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# SECOND CROP PLANTING IN DIAMANTINO/MT: COMPARATIVE ANALYSIS OF ECONOMIC VIABILITY BETWEEN CORN AND SUNFLOWER CROPS

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## ABSTRACT

**Objective:** This study aims to conduct a comparative analysis of economic feasibility between corn and sunflower crops for harvest in Diamantino/MT by applying the multi-index methodology.

**Theoretical framework:** The theoretical framework corresponds to contents related to the analysis of the financial viability of projects and investments, as well as materials related to the planting of ratoon crops, to the analyzed crops and others that help in understanding the theme.

**Method:** Four commercialization scenarios were projected, two for each genre studied, at market prices and by minimum prices of the National Supply Company - CONAB. A Minimum Rate of Attractiveness was defined and the multi-index methodology was applied, aiming to evaluate economic viability, allow comparison between the projected scenarios, evaluate the return on investment and the risks.

**Results and conclusion:** The study, limited to the case studied, demonstrated, from the definition of the Minimum Rate of Attractiveness in 12% p.a., only one of the sunflower scenarios proved to be economically feasible, and then the multi-index methodology was applied, which showed that the project would generate a return on the added investment of 8.19% and that the project's risks are moderate, and then the planting of sunflower is feasible for the producer.

**Implications of the research:** The main contributions of the study are in the sense of demonstrating a different and more comprehensive methodology than those traditionally used for investment evaluation, and can contribute to researchers, rural producers or even other people who aim to evaluate investments in a certain area using the multi-index methodology.

**Originality/value:** This study aimed at analyzing a crop that has been adopted as an alternative to corn in the off-season, the sunflower, applying a more comprehensive methodology of economic analysis than the ones traditionally used. By analyzing the financial viability and risk of sunflower planting in the safrinha compared to the main genus cultivated, corn, a projection is presented, for the specific case, of the producer migrating to a new product.

**Keywords:** Multi-index Methodology, Economic Feasibility Analysis, Sunflower, Corn.

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# PLANTIO DE SAFRINHA EM DIAMANTINO/MT: ANÁLISE COMPARATIVA DE VIABILIDADE ECONÔMICA ENTRE AS CULTURAS DE MILHO E GIRASSOL

**RESUMO**

**Objetivo:** Este estudo tem como objetivo realizar uma análise comparativa de viabilidade econômica entre as culturas de milho e girassol para plantio de safrinha em Diamantino/MT aplicando a metodologia multi-índice.

**Referencial teórico:** o referencial teórico corresponde a conteúdos relacionados à análise de viabilidade financeira de projetos e investimentos, bem como materiais relacionados ao plantio de safrinha, às culturas analisados e outros que auxiliam na compreensão do tema.

**Método:** Foram projetados quatro cenários de comercialização, dois para cada gênero estudado, a preços de mercado e por preços mínimos da Companhia Nacional de Abastecimento - CONAB. Definiu-se uma Taxa Mínima de Atratividade e foi aplicada a metodologia multi-índice, visando avaliar viabilidade econômica, permitir a comparação entre os cenários projetados, avaliar o retorno sobre o investimento e os riscos.

**Resultados e conclusão:** O estudo, limitado ao caso estudado, demonstrou, a partir da definição da Taxa Mínima de Atratividade em 12% a.a., apenas um dos cenários de girassol se mostrou viável economicamente, tendo sido então aplicada a metodologia multi-índice, que mostrou que o projeto geraria um retorno sobre o investimento adicionado de 8,19% e que os riscos do projeto são moderados, sendo então o plantio do girassol viável para o produtor.

**Implicações da pesquisa:** As principais contribuições do estudo são no sentido de demonstrar metodologia diferente e mais abrangente que aquelas tradicionalmente utilizadas para avaliação de investimentos, podendo contribuir para pesquisadores, produtores rurais ou mesmo outras pessoas que visam avaliar investimentos em determinada área utilizando a metodologia multi-índice.

