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EDENTREE: A WEB APPLICATION FOR OPTIMAL ROTATION AGE ANALYSIS

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ABSTRACT

The R/Shiny package is a tool that allows the creation of interactive web applications, transforming complex analyses into accessible interfaces. In the forestry sector, Shiny's potential is still little explored, despite its applications in areas such as forest inventory, fire monitoring, *LiDAR* data analysis, and biomass and carbon estimates in Brazilian forests. This tool has been adopted by researchers and companies for its ability to generate interactive statistical reports and dashboards, contributing to data visualization and supporting forestry decision-making. From this, the objective of this research was to develop a web application in R/Shiny for the forestry field that, through the calculation of biological and financial indicators, would assist the user in making decisions regarding their forestry project. The main packages used to create the web application interface were: Shiny, bs4Dash, and golem, which offer pre-built functionalities and allow the application to be developed with less effort. For validation, data from a *Eucalyptus urograndis* forest plantation in Alagoinhas, Bahia, collected in 2021, were used, along with Microsoft Excel and Planin® software. As a result, a functional and online web application was obtained for the forestry field, with satisfactory performance in the validation stages, meeting the established criteria. Thus, the developed tool can contribute to support decision-making during the planning and management of forest plantations.

Keywords: *Shiny*; *R*; Forestry sector; Financial viability

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EDENTREE: A WEB APPLICATION FOR OPTIMAL ROTATION AGE ANALYSIS

RESUMO O pacote R/Shiny é uma ferramenta que permite a criação de aplicações web interativas, transformando análises complexas em interfaces acessíveis. No setor florestal, o potencial do Shiny ainda é pouco explorado, apesar de suas aplicações em áreas como inventário florestal, monitoramento de incêndios, análise de dados de *LiDAR* e estimativas de biomassa e carbono em florestas brasileiras. Essa ferramenta tem sido adotada por pesquisadores e empresas por sua capacidade de gerar relatórios estatísticos e dashboards interativos, contribuindo para a visualização de dados e apoiando a tomada de decisão florestal. Dessa forma, o objetivo desta pesquisa foi desenvolver uma aplicação web em R/Shiny para a área florestal que, por meio do cálculo de indicadores silviculturais e financeiros, auxilie o usuário na tomada de decisões referentes ao seu projeto florestal. Os principais pacotes utilizados para criar a interface da aplicação web foram: Shiny, bs4Dash e golem, que oferecem funcionalidades pré-construídas e permitem que a aplicação seja desenvolvida com menor esforço. Para a validação, foram utilizados dados coletados em 2021 de um plantio florestal de *Eucalyptus urograndis* em Alagoinhas, Bahia, juntamente com os softwares Microsoft Excel e Planin®. Como resultado, obteve-se uma aplicação web funcional e online para a área florestal, com desempenho satisfatório nas etapas de validação, atendendo aos critérios estabelecidos. Assim, a ferramenta desenvolvida pode contribuir para o apoio à tomada de decisões durante o planejamento e manejo de plantios florestais.

Palavras-Chave: Shiny; R; Setor florestal; Viabilidade financeira

1. INTRODUCTION

The increase in forestry plantations in Brazil, including small and medium-sized properties, highlights the great importance of studying the economic viability for implementing a forestry project (Rocha; Sales; Cabacinha, 2015). According to IBÁ (2023), the area of planted forests in Brazil increased by 0.3% from 2021 to 2022, totaling 9.94 million hectares. *Eucalyptus* remains the most planted forest crop with 76% of the planted area in Brazil, followed by pine with 19%. In addition to the expansion of planted areas, the Brazilian forestry sector has been consolidating economically and showing strong global competitiveness, with exports reaching a record of 14.3 billion dollars in 2022 and a positive trade balance of 13.2 billion dollars in the same year (IBÁ, 2023).

The growth and strengthening of the Brazilian forestry sector demonstrate the need to use techniques and instruments to face the setbacks of forestry activity, such as the variation in input and final product prices, operational restrictions aimed at sustainable practices, as well as the logistical challenges of transportation and infrastructure (Oliveira, Y.M.M.; Oliveira, E. B., 2017). The definition of forest rotation is also an important and classic issue in decision-making in this sector. It refers to the planned age at which even-aged forest stands are harvested, comprising the period from planting to the final cutting of the trees (Clutter et al., 1983). The most used methods are optimal biological rotation age, which seek maximize forest productivity, and optimal financial rotation age, aiming at maximum forest profitability (Silva; Ribeiro, 2006).

To analyze these rotations, some productivity indicators are used, such as Mean Annual Increment (MAI) and Current Annual Increment (CAI) in biological rotation, as well as financial indicators, such as Infinite Net Present Value (Infinite NPV), Equivalent Annual Annuity (EAA) and, Land Expectation Value (LEV). Thus, analyzing forest rotation in electronic spreadsheets can be challenging due to the large number of combinations and variables, in addition to the complexity in manipulating tables and formulas, which increases the risk of errors and complicates data visualization and interpretation.

In this context, carrying out an analysis of the project's economic and financial viability is essential to ensure decision-making, as well as the success and profit in forestry implementation, avoiding possible economic loss to the investor. Therefore, the development of a Web application that calculates the optimal biological and financial rotation age, as well as its financial indicators, and that generates graphical results, might facilitate the decision on whether to proceed with the project or not. This platform can allow easy, interactive and agile access for researchers, investors, managers and the general public who are interested in analyzing the viability of a forestry project.

The use of free software is, therefore, a valuable tool for social empowerment and quick problem-solving at low cost, as it does not require a license and often openly shares its source code. However, the maintenance of these projects is carried out by user communities or institutions that have low or even non-existent financial income (Braga, 2019). In this context, important tools can be mentioned, such as R, which is a free software language and environment for processing statistical and graphical data that compiles and runs on different platforms which include UNIX, Windows and MacOS (R Core Team, 2024). Another example is the tool Shiny, which is an R framework that allows one to develop sophisticated Web applications and has the advantage of not requiring prior knowledge of HTML, CSS or JavaScript to be used (Chang et al., 2023).

