ECONOMIC AND COMPARATIVE PROFITABILITY OF COSTS IN SOYBEAN PRODUCTION

Carolina Cândida Rodrigues[1]; Andrecia Cósmem da Silva[2]; Matheus da Silva Araujo[3]; Jhécika da Silva Furtado[4]; Rodrigo Couto Santos[5]

[1] Agrônoma pela Universidade Estadual de Goiás, Campus Sul, UnU Ipameri/GO.
[2] Professora Mestre da Universidade Estadual de Goiás, Campus Sul, UnU Ipameri, GO. E-mail: andrecia.silva@ueg.br.
[3] Doutor em Solos e Nutrição de Plantas, Escola Superior de Agricultura "Luiz de Queiroz", Universidade de São Paulo -USP - Campus Piracicaba;
[4] Engenheira Florestal pela Universidade Estadual de Goiás, Campus Sul, UnU Ipameri, GO.
[5] Doutor em Engenharia Agrícola, Universidade Federal da Grande Dourados, Dourados, MS

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ABSTRACT

The objective of this work was to verify the economic and comparative profitability of the production costs of cultivating two soybean cultivars in the southeast of Goiás. The case study was carried out in two areas A (RR soybean) and B (RR2 soybean PRO), with five-year appreciation, applying the long-term interest rate (TJLP) of 5.32% p.a. For the economic analysis, the following indicators were considered: Gross Revenue (RB), Net Revenue (RL), Benefit-Cost Ratio (RB/C), Profitability Index (IL), Updated Payback, and Internal Rate of Return (IRR). The economic profitability of area A resulted in: RB = R$ 9,257.82, RL = R$ 5,845.55, RB/C = 2.48, IL = 63.14%, Payback = 1 years and IRR = 156% and area B in: RB = R$ 7,923.74, RL = R$ 4,981.16, RB/C = 2.46, IL = 62.86%, Payback = 1 years and IRR = 155%. Both cultivars were viable, however, area A presented higher values due to its greater productivity. Therefore, it is concluded that RR and RR2 PRO soybeans are viable for regions with the same characteristics as the area analyzed, confirming RR soybeans as the most profitable.

KEYWORDS: Economic indicator, Oilseed, Productivity, Viability.

RENDABILIDADE ECONÔMICA E COMPARATIVA DE CUSTOS NA PRODUÇÃO DE SOJA

RESUMO

Objetivou-se com a realização deste trabalho verificar a rentabilidade econômica e comparativa dos custos de produção do cultivo de duas cultivares de soja, no sudeste de Goiás. O estudo de caso foi realizado em duas áreas A (soja RR) e B (soja RR2 PRO), com apreciação de cinco anos, aplicando a taxa de juros a longo prazo (TJLP) de 5,32 % a.a. Para a análise econômica foram considerados os seguintes indicadores: Receita Bruta (RB), Receita Líquida (RL), Relação Benefício Custo (RB/C), Índice de Lucratividade (IL), Payback Atualizado, Taxa Interna de Retorno (TIR). A rentabilidade econômica da área A resultou em: RB = R$ 9.257,82, RL = R$ 5.845,55, RB/C = 2,48, IL = 63,14%, Payback = 1 anos e TIR = 156% e a área B em: RB = R$ 7.923,74, RL = R$ 4.981,16, RB/C = 2,46, IL = 62,86%, Payback = 1 anos e TIR = 155%. As duas cultivares foram viáveis, no entanto, a área A apresentou valores superiores, devido a sua maior produtividade. Portanto, conclui-se que a soja RR e RR2 PRO são viáveis para regiões que possuem as mesmas características da área analisada, atestando a soja RR como a mais rentável.

PALAVRAS-CHAVE: Indicador econômico, Oleaginosa, Produtividade, Viabilidade.

INTRODUCTION

Soybeans (Glycine max L.) belong to the Fabaceae family, also known as legumes. Its origins date back to China, where it was domesticated around the 11th century BC. The current form of soybeans arose naturally from the crossing of two wild species, which were later improved by Chinese scientists in ancient times. Soybeans were highly valued for their nutritional benefits in ancient China. Despite having been introduced to Europe as early as 1739 through experimental planting in the Paris Botanical Garden, soybeans only gained attention from American producers in 1880, with the first reference dating back to 1804 (BONATO & BONATO, 1987; MARTINS et al., 2022).

