Financial and economic viability analysis of baru almond (*Dipteryx alata* Vogel) agroextractivism in the Urucuia River Valley, Arinos/MG

Análise da viabilidade financeira e econômica do agroextrativismo da amêndoa do baru (Dipteryx alata Vogel) no Vale do Rio Urucuia, Arinos/MG

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ABSTRACT

The baru tree (*Dipteryx alata*) plays a vital role in the conservation of the Brazilian Cerrado. Its almonds are highly valued for their nutritional content and the increasing demand for sociobiodiversity products, generating income for agroextractivists. This study analyses the viability of baru extractivism in the Urucuia River Valley, Arinos/MG. Financial and economic data were collected from the 2013-2014 harvests through semi-structured interviews. Costs, revenues, and cash flow were calculated based on production volatility in different scenarios. The results indicated that extractivism is financially viable in most profitability indicators, except for medium-scale agroextractivists in the 2014 harvest, due to increased labour costs. The simulation of economic viability over 10 years, including investments, showed that extractivism is viable only in scenarios involving the association of agroextractivists. Therefore, cooperation and community organisation strategies are essential for the viability of baru extractivism.

Keywords: Non-timber forest products. Economic indicators. Profitability. Net present value.

RESUMO

O baruzeiro (Dipteryx alata) desempenha um papel vital na conservação do Cerrado. Suas amêndoas são valorizadas pelo alto valor nutricional e pela crescente demanda por produtos da sociobiodiversidade, gerando renda para agroextrativistas. Este estudo analisa a viabilidade do extrativismo do baru no Vale do Rio Urucuia, Arinos/MG. Por meio de entrevistas semiestruturadas, foram coletados dados financeiros e econômicos das safras de 2013-2014. Foram calculados custos, receitas e o fluxo de *caixa com base na volatilidade da produção em diferentes cenários. Os resultados indicaram que o extrativismo é financeiramente viável na maioria dos indicadores de rentabilidade, exceto para agroextrativistas médios na safra de 2014, devido ao aumento do custo da mão de obra. A simulação da viabilidade econômica para 10 anos, incluindo investimentos, mostrou que o extrativismo é viável apenas em cenários de associação entre agroextrativistas. Assim, estratégias de cooperação e organização comunitária são essenciais para a viabilidade do extrativismo do baru.*

Palavras-chave: *Produtos florestais não madeireiros. Indicadores econômicos. Rentabilidade. Valor Presente Líquido.*

1 INTRODUCTION

The Cerrado is the second largest Brazilian biome and has great biodiversity, especially of fruits with high nutritional value, unique flavours and aromas, characteristic properties and great acceptance among consumers who favour sustainable foods (Reis; Schmiele, 2019).

Even with all this biodiversity, the appreciation and commercialisation of Non-Timber Forest Products/ NTFPs in Brazil, which are important tools to stimulate the forest bioeconomy and essential in the search for sustainable development (Afonso, 2022; Marchetti; Palahí, 2020), are still incipient.

In recent years, Baru (*Dipteryx alata*, Vog.) has stood out as a native fruit species to the Cerrado with great potential for various uses, indicating that it is an important strategy in developing a sustainable bioeconomy for being a key component in the family farmers income and contributing to the appreciation and conservation of this important and threatened biome.

This species has the potential to become a key species in the Cerrado as its fruits ripen during the dry season, feeding several native species of the regional fauna, such as bats, primates and rodents (Sano; Ribeiro; Brito, 2016), being an important resource in the diet of bird life, such as the scarlet macaw (Ara chloropterus) (Ragusa Netto, 2024).

A number of studies indicate several potentialities for the food industry (Monteiro; Carvalho; Vilas Boas, 2022; Siqueira *et al*., 2015) and positive effects on human health since it has antioxidant properties and is rich in vitamin E. Its use indicated efficiency against muscle pain and rheumatism (Fernandes; Rocha; Santos, 2023), and contributed to reducing total cholesterol levels and the risk of cardiovascular diseases in rats, suggesting beneficial effects on humans and demonstrating its potential for use as a functional food and/or nutraceutical (Bento *et al*., 2014; Campidelli *et al*., 2022).