Web applications are "software products" or computer systems that use a distributed architecture, at least partially, under the http protocol (Paula Filho, 2003). As a result, at least part of the user interface is accessible through a browser. Web applications are also typically produced in a multidisciplinary work environment involving several aspects and components, based on a hypertext and/or hypermedia structure (Gonçalves et al., 2005). The use of software as a service (SaaS) has been increasing globally. One of the reasons is that there is no need for local installation of the software, as it is hosted by third parties and accessed via the internet, with cloud processing as a great advantage (Melo et al., 2007). Thus, creating Web applications through the combination of R and Shiny stands out as a valuable asset for professionals with expertise in this area (Doi et al., 2016).

There is a notable increase in the use of Shiny in several areas of research and teaching, mainly in academic institutions. Its applications include graph plotting, result presentation (Yu; Ouyang; Yao, 2018), scientific literature research (Robledo et al., 2022) and for the teaching of statistics (Doi et al., 2016). However, in the forestry field, the use of Shiny remains limited, with only a few studies being found, including: processing of forest inventory data (Braga, 2019), prediction of the occurrence of forest fires (Siknun; Sitanggang, 2016), extraction of forest information from data from LiDAR (Silva et al., 2022) and estimation of forest biomass and carbon in Brazilian forests in general (David et al., 2022).

In this scenario, the development of a Web application in R/Shiny that analyzes the financial viability of forestry projects is an innovative proposal. Aiming to facilitate access to information, provide potential investors in the forestry sector with key financial data, and promote the comparison of forestry projects, this study sought to develop a Web application using R/Shiny for the forestry field which, through calculation of biological and financial indicators, assists the user in making decisions regarding their forestry project. Thus, in a practical, fast and accessible way, the application can be used by any citizen who has an electronic device with internet access.

2. MATERIAL AND METHODS

2.1 Software architecture

The Web application developed to analyze the financial viability of forestry projects was named EdenTree, in reference to the tree of knowledge of good and evil present in the Garden of Eden, as mentioned in sacred texts. EdenTree was developed using the R language, within the RStudio environment, an open-source Integrated Development Environment (IDE) designed to combine several components of R programming (Allaire, 2012).

The application incorporates multiple R packages to support functionality, data manipulation, and user interface design. The most relevant packages include: Shiny, which enables the development of interactive web applications with reactive inputs and outputs; bs4Dash, which facilitates the construction of Shiny dashboards based on Bootstrap 4; golem, a framework that provides tools for building robust and scalable Shiny applications; dplyr, a grammar of data manipulation that operates efficiently both in memory and on disk; and DT, which allows for the rendering of interactive data tables that users can sort, filter, and download in Microsoft Excel and CSV formats (CRAN, 2024).

EdenTree was structured as a single-screen dashboard to centralize all functionalities. The interface was divided into four main sections: “Data”, “Optimal Biological Rotation Age”, “Cash Flow”, and “Optimal Financial Rotation Age”, as illustrated in Figure 1.

Figure 2 illustrates the web application interface before input data is entered, containing the sections that will be presented later in this topic. The complete application is available at the hyperlink: https://mavigusach.shinyapps.io/edentree/ .

The “Data” section allows the configuration of project parameters, including project name, planning horizon (in

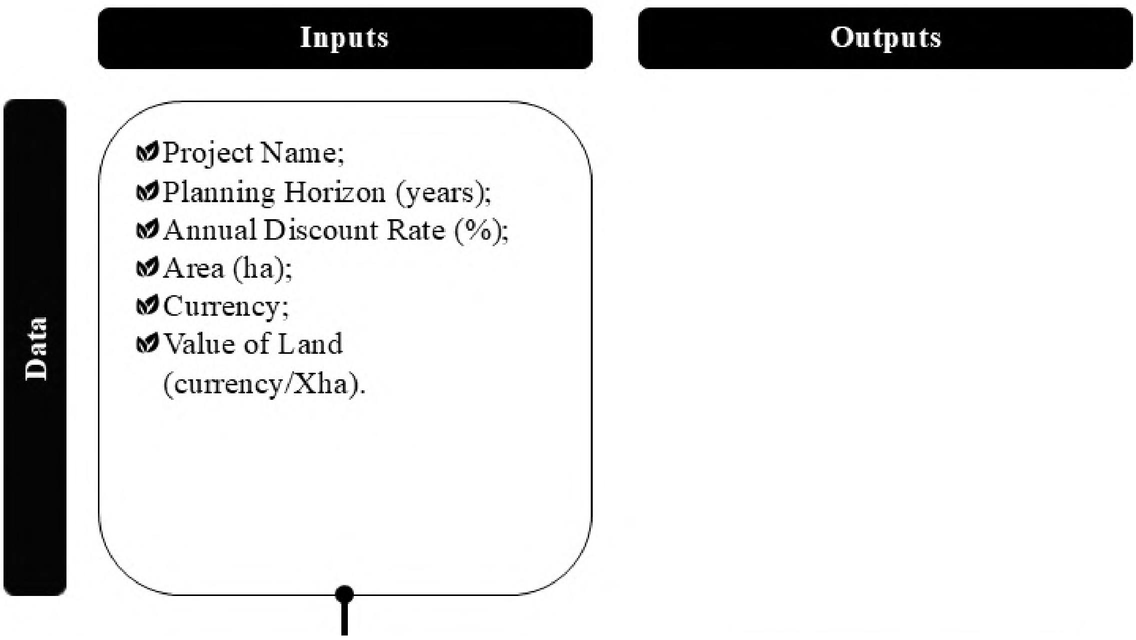

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Figure 1. EdenTree sections and their respective inputs and outputs. MAI: Mean Annual Increment; CAI: Current Annual Increment; NPV: Net Present Value; Infinite NPV: Infinite Net Present Value; EAA: Equivalent Annual Annuity; LEV: Land Expectation Value; IRR: Internal Rate of Return

Figura 1. Seções da EdenTree e suas respectivas entradas e saídas. MAI: Incremento Médio Anual; CAI: Incremento Corrente Anual; NPV: Valor Presente Líquido; NPV Infinito: Valor Presente Líquido Infinito; EAA: Anuidade Anual Equivalente; LEV: Valor Esperado da Terra; IRR: Taxa Interna de Retorno