In Brazil, the first reference was in 1882, when the results of the first tests in Bahia were reported. Since then, several studies have been conducted in different parts of the country. At the end of 1960, two factors influenced Brazil to see soy as a commercial product, at the time, the main crop in southern Brazil was wheat, and soy proved to be an option for summer cultivation in succession to wheat, in addition, a demand for soybean meal was being generated, due to the production of pigs and poultry (EMBRAPA SOJA, 2019).

At the end of the 1980s, the evolution of tropical agriculture made exploration possible in the Brazilian cerrado, and studies resulted in criteria for correcting acidic soils and developing improved plants to be cultivated in low latitudes, providing rapid expansion of the planting area in this biome. These areas were primarily of higher altitudes, flat reliefs, and soils suitable for agricultural cultivation, therefore, the states of Mato Grosso, Goiás, and Mato Grosso do Sul were first occupied, but currently, the MATOPIBA region (Maranhão, Tocantins, Piauí, and Bahia) known as the last agricultural frontier grows driven by soybean cultivation (ALMEIDA et al., 2016; EMBRAPA, 2019).

In Brazil, soybeans have immense economic significance, as they serve as a primary product of national agriculture and reinforce the country's position as an essential participant in the global agricultural market. This, in turn, allows more

significant influence in the domain of global commodity trade (HIRAKURI; LAZZAROTTO, 2014; CARVALHO et al., 2021). For the 2020/21 harvest, the estimated national grain production was 252.3 million tons. This number represents a 1.8% reduction in production compared to the previous harvest, which had production estimated at approximately 1.6 million tons (CONAB, 2021a).

Brazil is the largest producer of soybeans, with production of 135.409 million tons in the 2020/21 harvest, surpassing the United States, which produced 112.549 million tons in the same harvest (EMBRAPA SOJA, 2021). For the 2021/2022 harvest, the area to be planted with soybeans increased from 38.9 million hectares to 39.91 million hectares, estimating a production of 140.75 million tons (CONAB, 2021b). According to data from IBGE (2021), the central-west region produced around 61,122,849 tons and an area of 17,628,440 hectares in the 2020/21 harvest, where the state of Goiás participated with a total production of 12,895,706 tons of soybeans in the 2020/21 harvest in a planting area of 3,697,499 hectares.

The use of new agricultural technologies has been fundamental to increasing the productive capacity of this oilseed, among which is the adoption of measures to minimize phytosanitary problems, such as the use of RR soybean cultivars, which have the tolerance to the herbicide Glyphosate and cultivars with Intacta RR2 PRO technology, which provide tolerance to Glyphosate and act in the control of some caterpillars such as the soybean caterpillar (Anticarsa gemmatalis), false caterpillar (Rachiplusia nu and Chrysodeixis includens), apple caterpillar (Heliotis virescens) and act in the suppression of the elasm caterpillar (Elasmopalpus lignosellus) and Helicoverpa caterpillar (Helicoverpa zea and Helicoverpa armigera) (TESSELE et al., 2017).

In addition to new technologies, rural properties need efficient management of their businesses in order to predict risks, project investments, and manage them. Analyzing the activities carried out is a tool for good management, as it will directly assist farm managers in making decisions (CORSO et al., 2018). The assessment of the economic, financial situation and viability of investments and activities carried out in rural areas makes it possible to identify the return time for invested capital and predict the generation of cash flow, in addition to comparing the development between the activities performed (KRUGER et al., 2018).

It is known that soy is a crop of great national and global economic importance; however, it is essential that producers quantify the profitability of growing this oilseed, as each property and region has different realities. Therefore, the objective of this work was to carry out an economic and comparative analysis of production costs for the cultivation of two soybean cultivars, RR and RR2 PRO, in the southeast of Goiás.