The supply of almonds is mainly provided by agroextractivist families from the Cerrado (Bispo; Diniz, 2014), and it contributes to the economic resilience and sustainable use of forest resources for regional development (Budiyoko *et al*., 2024; Elias; Santos, 2016). Its production chain faces several challenges, especially in supply, due to the volatility and seasonality of the native baru trees' production, weakening commercial relations (Gueneau *et al*., 2020; Magalhães, 2019).

Studies evaluating the economic aspects of baru, especially those aimed at analysing the economic viability of this activity, are scarce. The analysis of costs and revenues must be complete to better define production costs, especially expenses that need to be carefully enumerated, quantified and described over time (Neumann; Hirsch, 2000).

In view of the above, the objective of this study was to analyse the economic aspects of baru almond extractivism, especially its financial viability, by studying the effect of production volatility on family income and the viability of a return on investment, observing different scales of production by agro-extractivist families in the Urucuia River Valley region.

2 MATERIALS AND METHODS

The study area comprises the municipality of Arinos, located in the immediate geographic region of Unaí, in the Northwest of Minas Gerais (IBGE, 2017), with geographic coordinates -150 54' 12.63” S and -460 05' 46 .35” W and average altitude of 520 m. According to the Köppen and Geiger classification system, the climate is classified as Aw. The average annual temperature in Arinos is 23.9 °C, and the average annual precipitation is 1,181 mm.

2.1 DATA COLLECTION AND ANALYSIS

For data collection, questionnaires were used and applied through semi-structured interviews, which consist of a research technique that combines open and closed questions in which the informant has the possibility of discussing the proposed topic (Ribeiro; Vieira, 2021). They estimated the costs and revenues of extractive activities and operational income. The research was carried out in May and August 2015, and the information and analyses carried out refer to the harvests of 2013 and 2014.

The research design was of the type field survey, characterised by direct interrogation of the participants of the selected profile. To determine the sample space, the size of the population and its percentage in relation to the group were used, considering the level of confidence and the acceptable error (Gil, 2008). Descriptive statistics was used applying graphs, tables and averages of the data collected (Bittencourt, 2012).

The interviewees were selected through non-probability sampling using the ‘snowball’ technique (Albuquerque *et al.*, 2010). This technique is a form of sampling in which the initial participants of a study indicate new participants from the universe to be studied (Silva *et al*., 2013). It is a technique used in the study of rare or unknown populations which do not have a list of their members (Campos; Saidel, 2022). This study used this technique to estimate the population of families selling baru almonds in the municipality and the region.

To analyse the effect of seasonality and volatility on prices, the study area was divided into regions, using the occurrence of natural populations of baru trees as criteria and the existence of extractivist families that sell the collected almonds. A comparative analysis of the production of the selected regions, which were considered as treatments, adopting a completely randomised design with four treatments, was carried out. The Variance Analysis System/Sisvar software (Ferreira, 1999) was used, which also compared the means by the Tukey test at a 5% probability of error.

The variables analysed to define the revenue were sales volume and the price of almonds at the harvest and off-season times in the years evaluated. Production volatility was simulated to prepare the cash flow according to the work of Sano and Simon (2008), who monitored the frequencies of fruit production classes for 10 years.

The cost of the activity was determined by estimating the average time dedicated to collecting, processing, transporting and selling the almonds. In this study, the costs were divided into fixed and variable, according to the National Supply Company methodology, to estimate agricultural production costs (Conab, 2010).

The fixed costs include all remuneration or expenses for maintaining the production process, so these costs exist even when the enterprise is not producing. Among the main fixed costs, we can mention the depreciation of machinery and facilities and interest on invested capital (Mendes, 1989). Among the main fixed costs evaluated is the depreciation of machines and facilities, such as the carts, barn, the adapted artisanal shelling device and the vehicle used in sales. The values of the fixed costs were calculated considering the time that the production factors were dedicated to the activity.

To determine the variable costs, the burden of materials and services, such as the labour used in collecting, processing and extracting the almonds from the raw fruits, was considered. The expenses for internal transport (by storing) and external transport (to sell the production) were estimated. Other analysed costs were maintenance, fuel and animal feed costs.

All revenue and cost figures in this study were updated using the General Price Index—Internal Availability (IGP-DI), which is the most used indicator in the agricultural sector (Neves, 2022).