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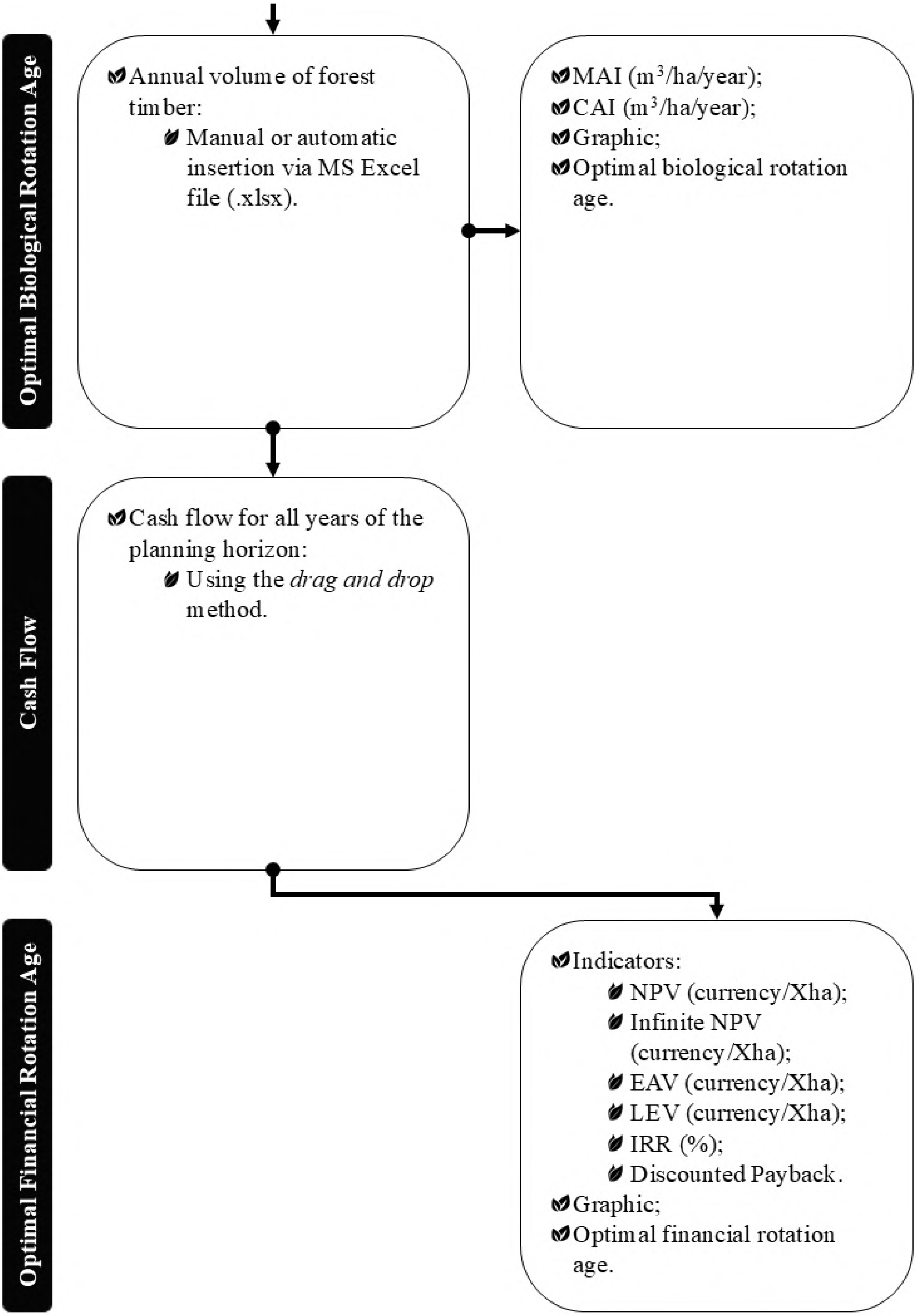
Optimal Biological Rotation Age
Annual volume of forest timber:
Manual or automatic insertion via MS Excel file (.xlsx).
MAI (m³/ha/year);
CAI (m³/ha/year);
Graphic;
Optimal biological rotation age.
Cash Flow
Cash flow for all years of the planning horizon:
Using the *drag and drop* method.
Optimal Financial Rotation Age
Indicators:
NPV (currency/Xha);
Infinite NPV (currency/Xha);
EAV (currency/Xha);
LEV (currency/Xha);
IRR (%);
Discounted Payback.
Graphic;
Optimal financial rotation age.

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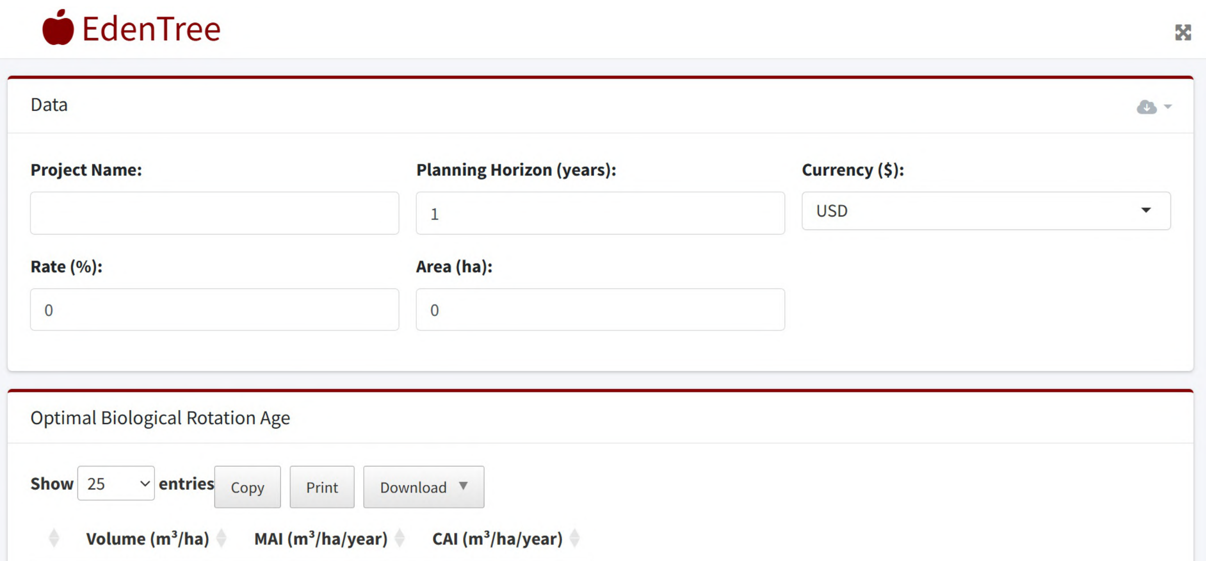

Figure 2. EdenTree homepage
Figura 2. Página inicial da EdenTree

years), annual discount rate (as a percentage), total planting area (ha), choice of currency, and value of land (currency/X ha) – in this context, the letter X represents the number of hectares. EdenTree was designed to support the analysis of projects with varying area sizes, considering the reality of small and medium-sized forest farmers, who often possess information aggregated by property rather than per hectare. After entering the data, the system automatically converts volume values to m³/ha and monetary values to currency/ha. This structure enables the presentation of financial indicators both per hectare and for the total project area, thereby facilitating the interpretation of results across different project scales. In this section, the analysis report can also be downloaded in PNG format.