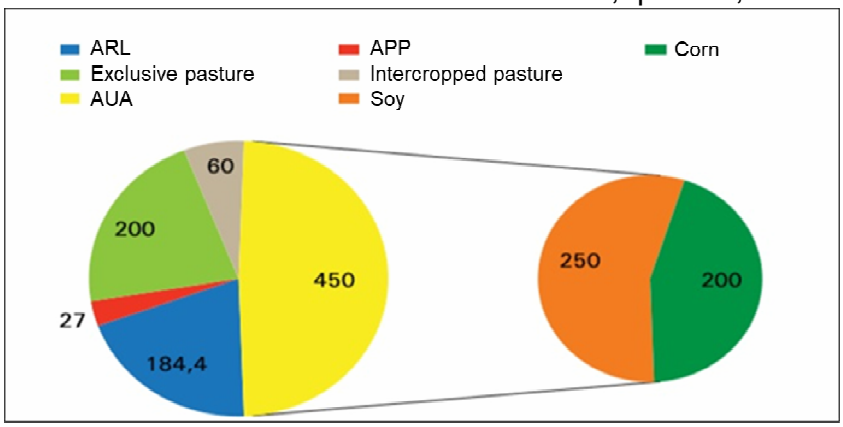
MATERIAL AND METHODS

The work is a case study on a rural property in the municipality of Ipameri, southeast of Goiás, located at 17º39'29.85" South latitude and 48º12'23.81" West longitude, with an altitude of 811 m. According to Köppen's classification, the region's climate is characterized as tropical (Aw), with a rainfall distribution similar to that prevalent throughout the Cerrado region, which has two well-defined seasons, one of rainy seasons that begins in October and ending in April and a dry period, which occurs from the month of June and continues until the month of October (CARDOSO et al., 2014).

The property's soil is classified as Dystrophic Red Latosol (EMBRAPA, 2018), naturally acidic and of low fertility, however with good drainage and clay-

sandy texture (45% clay). Its total area is 922 ha, divided into: 184.4 ha of Legal Reserve (ARL); 27 ha of Permanent Preservation Area (APP); 450 ha of Alternative Use Area (AUA); 200 ha of pasture area and 60 ha of pasture area with eucalyptus (Figure 1).

FIGURE 1. Areas in hectares of the farm, Ipameri, GO.



Source: OLIVEIRA et al., (2013).

The case study aimed to investigate and understand a specific activity through data collection and analysis. For the economic analysis, data collected in the 2020/2021 harvest from two areas, called area A and area B, with 64.8 ha and 69 ha, respectively, were used, and the costs per hectare were evaluated. The property has a computerized data collection system using the MultBovinos Software, which stores all farm management data, providing access to the technical coefficients necessary to collect study information.

In both areas, the direct planting system was carried out, with the application of KCl at a dosage of 100.79 kg/ha two months before the scheduled planting date. On the eve of planting, the area was desiccated with the application of herbicides due to the planting system used.

To plant area A, the RR cultivar, which is tolerant to glyphosate-based herbicides, and area B was used to cultivate RR2 PRO, which, in addition to its tolerance to glyphosate, acts in the control and suppression of some crop pest caterpillars. The sowing lines in the two areas were 0.50 m apart, establishing a stand of 400,000 plants/ha, and the fertilizer used was MAP formulation 11-52-00, with 3.3 kg/ha recommended. Subsequently, post-emergent was applied, followed by fungicides and insecticides to control diseases and insect pests. The harvest was 117 days after sowing, selling the grains in 60 kg bags.

The costs consisted of all items necessary to conduct the culture, such as inputs, mechanized operations, labor, and other costs. Mechanized operations took place using the property's machinery, which was supplied with fuel purchased directly from distribution companies, consequently reducing the costs of these operations. Each bag of soybeans worth R$118.69 was sold to a trading company in the study region.

To determine production costs, the methodology used by Matsunaga et al. (1976) and Martin et al. (1998) and adapted by other authors such as Martins et al. (2018), which is composed of Effective Operating Cost (COE), consisting of the sum of expenses with operations and inputs, composing the effective value per hectare for the production of a given product; Total Operating Cost (COT), established by the

sum of COE with other operating costs, which contains general company expenses such as Funrural, land opportunity, technical assistance and expenses not included.

Subsequently, calculations were carried out with cash flow, which is defined as the control of financial movements, inflows (gross revenue), and outflows (expenses) of values in a given period (ERBANO et al., 2014). To analyze financial viability, the following economic indicators were analyzed:

Gross revenue (RB) - The revenue generated from the commercialization of a given activity is based on the predefined sales value (MARTIN et al., 1998). Thus we have equation 1:

$$RB = Pt \times Pc \quad (1)$$

Wherein: Pt – Total productivity and Pc – Selling price.