2.2 ECONOMIC AND FINANCIAL ANALYSIS

For the analysis of the extractivist activity, the families involved were categorised according to the volume of almonds sold. In this way, scenarios can be simulated to study the economic viability on remunerating the capital invested, which in this study was the investment in the construction of a barn for storing the production.

In face of the above exposed, the families were divided into average producers, those who sold above average, called more productive, and the formation of an agroextractivists association simulation in Sagarana (Region III). This region is notably known for its high production capacity and for having agroextractivist families lasting the longest time in the activity and producing the largest quantities of almonds.

For the analysis of the viability, preparing a cash flow simulating the costs and revenues from the sale of baru over a period of 10 years, covering the period from 2005 to 2014 was necessary, whose values were deflated by the annual variation of the General Index of Prices - Internal Availability (IGP-DI).

All the prices employed in the economic analysis, such as of products, materials, equipment and/or services, were collected in the region itself, reflecting the real economic potential of the alternatives tested. It is also observed that this model investigates the performed costs, that is, the actual figures spent in the almond production process, which differs from an analysis using costs estimated by secondary data (Castelo, 2000).

2.2.1 NET PRESENT VALUE (NPV)

The economic viability of a project analysed by using this method is indicated by the positive balance between revenues and expenses, both updated to a given discount rate. The NPV aims to evaluate capital investment proposals (Rezende; Oliveira, 2013). The minimum attractiveness rate used was 3.5% p.a., which refers to the values adopted in financing the implementation of fruit-growing areas under the National Program for Strengthening Family Farming (Pronaf/fruticultura).

NPV was calculated using the equation:

$$VPL = \sum_{J=0}^{n} R_j \,(1+i)^{-j} - \sum_{J=0}^{n} C_j \,(1+i)^{-j}$$

Equation 1

Where:
Cj= costs in period j;
Rj= revenue in period j;
i= discount rate;

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j= period in which Cj and Rj occur; and
n= project duration in years.

To analyse the payment capacity of agroextractivist unities both from individual investment projects and associations, the construction of a shed worth R$ 4,191.15 was planned, as considered in the study by Leite *et al*. (2014). This value was depreciated and deflated for the cash flow period.

2.2.2 EQUIVALENT PERIODIC BENEFIT (EPB)

This method aims to turn the current value of the project, or its NPV, into a flow of annual and continuous revenues or costs equivalent to the current value during the project's lifespan (Silva *et al*., 2008). It is the recurring and regular instalment required to pay an amount equal to the NPV of the investment option analysed throughout its lifespan (Rezende; Oliveira, 2013).

EPB was calculated using the equation:

$$BPE = \frac{NPV\,[(1+i)^{t} - 1]\,(1+i)^{nt}}{(1+i)^{nt} - 1}$$

Equation 2

Where:
NPV= Net present value;
i = discount rate;
n = project duration in years; and
t = number of capitalisation periods.

2.2.3 AVERAGE COST OF PRODUCTION (ACP)

The definition of production costs is crucial to analysing the economic viability of extractivism. ACP consists of dividing the current value of the total cost by the equivalent total production. Equivalent production is the quantity discounted or updated according to the interest rate. It indicates the point where production operates at a minimum cost. If it is under market price, the project will be viable (Silva *et al*., 2008).

ACP was calculated using the equation:

$$ACP = \frac{\sum_{j=0}^{n} CT_J\,(1+i)^{-j}}{\sum_{j=0}^{n} PT_J\,(1+i)^{-j}}$$

Equation 3

Where:
CTj = total cost updated to each period, R$.harvest-1; and
PTj = equivalent total production in each period, kg.harvest-1.

2.2.4 FAMILY LABOUR REVENUE (FLR)

This indicator is essential for a direct analogy between the remuneration that could be obtained by selling labour on properties in the region (opportunity cost) and the revenue that can be generated on the family's property, that is, the value that the extractivist activity can return to the family (Rêgo, 2014; Sá *et al*., 2008; Silva *et al*., 2013).

If the value of FLR is higher than the value paid per day for baru extraction, it means that it pays the family members to work on their property. However, when the family members' revenue does not compete with this value, it may indicate a propensity to seek alternative jobs in other activities with better pay.

FLR was estimated according to Sá *et al*. (2000):

$$FLR = \frac{RTF}{P/DF}$$

Equation 4

Where:
FLR = family labour revenue, R$. harvest-1;
RTF = family wages, R$. harvest-1; and
P/DF = total number of working day payments (p/d).