The "Optimal Biological Rotation Age" section processes the annual wood volume (m³/X ha) data to calculate the Mean Annual Increment (MAI) and Current Annual Increment (CAI) per hectare using Equations 1 and 2, respectively. The year corresponding to the peak MAI value is identified as the biological rotation age, which represents the point of maximum forest productivity (Floriano, 2018).

$$MAI_t = \frac{Volume_t}{Age_t} \quad \text{(Eq. 1)}$$

$$CAI_t = Volume_t - Volume_{t-1} \quad \text{(Eq. 2)}$$

Where:
MAI_t: Mean Annual Increment in period t;
CAI_t: Current Annual Increment in period t;
$Volume_t$: Planting volume in period t, in m³/ha;
$Volume_{t-1}$: Planting volume in period t-1, in m³/ha;
Age_t: Age of planting in period t, in years.

In the "Cash Flow" section, the application simulates the financial flow of the forestry project throughout the entire planning horizon. It categorizes economic activities into three types based on their relationship with production (Figure 3) as follows: (i) Volume – Independent Costs, which are fixed per hectare and unaffected by wood production (e.g., topdressing, subsoiling); (ii) Volume – Dependent Costs, which vary in direct proportion to the harvested volume and are calculated by multiplying a unit cost per cubic meter by the projected yield in the cutting year (e.g., harvesting, transportation); and (iii) Revenues, also dependent on production and

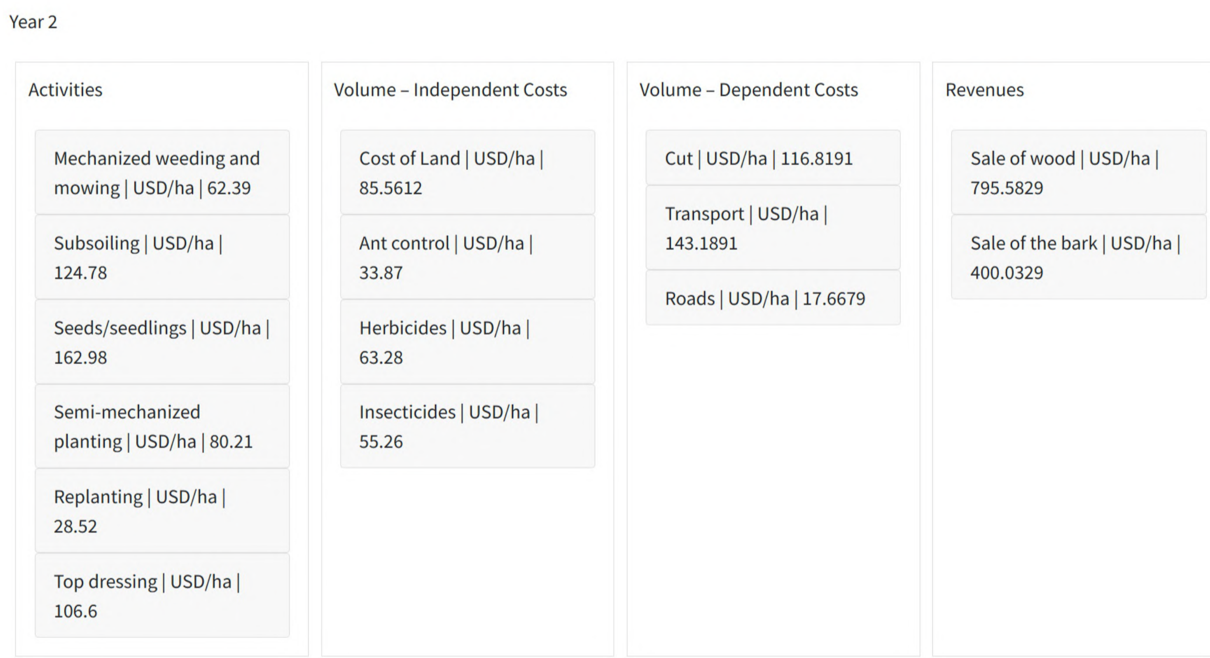

Figure 3. Example of how to organize annual cash flow at EdenTree
Figura 3. Exemplo de como organizar o fluxo de caixa anual na EdenTree

are estimated using similar approach (e.g., timber and bark sale).

The application includes the opportunity land cost (currency/ha), representing the return foregone by allocating capital to forestry rather than alternative investments (Silva et al., 2008). Given the high capital requirements of forestry land investments, incorporating this cost is essential for a comprehensive evaluation (Rodrigues et al., 1999). Activities classified under the above-mentioned categories are used in the economic analyses, whereas those stored in a separate repository within the interface do not affect the computations unless reclassified.

The “Optimal Financial Rotation Age” section aggregates the results of the financial indicators calculated for each year and presents them graphically. These indicators support the identification of the optimal rotation age — defined as the point in time at which the financial return from the forest stand is maximized.