Net revenue (RL) – The difference between total operating costs and gross revenue is known as net revenue. In other words, it is the revenue remaining after deducting production expenses (MARTIN et al., 1998). Thus, we have equation 2:

$$RL = COT - RB \quad (2)$$

Wherein: COT – Total operating costs and RB – Gross revenue.

Benefit-cost ratio (RB/C) – Indicates the economic efficiency and presents the return on investment by comparing discounted costs and revenues. Therefore, the activity will be feasible if BCR is greater than 1, meaning the higher the ratio, the more viable the investment (COSTA et al., 2005; ARAÚJO et al., 2015). Thus, we have equation 3:

$$RB/C = \frac{RB}{COT} \quad (3)$$

Wherein: RB - Gross revenue; and COT - Total operating costs.

Profitability index (IL) – Presents the relationship between net revenue and gross revenue as a percentage, showing the rate of revenue available after paying all costs (MARTIN et al., 1998). Thus, we have equation 4:

$$IL = \frac{RL}{RB} * 100\% \quad (4)$$

Wherein: RL - Net revenue and RB - Gross revenue.

Updated Payback - Determines how many years the activity will take to recover the amount invested to the company, defined as the ratio of the present value of profits and the present value of investments (VERGARA et al., 2017; ARAÚJO et al., 2018). Calculated by equation 5:

$$Updated\ Payback = -I_0 + \sum_{t=1}^{n} \frac{(Rn - Cn)}{(1+i)^n} \quad (5)$$

Wherein: I_0 - initial investment; R_n - profitability in year n; C_n: cost from year n and i - interest rate.

Internal rate of return (TIR) - It is the discount rate that equals the value of expected revenues to the value of future costs, being considered viable if the IRR is greater than the discount rate used (COELHO et al., 2016; SANTOS FILHO et al., 2016). Calculated by equation 6:

TIR= $\sum_{i-0}^{n}(R_i - C_i)/(1+r)^i = 0$ (6)

Wherein: Ri - Project revenue in year i; Ci - Project costs in year i; ni - Period in years and r - Internal rate of return.

For the analysis of data from the 2020/2021 harvest, the long-term interest rate (TJLP) of 5.32% p.a. was considered. (BNDES, 2021) with a five-year appreciation period. The results of the economic analyses were structured in a Microsoft Excel ® spreadsheet database. the values are in R$, referring to the month 10/2023, where 1US$ = R$5.04 (CNNBRASIL, 2023).

RESULTS AND DISCUSSION

According to the results obtained in the research, the Total Operating Cost (COT) for the production of RR soybeans and RR2 PRO soybeans were R$ 3,412.27 and R$ 2,946.76, respectively (Table 1). The Effective Operating Cost (COE), consisting of inputs and services effectively directed towards the production of the crop, was R$ 1,601.21 (RR soy) and R$ 1,203.44 (RR 2 PRO soy).

TABLE 1. Production cost of RR Soy and RR2 PRO Soy for 1 hectare in the municipality of Ipameri, Goiás, 2020/2021 harvest.

