because to the extent that IRR was increased, the recovery time of the capital was reduced. The value found at the *Payback period* ranged from 4 years and 252 days up to 1 year and 324 days in the plans 40 to 70% of G removed, respectively. The capital return in the first plan regarded as the worst case (Tables 4 and 5).

Tabela 5: *Payback period* da viabilidade econômica dos planos de manejo do barbatimão em diferentes percentuais de área basal removida.

Basal area (%)	Discounted *Payback period*			
	% PP	Year	Month	Day
40	4.7	4	8	12
50	3.2	3	2	12
60	2.4	2	4	24
70	1.9	1	10	24

Source: Authors.

To Henriques et al. (2010), *Payback period* of the plan 40% of G, even though the worst turnaround time from the plans evaluated is considered low risk. Vinha and Verissimo (2006) corroborate the authors when state that this value is feasible and likely to accept the plan. For the authors, the key criteria for acceptance of the project defined by *Payback period* discounted is that the return period will not exceed the planning horizon. This is true, since the period of greatest demand turnaround costs applied in the project was little more than four years, well below the cutting cycle of ten years. This is not considered sufficient time for currency devaluation.

According to Rezende and Oliveira (1999) the time of return on invested capital for all plans pointed by *Payback period*, does not define the timing of recovery of capital.The decision about the ideal time of return is set by the evaluator of the project. In this sense the plan of best economic viability for the extracts was defined by shorter return found to management plans. Among these, the plan 70% of G removed, was defined as the maximum limit for having submitted a time of return on capital employed less than 2 years and a maximum production of barks.

The results presented by IRR and *Payback period* were confirmed in the analysis of Break-even Point (BEP). In this analysis we tried to show the percentage of production that pays all costs and fix and variable costs of the plan. It is at this point that the production that NPV equals itself to zero, ie, becomes null, not generating profit or loss, and balances the IRR, leveling to the rate of initial attractiveness of 10%. This way, it is possible to achieve BEP of the investment which serves of direction to investors, showing the minimum capacity in which the company must operate not to suffer damage (Ponciano et al., 2004; Padoveze, 1996). From the results of this analysis, we have the limit of production in which the expenses are paid. These values were 75% (168.01 kg) of barks produced in 40%, 66% (179.85 kg) in 50%, 57% (183.47 kg) in 60% and 51% (187.06 kg) in 70% of removal of G, which corresponds, multiplying the boundary production for the value paid for the kilogram of bark in the market, at R$ 840.70, R$ 899.25, R$ 917.35 and R$ 935.28 equivalent to gross revenue per hectare, respectively. Above these rates of production of barks, the NPV becomes greater than 1 and starts to add value to the investor.

To economists, when the NPV is zero, the project is considered economically unfeasible since this percentage pays only the costs (Souza et al. 2003). In a way, besides not generating profit, there is the loss of time invested in the project. Lapponi et al. (2007) corroborates this idea by emphasizing that invest in a positive NPV project is also at risk as a positive but low value, undermines the viability of the project due to the cost of investment in which the estimated return is uncertain. Thinking this way the balance point had the efficiency of pointing the margin of safety for all plans (Castro et al., 2007). In which for the plan 40% of removal of G, the reduction in the production of barks in up to 25% does not cause harm to the investor. In other treatments this margin was 34%, 43% and 49% corresponding to the planes 50, 60 and 70% of G removed, respectively. Therefore, from this analysis, the investor is assured as to the level of production of the species under management process.

However, the presented results showed that the implementation of the project is economically viable, given that all methods employed showed the superior profitability to the minimum rate of attractiveness and high positive NPV. From all options, the one which showed itself more economically viable was 70% removal of basal area. In this percentage, the project maintains a large number of individuals in the managed area, giving it a position to recover without damage to the original structure of the population and the conservation of the species. It is expected that this study be useful to encourage the sustainable exploitation of barbatimão to contribute to social and economic development of rural communities in North of Minas Gerais state.

4. Conclusion

We conclude that the production of barks of barbatimão is economically feasible. Since the intervention occurs in the percentage of 70% of basal area within a sustainable management.

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