The calculation of the FLR results from subtracting all expenses from the gross income, except family labour, and the net income obtained is divided by the total daily wages required for the activities. It was considered that most human labour is performed by family members, presuming they are trained for it (Rêgo, 2014). The opportunity cost values of R$ 65.87 for the 2013 harvest and R$ 81.88 for the subsequent harvest were adopted.

2.2.5 NET INCOME

Net Income is defined as the difference between gross revenue and the total cost in the period analysed (Santos *et al*., 2002). It is the remaining value after replacing all products and services provided to the means of production (Castelo, 2000).

NI was estimated according to Santos *et al*. (2002):

$$NI = \Sigma R_j - \Sigma C_j$$

Equation 5

Where:
Rj = Total revenue from harvest, R$. harvest-1;
Cj = Total cost in the period, R$. harvest-1;

It represents a fraction of the gross income that becomes available after the producer pays all costs and distributes the remunerations considered normal (opportunity cost) to the factors used (but not paid), that is, his own work (executive and management), family work, their own capital (Castelo, 2000).

3 RESULTS AND DISCUSSION

3.1 PROFILE OF THE AGRO-EXTRATIVIST FARMER

Based on indications from members of the baru production chain, 4 regions were defined, namely the Chico Mendes Settlement Project Region (Region I), the Rancharia Settlement Project Region (Region II), the Sagarana District Region (Region III) and the Igrejinha District Region (Region IV).

Considering the results of the interviews, the agro-extractivist population was estimated to be 119 families that worked in the studied harvests. This figure represents 2.21% of the families in the municipality, establishing an effort of 27 agro-extractivist families, considering a confidence level of 95%. Aiming at a greater representativeness, 30 interviews were conducted in the four regions selected for their production and commercialisation, which represents approximately a quarter of the total recorded.

The families involved perform between three and six distinct productive activities at the same time as they do agricultural, household and extractive activities, being thus called agro-extractivists, coinciding with the studies of Bispo and Diniz (2014) and 43.33% are land reform settlers.

The sale of almonds contributed with 21.39% to the family income in the 2013 harvest and 14.63% in the subsequent harvest. This significant drop is a consequence of the volatility in the baru tree production. Values close to these were presented in studies by Carneiro (2014) and Pimentel *et al*. (2009), when the sale of almonds made up 12.34% of the family income in the 2005 harvest and 8.44% in the 2007 harvest in the Pirenópolis region in the State of Goiás.

Among the production practices and/or social aid sources that most contributed to the building up of agro-extractivist families' income, the most notable is the commercialisation of Baru, with 26.67% of observations, while dairy farming was cited by 23.33% and retirement and wage labour mentioned by 13.33% of the interviewed.

Regarding the participation in governmental cash transfer programs, 63.33% of the interviewed are Bolsa Família Program recipients, finding themselves in a situation of social vulnerability. When comparing the families’ income with the national minimum wage, agro-extractivist farmers obtained an average of 1.91 minimum wages in 2013 and 1.83 wages in 2014.

The families that produce above average generally buy fruits from other gatherers, especially because collecting the fruit is considered by 66.67% as the worst activity in the production process. By doing so, more can be dedicated to processing, which adds more value to the product. The vast majority (87.67%) prefer to sell raw nuts, and 76.66% of participants would be willing to invest their own resources in the production of processed baru almonds, seeking improvements in the production process.

3.2 AGRO-EXTRATIVIST PRODUCTION PROCESS

Most families also collect fruits (73.33%) from isolated trees in pastures, and 83.33% collect them simultaneously from third-party lands. Generally, such collecting is done with the consent of the landowners, who in 90% of the cases allow free access to the baru trees, whereas 10% of the interviewed gather the fruits with the condition of handing over a percentage to the owner.

Collecting usually takes place between the months of August and November, ending with the arrival of the rainy season. The collected fruits are packed in feed bags and temporarily placed under the baru trees until they are sent to the storage location. The average time dedicated to the activity of collecting is 3.12 months, a period in which they gather an average of 6.4 bags per day of work, crossing some 6.3 kilometres with 3.48 routes and collecting from approximately 13 trees each day.