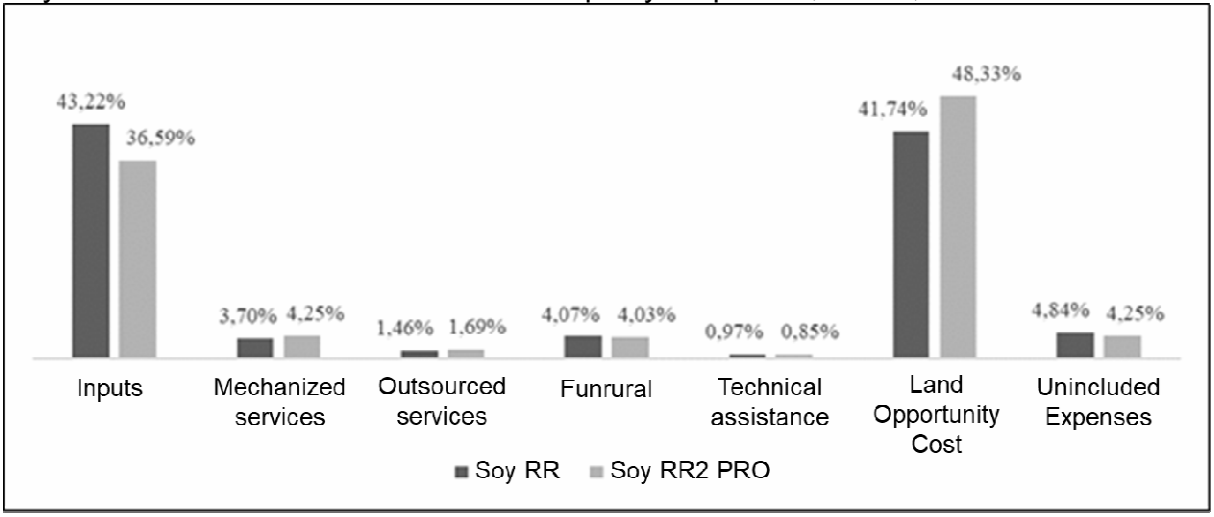
Description	Soy RR (R$/ha^{-1})*	Soy RR2 PRO (R$/ha^{-1})
A. Inputs		
Seeds	R$503.29	R$200.08
Fertilizers	R$303.47	R$315.53
Herbicides	R$169.48	R$169.48
Insecticides	R$206.24	R$168.24
Fungicides	R$277.46	R$204.90
Adjuvants	R$14.16	R$19.23
Inoculants	R$0.75	R$0.75
Subtotal A	**R$1,474.84**	**R$1,078.21**
B. Services		
Chloride Application	R$57.88	R$57.88
Sowing	R$14.57	R$13.42
Spraying	R$5.42	R$5.42
Harvesting	R$48.50	R$48.50
Subtotal B	**R$126.37**	**R$125.23**
C. Outsourced Services		
Transport	R$49.79	R$49.79
Subtotal C	**R$49.79**	**R$49.79**
Effective Operating Cost (COE)	**R$1,651.01**	**R$1,253.23**
Funrural[1]	R$138.87	R$118.86
Technical assistance[2]	R$33.02	R$25.06
Land Opportunity Cost[3]	R$1,424.28	R$1,424.28
Unincluded Expenses[4]	R$165.10	R$125.32
Total Operating Cost (COT)	**R$3,412.27**	**R$2,946.76**

[1] Refers to 1.5% of Gross Revenue.
[2] Refers to 2% of the Effective Operating Cost.
[3] According to the value practiced in the region (12 bags/ha).
[4] Refers to 10% of the Effective Operating Cost.
*1US$ = R$5.04

The production cost values prepared by IFAG (2021a) were R$ 4,110.74/ha (RR soybeans) and R$ 4,028.60/ha (RR2 PRO soybeans) (IFAG, 2021b); such values were higher than those of the present study mainly due to soil correction management, which was not applied on the property studied due to the direct planting system already in place. However, both studies are similar in that the TOC of the RR cultivar was higher than those of the RR2 PRO cultivar, a fact that is justified by the greater quantity of some of the inputs (seeds, insecticides, and fungicides) that were spent on conducting the crop with the cultivar RR.

The distribution of costs was different for the two cultivars, in which the land opportunity, which registered between 41% and almost 49%, item consists of the value paid for leasing the area; as the property has its areas, it was estimated. This value is based on what has been practiced in the region, 12 bags of soybeans per hectare, totaling R$ 1,424.28/ha. Ribeiro et al. (2021) found a lower percentage of 32.47% in the participation of land opportunity costs for RR soybeans compared to the present work. This difference is due to the commercialization value used in each work, where in the present work, a value of R$118.69/sc was used, and in the work of Ribeiro et al. (2021), only R$117.50/sc. This difference in value is linked to fluctuations in the national and international soybean market (Figure 2).

FIGURE 2. Representative participation of costs for the production of Soy RR and Soy RR2 PRO on 1 hectare in the municipality of Ipameri, Goiás, 2020/20 harvest



Source: The authors (2023)

The second most expensive cost of the COT was inputs, which represented between 36% and 44% of the total operational cost, mainly consisting of fertilizers (10.71% for RR2 PRO soybeans and 8.89% for RR soybeans), which are used to provide plants with all the essential nutrients for the satisfactory development of the species. Another product that increased the cost of inputs was seeds (14.75% for RR soybeans and 6.79% for RR2 PRO soybeans), which have high technology, increasing their value. The data obtained in a study carried out by Ribeiro et al. (2021) in the 17/18 harvest, where the participation of inputs was 54.48% of the TOC, corroborates the current values.