The financial indicators adopted in the application include: Net Present Value (NPV) (Equation 3), Infinite Net Present Value (Equation 4), Equivalent Annual Annuity (EAA) (Equation 5), and Land Expectation Value (LEV) (Equation 6), following the formulations of Rezende & Oliveira (2008) and Klemperer (1996). In addition, the Internal Rate of Return (IRR) and the Discounted Payback Period were also calculated. The IRR (Equation 7) represents the discount rate that makes the NPV equal to zero and reflects the project’s rate of return (Rodrigues et al., 2019); projects with IRR higher than the minimum acceptable rate of return are considered economically viable. The Discounted Payback Period (Equation 8) indicates the time required to recover the initial investment through the project’s discounted cash flows, thus considering the time value of money in the capital recovery analysis (Pradhan et al., 2019). These indicators allow for a comprehensive evaluation of forestry projects by integrating temporal financial performance into decision-making (Table 1).

$$NPV = \sum_{j=0}^{t} R_j(1+i)^{-j} - C_j(1+i)^{-j} \quad \text{(Eq. 3)}$$

$$Infinite\ NPV = \frac{NPV * (1+i)^t}{(1+i)^t - 1} \quad \text{(Eq. 4)}$$

$$EAA = \frac{NPV * i * (1+i)^t}{(1+i)^t - 1} \quad \text{(Eq. 5)}$$

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$$LEV = \frac{NPV_{WCL} * (1+i)^t}{(1+i)^t - 1} \quad \text{(Eq. 6)}$$

$$IRR = \sum_{j=1}^{t} R_j(1+IRR)^{-j} - C_j(1+IRR)^{-j} = 0 \quad \text{(Eq. 7)}$$

$$Discounted\ Payback\ Period = n - 1 + \frac{|CDCF_{n-1}|}{DCF_n} \quad \text{(Eq. 8)}$$

Where:
NPV: Net Present Value;
Infinite NPV: Infinite Net Present Value;
EAA: Equivalent Annual Annuity;
LEV: Land Expectation Value;
IRR: Internal Rate of Return;
NPV WCL: Net Present Value without the Cost of Land;
t: Project Duration in years;
i: Annual Discount Rate;
C_j: Cost at the End of Year j;
R_j: Revenue at the End of Year j;
n: the particular year when the cumulative discounted cash flow value is positive or zero for the first time;
$CDCF_{n-1}$: the cumulative discounted cash flow value in the 'n-1′ year;
DCF_n: the discounted cash flow in the 'n'th year.

Table 1. Interpretation of financial viability indicators for forestry projects
Tabela 1. Interpretação dos indicadores de viabilidade financeira para projetos florestais

Indicator	Interpretation
NPV	>0 ⇒ Feasible. =0 ⇒ Zero profit. <0 ⇒ Not feasible.
Infinite NPV	>0 ⇒ Feasible. =0 ⇒ Zero profit. <0 ⇒ Not feasible.
EAA	>0 ⇒ Feasible. =0 ⇒ Zero profit. <0 ⇒ Not feasible.
LEV	>Value of Land ⇒ Feasible. = Value of Land ⇒ Zero profit. < Value of Land ⇒ Not feasible.
IRR	> Discount rate ⇒ Feasible. = Discount rate ⇒ Zero profit. < Discount rate ⇒ Not feasible.
Discounted Payback Period	Cash Flow≥0 ⇒ Occurred. Cash Flow

NPV: Net Present Value; Infinite NPV: Infinite Net Present Value; EAA: Equivalent Annual Annuity; LEV: Land Expectation Value; IRR: Internal Rate of Return.
NPV: Valor Presente Líquido; NPV Infinito: Valor Presente Líquido Infinito; EAA: Anuidade Anual Equivalente; LEV: Valor Esperado da Terra; IRR: Taxa Interna de Retorno.

2.2 Web application validation

2.2.1 *Data collect*

To achieve the financial viability of a forestry project, it is necessary to have information regarding forestry productivity and the financial context in which the plantation is inserted. Thus, to demonstrate the usefulness of the developed Web application , data on implementation costs were gathered (Table 2), which were converted to US dollars using the exchange rate of the US commercial dollar (USD) to the Brazilian real (BRL), fixed at R$5.61 on July 30, 2024 (Google Finance, 2024), and data on growth and total annual volume (Table 3) from a *Eucalyptus urograndis* stand

Table 2. Costs of implementing *Eucalyptus urograndis* in Alagoinhas in 2021
Tabela 2. Custos de implantação do *Eucalyptus urograndis* em Alagoinhas em 2021

Activity	Unit	Value	Year of occurrence
Area preparation			
Mechanized weeding and mowing	USD/ha	62.39	0 and 1
Subsoiling	USD/ha	124.78	0
Planting			
Seeds/seedlings	USD/ha	162.98	0
Semi-mechanized planting	USD/ha	80.21	0
Replanting	USD/ha	28.52	1
Forestry treatment			
Ant control	USD/ha	33.87	0 to 5
Herbicides	USD/ha	63.28	1 to 7
Insecticides	USD/ha	55.26	1 to 7
Top dressing	USD/ha	106.60	0
Harvest			
Cut	USD/m³	4.43	t
Transport	USD/m³	5.43	t
Roads	USD/m³	0.67	t
Sale of wood	USD/m³	30.17	t
Local taxes			
Discount rate	Year	12%	1 to t
Annual cost of land	USD/ha	85.56	1 to t
Value of land	USD/ha	713.01	-

t: Project duration. Source: Morais (2021). Adapted.
t: Duração do projeto. Fonte: Morais (2021). Adaptado.

Table 3. Total annual volume and optimal biological rotation age analysis of the *Eucalyptus urograndis* forestry project in Alagoinhas/BA carried out in MS Excel
Tabela 3. Análise do volume total anual e da rotação silvicultural do projeto florestal de *Eucalyptus urograndis* em Alagoinhas/BA realizada no MS Excel

Year	Volume (m³/ha)	CAI (m³/ha/year)	MAI (m³/ha/year)
0	-	-	-
1	-	-	-
2	26.37	26.37	13.19
3	69.23	42.86	23.08
4	112.16	42.93	28.04
5	149.83	37.67	29.97
6	181.73	31.9	30.29

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Year	Volume (m³/ha)	CAI (m³/ha/year)	MAI (m³/ha/year)
7	208.60	26.87	29.80
8	231.33	22.73	28.92
9	250.70	19.37	27.86
10	267.36	16.66	26.74
11	281.81	14.45	25.62
12	294.45	12.64	24.54

Source: Morais (2021). Adapted.
Fonte: Morais (2021). Adaptado.

in the city of Alagoinhas/BA (12°8′9″ S, 38°25′8″ W) in the year 2021, referring to the work of Morais (2021). Then, with that information in hand, it was possible to proceed with the feasibility analysis of the forestry project.

In order to validate the results generated by EdenTree, the calculations were replicated in an electronic spreadsheet (Microsoft Excel) and the results were checked. A second validation was carried out with the software Planin®, which calculates the most used financial analysis parameters for evaluating timber production from forest plantation management regimes (Embrapa Florestas, 2022). Data from the *Eucalyptus urograndis* stand in Alagoinhas/BA were inserted into both software.