At the end of the collecting, the production is internally transported, which consists of taking it from the collection spot to the storage location. The main means of transport for production are carts and cars, with 56.67% and 40%, respectively, which allow transporting approximately 5.5 bags of 50 kilos per trip.

Storing the production is a preparatory stage for the processing and marketing of almonds. These are usually stored in rooms in the farmers' homes (40%), which may be on the balcony or in an unoccupied internal room. Other places used for storage are barns (wider use) and shelters (exclusively used for agricultural products), with 26.67% and 20% of use, respectively.

The tool most used for processing the fruits and extracting the almonds from their shells was an adapted blade, which could be the one of an axe or machete fixed to a wooden base, used by 63.33% of the respondents. Another widely used piece of equipment was an iron sickle coupled to a lever and fixed to a base made of the same material, a method used by 56.66% of the interviewees, and 20% had both types of equipment.

After this stage, the raw almonds are packaged for sale. The agro-extractivist farmers pack their seeds in reused Polyethylene Terephthalate soda bottles (PET bottles), making up 50% of the cases. A small proportion of the interviewed reuse resistant plastic bags made available by local businesses, and 26.67% use resistant and transparent plastic bags donated to members of the Sustainable Family Agriculture Cooperative based on Solidarity Economy (Copabase).

When analysing the agro-extractivist farmers' access to technical assistance and rural extension, half of the participants did not receive any support, reflecting in the result that 86.67% of interviewees stated that they did not receive guidance on sustainable extractivism practices. This absence points to the dismantling of public Technical Assistance and Rural Extension and reflects the result of unsustainable practices, as discussed by Magalhães (2019). As an example, only 15.66% of the interviewed used to leave part of the fruits for the fauna and for the dispersion of the species, results that differ from the studies by Bassini (2008) and Pimentel *et al*. (2009), who report that 25% and 50%, respectively, adopt this practice.

3.3 PRODUCTION AND COMMERCIALIZATION

In their majority, the agro-extractivist farmers basically produce and sell raw almonds, not making full use of the fruits nor adding value to the product. The almond roasting stage is mostly done by the Cooperative and intermediaries, where only 10% of the interviewees do roasting.

After analysing the results, a significant difference in almond production was observed, except Region III (Table 1). This information corroborates the discussion by Magalhães (2019), in which the sudden variation in production fragments commercial relations and affects prices.

Table 1 – Production and prices practised in the harvest and between-harvest periods

	2013 Harvest			2014 Harvest		
Region	PH (R$)	PB (R$)	P (kg/almonds)	PH (R$)	PB (R$)	P (kg/almonds)
I	31,18 b	43,48 b	121,40 a	56,21 b	56,21 a	50,40 ab
II	28,54 ab	29,99 a	230,00 a	38,05 a	49,76 a	78,33 ab
III	28,81 ab	36,23 ab	185,00 a	41,43 ab	51,60 a	183,75 b

	2013 Harvest			2014 Harvest		
Region	PH (R$)	PB (R$)	P (kg/almonds)	PH (R$)	PB (R$)	P (kg/almonds)
IV	26,35 a	31,47 a	123,33 a	39,52 ab	43,91 a	32,33 a
CV%	6,61	11,36	13,85	9,20	13,38	15,05

Source: Prepared by the authors (2015)

Where: PH: Price during harvest, PB: Price in the between-harvest period, P: Production

Through the interviews, the agro-extractivist families classified the 2013 harvest as high. This information is observed in the results presented, as there were no significant differences in production between the regions observed. However, the 2014 harvest was classified as low production, occurring with an average reduction of 49.72%, except in the Sagarana region (Region III), which maintained productivity.

Throughout the period of analysis, there were significant differences in the prices received for the sale of raw almonds, both in the harvest and in between harvests, except the 2014 between-harvest, which due to low supply forced a price increase in all regions researched.

The highest almond prices were practised near the Chico Mendes settlement project (Region I), which has easy access to paved roads, facilitating the transit of intermediaries who work informally in the market and carry low operating costs, allowing purchases withhigher values than the ones practised by the family farming cooperative that operates in the region. Another determining factor for achieving higher prices is the strategy of storing the fruits and selling them only during the between-harvest time (this practice was observed only in this region).

Regarding the commercialisation of production, 40% of the agro-extractivist farmers deal exclusively with intermediaries, against 23.38% that trade exclusively with the cooperative; and 16.67% of the interviewees trade with both.