The items services and outsourced services represented 5.16% and 5.94%, respectively, for RR soy and RR2 PRO soy. These values represented a much lower

cost of inputs, as the property has highly efficient machinery and professionals adequately trained to carry out the activities, thus reducing service costs.

Profitability analysis makes it possible to check how much return will be obtained immediately when selling the grains. Gross Revenue (RB) was calculated at R$9,257.82 and R$7,923.74/ha (Table 2), based on the production obtained from 78 bags/ha and 67 bags/ha, respectively, area A and area B, the grains harvested from the two areas were sold at R$117.50 per bag/ha, the value used on the property under study.

TABLE 2. Results of the economic analysis of the soybean cultivars RR (area A) and RR2 PRO (area B) on 1 hectare in the municipality of Ipameri, Goiás, 2020/2021 harvest

Profitability analysis		
	Area A	Area B
Gross Revenue (RB)*	R$9,257.82	R$7,923.74
Net Revenue (RL)	R$5,845.55	R$4,981.16
RB/C	2.48	2.46
Profitability Index (IL)	63.14%	62,86%
PayBack	Ano 1	Ano 1
TIR	156%	155%

* Production: 78 bags/ha (RR) and 66.76 bags/ha (RR2 PRO); sold at R$118.69 per bag.

The IL represents the percentage of net revenue obtained; therefore, based on this analysis, it can be seen that 63.14% for area A and 62.86% for area B. This index makes it possible to verify that there was a return on investment; however, only this does not allow certifying whether the return is sufficient to obtain profits.

The RB/C of 2.48 for area A shows that for every R$ 1.00 invested, the producer had a return of R$ 1.48, noting that revenues were higher than expenses, and the result was also positive for area B, RB/C of 2.46, obtaining a return of R$1.46 for every R$1.00 invested. The values found by the authors Keleski et al. (2018) were lower than the present study, mainly because the quantity of grains harvested was approximately 48 bags/ha and the commercial value was R$65.00 per bag, resulting in an RB/C of 1.42 (RR soybeans) and 1.41 (RR2 PRO soybeans), generating an RL of R$769.61 and R$754.25, respectively.

The Payback result was the same for both areas, one year, showing that the culture has a quick return on invested capital. It was possible to observe that for RB and IL, the results were superior for area A, and with IRR, it was no different; area A resulted in 156% and area B 155%; this superiority is justified by the greater productivity, generating responses favorable for the RR soybean cultivar.

In accordance with the economic indicators analyzed, it was noticed that the 2020/2021 soybean harvest of the property under study presented viability for both cultivars; however, the RR cultivar (area A) resulted in more attractive values than the RR2 PRO cultivar (area B). The production costs of RR2 PRO soybeans were lower than the costs of RR soybeans due to the smaller amount of insecticides, labor, and machinery used; the results obtained by the authors Carvalho et al. (2016) corroborate the present study, both cultivars presented economic viability.

Thus, prior to any agricultural activity, in order to guarantee the sustainability of the enterprise in the short and long term, it is necessary to carry out economic

studies on the implementation and management of the crop, and for this, the use of economic indicators is a tool for extreme importance and efficiency, guaranteeing the producer accurate decision-making and awareness of his financial return.

CONCLUSIONS

The case study proved the economic viability of RR and RR2 PRO soybeans for regions with the same characteristics as the studied area. Attesting through economic analysis and comparative production costs that RR soybeans were more profitable, the property would therefore recommend investing in more areas for planting this cultivar, as even with higher production costs, it still presented higher productivity, thus achieving greater profitability. Soybeans are viable as they have not lost their purchasing value against the IGPM and have become profitable compared to other indices, such as IPCA and INPC.

In order for soybean producers in Brazil to capitalize on the crop's potential benefits, they must first have a clear understanding of the costs associated with production, as well as current market prices. Adequate preparation is essential to navigate the unpredictable nature of marketing prices and crop productivity, as evidenced by the negative safety index.

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