3. RESULTS

Based on the information previously presented, it was appropriate to evaluate EdenTree's performance in the analysis of the *Eucalyptus urograndis* forestry project from Alagoinhas/BA. The forest stand data was inserted into the Web application, obtaining satisfactory results that correspond to the results generated by the financial viability analysis spreadsheet for forestry projects prepared in Microsoft Excel and by the software Planin®.

Through the results of the MS Excel spreadsheet, it is clear that the optimal biological rotation age of the forest stand occurs in year 6 (Table 3), with MAI of 30.29 m³/ha and CAI of 31.9 m³/ha. The optimal financial rotation age occurs in year 6 (Table 4), the age at which the maximum values for the financial indicators were found, including: Infinite NPV of USD 395.28/ha, EAA of USD 47.43/ha, LEV of USD 1108.29/ha, and IRR of 15.13%, while the Discounted Payback Period is reached in year 4, but the project maintains positive cash flows contributing to payback up to year 9. The NPV result was USD 195.02/ha. Thus, calculating the NPV is essential because it serves as an input for the computation of the Infinite NPV, EAA, and LEV. However, it should not be used to determine the economic rotation since this method is not suitable for comparing projects with different durations.

The IRR and Payback period are also provided in our Web application, but they are not applied in the rotation analysis as they may produce inaccurate results specifically for this purpose. Nevertheless, these indicators were included because they are easy to interpret and widely used in the forestry sector, thus serving as complementary profitability metrics after the economic rotation is established.

The software Planin® presented the same results obtained in the MS Excel spreadsheet, however, it was not possible to enter the land value into Planin®. The same metrics were obtained for the financial indicators, proving the integrity of the results. The results generated by EdenTree demonstrate the viability of the forestry project in Alagoinhas/BA, with both biological and financial rotations age occurring in year 6 (Figures 4 and 5),

Table 4. Results of financial viability indicators and analysis of the optimal financial rotation age of the forestry project in Alagoinhas/BA carried out in MS Excel

Tabela 4. Resultados dos indicadores de viabilidade financeira e análise da rotação econômica do projeto florestal em Alagoinhas/BA realizados no MS Excel

Project Duration (years)	Metrics					
	NPV (USD/ha)	Infinite NPV (USD/ha)	LEV (USD/ha)	EAA (USD/ha)	IRR (%)	Discounted Payback Period
1	-864.47	-8068.42	-7355.41	-968.21	-99.99	
2	-641.31	-3162.19	-2449.18	-379.46	-53.09	
3	-255.77	-887.43	-174.42	-106.49	-0.61	
4	25.13	68.95	781.96	8.27	12.75	✔
5	159.91	369.68	1082.69	44.36	15.35	✔
6	195.02	395.28	1108.29	47.43	15.13	✔
7	147.67	269.64	982.65	32.36	13.93	✔
8	94.85	159.12	872.13	19.09	13.04	✔
9	4.58	7.16	720.17	0.86	12.05	✔
10	-107.86	-159.07	553.94	-19.09	11.07	
11	-232.01	-325.62	387.39	-39.07	10.18	
12	-360.73	-485.29	227.72	-58.23	9.37	

NPV: Net Present Value; Infinite NPV: Infinite Net Present Value; EAA: Equivalent Annual Annuity; LEV: Land Expectation Value; IRR: Internal Rate of Return

NPV: Valor Presente Líquido; NPV Infinito: Valor Presente Líquido Infinito; EAA: Anuidade Anual Equivalente; LEV: Valor Esperado da Terra; IRR: Taxa Interna de Retorno

confirming the application's reliability in analyzing the financial feasibility of forestry projects. The generation of individual graphs for each indicator, for both the total area and a 1-hectare reference, improves curve visualization, enhancing result interpretation. Therefore, the outcomes are consistent with the expected results.

4. DISCUSSION

For now, the availability of a free software to evaluate the financial viability of forestry projects in the Brazilian market is limited, causing users to resort to spreadsheet software or Planin®, which is available by Embrapa Florestas. Therefore, new features should be implemented in EdenTree, such as: intuitive design, clean interface, cloud processing, cross-platform (Web application working on different devices and operating systems), scalability, stability and open source.

In the international context, it is already possible to find studies on this field, such as the JuWaPf and HeProMo software, which support forest managers in the decision to estimate times and costs of processes related to forest maintenance and wood production. One point to highlight is the use of this software for teaching at universities and forestry schools in Switzerland and Germany, showing a vast field of applicability of software related to forestry finance issues (Holm et al., 2023).

In Sweden, a country with experience in intensive forest management, a versatile and multi-objective forestry decision support system called Heureka Forestry Decision

Optimal Biological Rotation Age

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	Volume (m³/ha)	MAI (m³/ha/year)	CAI (m³/ha/year)
2	26.37	13.185	26.37
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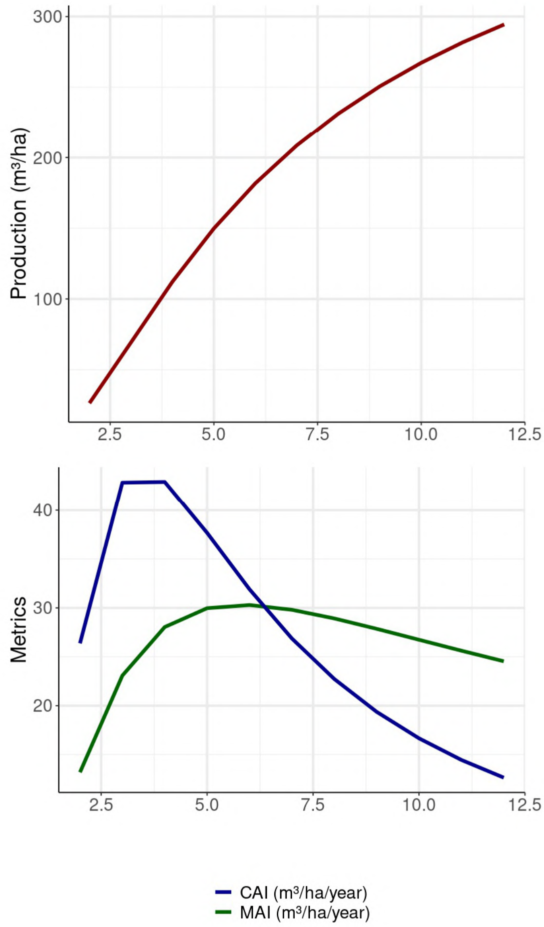
7	208.6	29.8	26.87
8	231.33	28.9163	22.73
9	250.7	27.8556	19.37
10	267.36	26.736	16.66
11	281.81	25.6191	14.45
12	294.45	24.5375	12.64