3.4 TECHNICAL COEFFICIENTS OF THE PRODUCTION SYSTEM

To assess the viability of extractivist activity, it is necessary to correctly quantify the production cost, studying the expenses involved in the performance of services, use of materials, equipment and facilities in the production of baru almonds, establishing the technical coefficients and time of use in each stage.

During the analysed period, 4,824.28 and 2,763.80 kilos of fruit were collected, corresponding to 80.4 and 46.06 bags with 50 kilos in the 2013 and 2014 harvests, respectively (Table 2). An average of 3.12 months were dedicated to collecting the fruits, by collecting 6.4 bags per day, in a total of 3.48 routes, totalling 12.56 days of work per person per day (p/d) to collect the 2013 harvest and 9.36 in the subsequent harvest.

Table 2 – Technical variables of the internal transport and processing stage

Activity	2013	2014	Unity
Trips for internal transport	14,49	8,38	Unity/harvest
Days dedicated to collecting	12,45	9,36	p/d
Days dedicated to processing	43,52	25,16	p/d
Average production	4.824,28	2.763,80	Kilos/fruits

Source: Prepared by the authors (2015).

In this study, the agro-extractivist farmers declared to produce 4.46 kg of baru per day of work at processing and shelling, which was therefore distinct from the studies presented by Botezelli *et al*. (2000), Pimentel *et al*. (2009) and de Sano *et al*. (2004), who estimated a yield of 2.36, 1.13 and 2.00 kilos of almonds per working day, respectively. The greater experience and skill of the extractivist farmers interviewed can explain this difference.

The production is generally stored in a barn, shelter or in rooms in the farmers' residence. Baru processing is time-consuming and little productive, corresponding to 43.52 days of dedication in the 2013 harvest and 25.16 days in 2014, demonstrating the impact of seasonality on days worked in the harvests analysed.

The variable days of dedication to the stages of the process were established considering exclusive dedication to the activity, which in practice does not occur due to the pluriactivity of agro-extractivist farmers, which enables them to work in shifts in such a manner as collecting the fruits only in the morning and processing them in the afternoon or at night.

3.5 PRODUCTION COSTS

Variable costs for the production of raw almonds made up 94.28% of total costs, highlighting collection and fruit processing and shelling, with 14.57% and 50.92%, respectively, for the 2013 harvest. For the subsequent harvest, these values corresponded to 97.38%, 17.46% and 47.75% in the same order (Table 3).

Table 3 – Technical variables of the internal transport and processing stage

	2013				2014			
Items	Q(p/d)	C (R$)	TC(R$)	(%)	Q(p/d)	C (R$)	TC(R$)	(%)
Collecting	12,45	65,05	809,87	14,57	9,36	81,78	765,46	17,46
Animal feed	3,12	130,34	406,66	7,31	3,12	122,67	382,73	8,73
Mantenance/cart	3,12	47,53	148,29	2,67	3,12	44,93	140,18	3,20
Mantenance/car	3,12	86,89	271,10	4,88	3,12	81,78	255,15	5,82
Fuel	5,79	9,45	54,72	0,98	3,35	21,28	71,29	1,63
External transport	3,00	65,05	195,15	3,51	2,00	81,78	163,56	3,73
Tickets costs	3,00	65,05	195,15	3,51	2,00	61,49	122,98	2,80
Processing	43,52	65,05	2830,98	50,92	25,60	81,78	2093,57	47,75
Materials used	1,00	266,40	266,40	4,79	1,00	215,34	215,34	4,91
Administrative costs	3,12	20,17	62,93	1,13	3,12	19,06	59,47	1,36
Total variable cost			**5241,25**	**94,28**			**4269,73**	**97,38**
Fixed capital remuneration	1,00	14,45	14,45	0,26	1,00	13,47	6,58	0,15
Depreciation/Cart	1,00	14,95	14,95	0,27	1,00	13,94	6,81	0,16
Depreciation Shelter	1,00	12,91	12,91	0,23	1,00	12,04	5,88	0,13
Depreciation residence	1,00	117,68	117,68	2,12	1,00	109,23	53,36	1,22
Depreciation car	1,00	153,20	153,20	2,76	1,00	81,82	39,97	0,91
Depreciation adapted device	1,00	5,01	5,01	0,09	1,00	2,68	2,28	0,05
Total fixed cost			**318,20**	**5,72**	**6,00**	**233,18**	**114,88**	**2,62**
Total cost			**5559,45**				**4384,61**	

Source: Prepared by the authors

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Considering the lack of funding, low technological level and lack of specific infrastructure, fixed costs represented a percentage of 5.72% for the 2013 harvest and 2.62% for the 2014 harvest, highlighting the depreciation of vehicles and residence as the most significant fixed costs.

The use of strategies that involve associations or cooperativism allow the reduction of agro-extractivist production costs (Engel; Almeida; Deponti, 2017). However, improvement in cost management is necessary, as this control is generally not done (Oliveira *et al*., 2020). Considering the above exposed, it was necessary to arbitrate values to build up a scenario for an economic analysis of the organisation in association with the most productive agro-extractivist farmers in Region III (District of Sagarana).

For this purpose, a reduction of around 28.75% in fixed costs in storage was established, as the production would be stored in more appropriate locations and in a more organised way, optimising the use of these spaces. The collective organisation of collection routes would generate savings of 14.28% in the variable cost of internal transport, as the search for fruits would be more effective through better targeting of collection spots, avoiding unnecessary trips.

The average unit production cost was estimated at R$ 28.34 per kilogram of raw almonds in the 2013 harvest, which production reached 196.16 kilograms of raw almonds, and R$ 39.02 in the subsequent harvest, which production amounted to 112. 38 kilograms (Table 4), making total costs of R$ 5,559.45 and 4,384.61 respectively.

3.6 REVENUES

The average revenues obtained were R$ 6,267.31 in the 2013 harvest and R$ 5,161.61 in the 2014 harvest. When comparing the two revenues, a significant reduction in the revenue obtained in the evaluated period was observed (Table 4).

Table 4 – Comparative analysis of costs in the different harvests under study.

Harvest	Average price (R$)	Production cost (R$)	Production (Kg/almonds)	Total Revenue(R$)	Dedicated days	Daily revenue (R$)
2013	31,95	28,34	196,16	6.267,31	59,48	105,36
2014	45,93	39,02	112,38	5.161,61	36,52	141,33

Source: Prepared by the authors.

When analysing the total revenue in comparison with the days dedicated to the activity, it is noted that the 2014 harvest paid R$ 141.33 per day of work, while in the 2013 harvest, the day was paid R$ 105.36, demonstrating the effect of supply and demand on prices, as the scarcity of almonds forces an increase in the values paid to agro-extractivist farmers for a day of work, a phenomenon observed in the 2014 harvest.

3.7 ECONOMIC AND FINANCIAL ANALYSIS

3.7.1 ECONOMIC INDICATORS OF PROFITABILITY

The financial results demonstrate that the extractivism of baru is economically feasible in all profitability indicators used, except the average agro-extractivist farmers for the 2014 harvest, which obtained a negative Net Revenue value, indicating that the increase in the value of labour in the year in question affected the result (Table 5).

Table 5 – Profitability of extractivism

Indicator	*Unity*	Average agro-extractivist farmer		More productive agro-extractivist farmer		Extratívist Association	
Harvest	*year*	2013	*2014*	*2013*	*2014*	C *(R$)*	*TC(R$)*
FLR	R$/harvest^{-1}	4.647,23	3.111,84	7.552,07	5.716,23	8.466,20	10.359,21
NR	R$/harvest^{-1}	409,68	- 0,86	835,26	565,85	1.772,45	2.250,28
FLR	R$. day^{-1}	81,29	85,22	83,11	93,22	90,86	110,03
UPC	R$/Kg	29,34	39,73	29,03	36,72	28,52	35,21
Price sell	R$/Kg	33,62	42,82	33,95	42,62	36,80	46,06

Source: Prepared by the authors (2015).

Where:

FLR = Family labor revenue, R$. Harvest-1;
NR= Net revenue, R$. Harvest-1,
FLR= Family labour remuneration;
UPC= Unity Production Cost, R$/Kg almonds.