Showing 1 to 11 of 11 entries Previous 1 Next



Optimal Biological Rotation Age: 6

Figure 4. Analysis of the optimal biological rotation age of the forestry project in Alagoinhas/BA carried out on EdenTree. MAI: Mean Annual Increment; CAI: Current Annual Increment
Figura 4. Análise da rotação silvicultural do projeto florestal em Alagoinhas/BA realizada na EdenTree. MAI: Incremento Médio Anual; CAI: Incremento Corrente Anual

Support System was launched in 2009. The system has a set of software that manages and analyzes different types of values in the forestry sector, being used to analyze forest impact and for long-term forest planning, directly influencing decision-making and forest management activities in half from the Swedish forest area. As it is a robust set of software, its applicability and relevance to the scientific community is also well known, with a significant number of articles published on this system (Lämås et al., 2023).

Delving a little deeper into the area of forestry decision support, other important software are also found, such as PRISM, which is open source and allows for the development of models, database management and the performance of sensitivity analysis for the US National Forest seeking to replace obsolete tools (Nguyen; Henderson; Wei, 2022), and MultiOptForest, which is also open source and seeks to build the optimal solution for multi-objective optimization problems for forest planning with a focus on meeting linked political objectives to forest management (Eyvindson et al., 2023). When

Optimal Financial Rotation Age

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	NPV (USD/ha)	Infinite NPV (USD/ha)	EAA (USD/ha)	LEV (USD/ha)	IRR (%)	Dicounted Payback
0	-570.83					
1	-864.4739	-8068.4233	-968.2108	-7355.4133	-99.99	
2	-641.311	-3162.1875	-379.4625	-2449.1775	-53.085	
3	-255.7749	-887.4303	-106.4916	-174.4203	-0.6141	
4	25.1321	68.9531	8.2744	781.9631	12.7548	✔
5	159.9124	369.6772	44.3613	1082.6872	15.3539	✔
6	195.0197	395.2817	47.4338	1108.2917	15.13	✔
7	147.6697	269.6421	32.3571	982.6521	13.9309	✔
8	94.8529	159.118	19.0942	872.128	13.0432	✔
9	4.5803	7.1636	0.8596	720.1736	12.0455	✔
10	-107.8555	-159.0726	-19.0887	553.9374	11.0736	
11	-232.0099	-325.617	-39.074	387.393	10.1777	
12	-360.7277	-485.2893	-58.2347	227.7207	9.3653	

Showing 1 to 13 of 13 entries Previous 1 Next

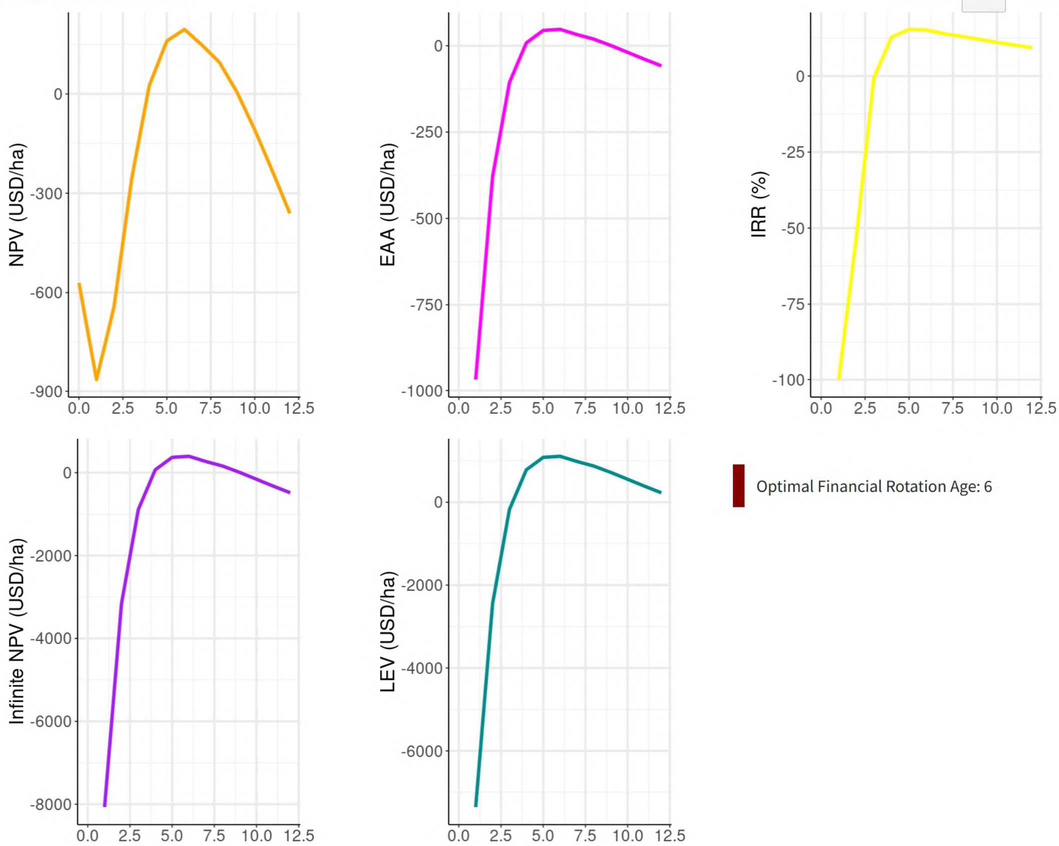

Figure 5. Results of financial viability indicators and analysis of the optimal financial rotation age of the forestry project in Alagoinhas/BA carried out on EdenTree. NPV: Net Present Value; Infinite NPV: Infinite Net Present Value; EAA: Equivalent Annual Annuity; LEV: Land Expectation Value; IRR: Internal Rate of Return
Figura 5. Resultados dos indicadores de viabilidade financeira e análise da rotação econômica do projeto florestal em Alagoinhas/BA realizado na EdenTree. NPV: Valor Presente Líquido; NPV Infinito: Valor Presente Líquido Infinito; EAA: Anuidade Anual Equivalente; LEV: Valor Esperado da Terra; IRR: Taxa Interna de Retorno

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analyzing both software, the relevance of open-source software for forestry planning and management becomes clear, which directly impacts production, operational efficiency and market competitiveness for free, at the same time that it reduces costs and promotes innovation in the forestry sector.

The use of technological solutions has a positive impact on the effectiveness of forestry sector processes, as demonstrated in the impact assessment of software implementation, on the administrative costs of wood flow management and on the efficiency of wood suppliers in the southeastern United States, where the software Timber Resource Analytics and Contract Tracking were used, providing an average saving of 43 hours per week in administrative tasks and an estimated annual saving of approximately 62,000.00 US dollars (Miller et al., 2024).

Based on the information above, EdenTree proved to be a tool with innovative features that can be used for teaching, research, and to support forest managers in the management of planted forests, as it offers an excellent cost-benefit ratio and contributes to task optimization by reducing production costs. It is important to highlight, however, that version 1.0 of EdenTree is still in the testing phase and features a simplified structure. Although it is already capable of performing basic financial and economic analyses of forestry projects, the available features and generated reports still require improvement to meet more complex demands. Enhancements are planned for future versions of EdenTree, which will include new functionalities, more robust calculations, and a more detailed results interface, aiming to provide more comprehensive support for decision-making by forestry farmers and managers.

4.1 Limitations and improvements

The current version of EdenTree (v1.0), while offering promising functionalities and practical applications in teaching, research, and in the management of planted forests, is still in an early development stage and reflects the natural limitations of a simplified prototype. Initial feedback from users and collaborators has been valuable in highlighting opportunities for refinement and areas where the tool may benefit from greater analytical depth and flexibility.

The aspects identified for improvement include the limited availability of financial indicators, the absence of features for sensitivity analysis, and the lack of support for more complex forest management scenarios, such as multi-rotation cycles or simulations involving diverse assortments of wood products. Additionally, some users have expressed interest in more detailed reporting options, including customizable tables and charts that can better support decision-making processes.

Addressing these points presents a number of important challenges. These include reconfiguring the tool's underlying architecture to support greater analytical complexity, expanding the data model to accommodate new biometric and economic variables, and developing advanced modules capable of simulating variability and uncertainty across different scenarios. Balancing these technical enhancements with a user-friendly interface remains a central design consideration.

To meet these goals, several improvements are planned for future releases of EdenTree. These include the integration of additional financial metrics (such as the Benefit-Cost Ratio and Average Production Cost), the implementation of a sensitivity analysis module, and expanded support for modeling more diverse forest management strategies. Together, these developments aim to increase the tool's robustness, adaptability, and overall value to forestry managers.

As noted in Figure 6, the developers assume no responsibility for outcomes resulting from the use of EdenTree. While version 1.0 marks an important step forward, the tool remains under active development. Continued refinement, guided by feedback from users and the evolving needs of the forestry sector, will help ensure that

⚠ Disclaimer

> EdenTree was developed to support the financial analysis of forestry projects, offering users a tool based on silvicultural and economic indicators. However, all decisions made using the results are the sole responsibility of the user, and the developers assume no legal liability for any outcomes. The current version (1.0) is in the testing phase and has limitations due to its simplified structure, such as the absence of detailed reports, a limited set of financial indicators, and no advanced tools like sensitivity analysis. These factors may restrict its use in more complex scenarios. Future updates aim to address these gaps by adding features like report generation, new financial metrics (e.g., Benefit-Cost Ratio), sensitivity simulations, and modeling for different rotation cycles and log assortments—enhancing the tool's robustness and alignment with the needs of the forestry sector

Figure 6. EdenTree Disclaimer.
Figura 6. Aviso de isenção de responsabilidade da EdenTree.

EdenTree becomes a more comprehensive and effective solution for forest planning and analysis.

5. CONCLUSION

The EdenTree web application has proven to be a free, reliable, stable, dynamic, and easily accessible tool, developed using R and Shiny technologies. Its structure enables any user with internet access to perform financial viability analyses of forestry projects, serving both small- and large-scale rural properties.

Although the current version (1.0), codenamed openeyes, is still in a testing phase and presents a simplified interface, it already provides relevant indicators that significantly support users decision-making regarding the planning and management of their forestry projects. The performance of the application was validated throughout the study, demonstrating its effectiveness and reliability during the testing stages.

Substantial improvements are planned for future versions, including the incorporation of new financial indicators such as the Benefit-Cost Ratio and Average Production Cost; the implementation of sensitivity analysis; the inclusion of multiple product assortments per rotation; customization of reports and charts; support for different currencies and languages; among other enhancements that will make the system even more robust and aligned with the needs of forest managers and researchers in the field.

It is therefore concluded that EdenTree successfully achieved its goal of being a web application aimed at analyzing the financial viability of forestry projects, assisting users through both biological and financial indicators. It is important to emphasize, however, that decisions based on the results provided by the application are the sole responsibility of the user, thereby exempting its developers from any legal liability. Nonetheless, EdenTree stands out as a relevant and promising contribution to the forestry sector and to the scientific community interested in integrating technology with natural resource management.

METADATA

Current code version: Version 1.0 (openeyes) – July 2023;
Permanent link to code/repository used for this code version: https://github.com/mavigusach/EdenTree;
Permanent link to reproducible capsule: None;

Legal code license: GPL-3;
Code versioning system used: git;
Software code languages, tools and services used: R, R-Shiny;
Compilation requirements, operating environments and dependencies: R (≥4.3.0), *Imports:* bs4Dash, config (>= 0.3.1), DT, ggpubr, golem (>= 0.4.1), readxl, shiny (>= 1.7.4), shinyscreenshot, ggplot2, sortable, shinyjs, tools, dplyr, FinCal;
If available, link to developer documentation/manual: -;
Support email for questions: marcelo160102@gmail.com.

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AUTHOR CONTRIBUTIONS

Chaves, M.V.G.S.: Conceptualization; Methodology; Writing – original draft; Writing – review & editing. Pauletti, M.L.: Writing – review & editing; Visualization. Rocha, S.J.S.S.: Writing – original draft; Writing – review & editing. Gomide, L.R.: Writing – review & editing; Visualization. Silva, C.S.J.: Investigation; Data curation; Writing – original draft; Writing – review & editing.

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