With the increase in scale, there were improvements in the financial viability indicators, demonstrating that the dedication to the activity improves revenue. When comparing the net income of a member of the association with that of the average agro-extractivist farmer, it is clear that there was an increase of 4.32 times in the figures received. And compared to the most productive ones, this increase was 2.12 times. This result was obtained due to the dedication to the activity, the scale of production and the obtained prices. The agro-extractivist farmers from the Sagarana region (Region III) obtained a significantly higher net income because of their production of a greater quantity. This region has a larger number of baru trees, which mitigates the effects of seasonality, in addition to achieving more advantageous sale prices due to direct-selling to the end consumer, consequently improving their financial indicators.

All profiles analysed remunerated family labour (FLR), and it was verified that increasing the scale resulted in improvements in the indicators, especially in income, due to the higher figures received. With the organisation in a simulated association, agro-extractivist farmers were able to negotiate with buyers who remunerated production better, in addition to having better technical coefficients and obtaining lower production costs.

3.7.2 FINANCIAL EVALUATION

Analysing the financial viability of investing in the construction of a shelter, using the Net Present Value (NPV) method, the unfeasibility of investment by the average and the more productive agro-extractivist farmers was observed (Table 6). However, when analysing the situation of the agroextractivist association members, the NPV was positive, indicating the viability of the enterprise in this scenario.

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Table 6 – CViability indicators that vary the value of capital over time.

Economic indicator	Unity	Average agro-extractivist farmer	More productive agro--extractivist farme	Extractivist Association
NPV_{10}	R\$. $harvest^{-1}$	-3.140,19	-3.005,77	11.679,38
BPE_{10}	R\$. $ha^{-1}.ano^{-1}$	-377,57	-361,42	1.404,34
ACP	R\$.kg^{-1}	29,48	28,35	25,06
Average price	R\$.kg^{-1}	28,47	28,45	30,85

Source: Prepared by the authors (2015).

Where:

NPV = Net Present Value
EPB = Equivalent Periodic Benefit
ACP: Average Cost of Production

Considering the specific hypothesis of the agro-extractivist farmers from the Sagarana region (Region IV) organising themselves in an association, taking into account the technical coefficients and prices charged, investment in a shelter would be economically viable within the horizon evaluated in all indicators analysed, demonstrating the potential for improvements via organisations between the agro-extractivist farmers and that community cooperation strategies are essential for the viability of baru extractivism.

4 CONCLUSION

Baru's agroextractive activity in the Urucuia River Valley region has proved to be economically viable, positively remunerating the opportunity cost for the most common family farmers' job, which is working as a day labourer on third-party properties. However, the income generated by the activity does not allow a flow of resources to pay for investments in the construction of infrastructures that improve the production process, such as storage shelters.

The unfeasibility of investing its own resources in storage facilities reflects the reality on the ground, as the majority of agro-extractivists and/or family farmers are unable to afford to pay off instalments.

The labour, fruit processing and shelling costs are significant, directly influencing economic viability. The absence of agricultural machinery and/or implements that improve operational performance has become a limiting factor in the development of the production chain, increasing the price of baru and making it one of the most expensive oilseeds on the market, making access difficult for some consumers, who may prefer substitute products, such as Brazil nuts, cashew nuts, etc.

It must be taken into account that this is a time frame, and new studies must be developed, but it was observed that the phenomena, in general, are still recurrent. The production chain changed; multinational companies were set up, baru tree plantations were established, and more agro-extractivist farmers and other agents were incorporated into the activity, but the challenges and limitations of the production chain, have not yet been overcome, especially regarding the cost of processing, which remain high because efficient equipment has not been developed and the methods for breaking the shell and obtain almonds remain the same (WWF, Conexsus, 2021).

These dynamics made baru even more relevant to the bioeconomy of non-timber forest products in the Urucuia River Valley and the Cerrado in general, resulting in great coordination between various institutions and organisations that operate in the production chain. Due to this major importance, the State of Minas Gerais granted the municipality of Arinos, by State Law No. 24,181 from June 14, 2022, the title of "State Capital of Baru" (Minas Gerais, 2022). The City Council approved Law No. 1,669 on December 21, 2022, which "Declares the baru tree's (*Dipteryx alata* Vog.) need and form of management in the municipality of Arinos" (Arinos, 2022). Another action that is underway is the Baru/Fenabaru National Fair, which is in its fifth edition and is characterised as a cultural, gastronomic, touristic and socioeconomic festival of Baru in the region.

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