**Originalidade/valor:** Este estudo se propôs a analisar uma cultura que vem sendo adotada como alternativa ao milho na safrinha, o girassol, aplicando metodologia de análise econômica mais abrangente que as tradicionalmente utilizadas. Ao analisar a viabilidade financeira e risco para plantio de girassol na safrinha comparativamente ao principal gênero cultivado, o milho, se apresenta uma projeção, para o caso específico, de o produtor migrar para um novo produto.

**Palavras-chave:** Metodologia Multi-Índice, Análise de Viabilidade Econômica, Safrinha, Girassol, Milho.



## 1 INTRODUCTION

The existence of a defined dry and rainy season, which favors the planning of planting and harvesting, the deep soils with good physical quality and the flat topography made the Cerrado biome the largest Brazilian agricultural frontier in the 1970s and 1980s (SIQUEIRA NETO et al., 2009).

In the Center-South region of Brazil, where most of the corn production is concentrated, there are two distinct harvests: the normal season, with sowing from the end of September to mid-December, and the safrinha, with sowing from January to April, depending on the region (GONÇALVES et al., 1999).

Safrinha started as an initiative of farmers, especially in the state of Paraná, in the 1980s, as a succession option to soybeans sown in summer. Over the years, the importance of this practice grew and spread to other states (GONÇALVES et al., 1999).

The corn crop has great geographical dispersion, since it is produced practically throughout the national territory (MURAKAMI et al., 2004). Safrinha corn is grown in autumn-winter and

represents the main mode of corn cultivation in the states of Mato Grosso and Mato Grosso do Sul (DUARTE, SILVA, DEUBER, 2007).

In the Center-West region of Brazil, in the states of Mato Grosso, Goiás and Mato Grosso do Sul, characterized by less rigorous and drier winters, sunflower cultivation occurs mainly as a second crop, from February to the beginning of March (LEITE et al., 2007).

In calculating the cost of production of a given crop, basic information is the combination of inputs, services, and machinery and implements used throughout the production process. This combination is known as the "technological package" and indicates the quantity of each particular item, per unit of area, that results in a given level of productivity. These mentioned quantities, referred to the unit area (hectare) are called technical production coefficients(CONAB, 2016).

The basic requirement of an investment project is the generation of an economic return, which compensates for the risks and capital costs involved in the investment. The investment and financing decisions of an investment project may be separable, but they can hardly be independent. Capital is a factor of production, and like other factors, has its associated cost (SCHROEDER et al., 2005).

The rural producer seeks to explore his activities so that he can obtain the best profitability through the exploration of his economic activity. Thus, there is a need to analyze which alternative crop generates better results if applied to the property in the off-season period. Thus, we have the following research question: considering sunflower and corn as alternatives, which crop generates better economic results for planting in the off-season in the Diamantino/MT region?

The justification for the research lies in the recent option of sunflower cultivation in the "safrinha" season for the Brazilian Midwest, opening a new perspective of cultivation and income for the farmer, who now has more alternatives to corn and, thus, can choose the product that generates better results. Among the factors that present themselves as an option for the choice of cultivation are profitability and productivity. Profitability is not only a function of the  priescharged in the market, but also of the management of the crop/production cost achieved. From the theoretical point of view, the study is justified by the relevance of the theme, demonstrated in other academic publications related to the application of the multi-index methodology for investment analysis in the agribusiness area (KREUZ, SOUZA, CLEMENTE, 2008; RAMOS et al., 2016; OLIVEIRA et al., 2015).

## 2 THEORETICAL FRAMEWORK

Brazil is the only country in the tropical belt of the globe that has been able to conquer the position of an agricultural powerhouse. Management technologies have transformed poor soils into fertile land, and the tropicalization of crops, with differentiated cycles, has allowed the use of land in all climatic conditions. With their entrepreneurial dynamism, producers knew how to combine this knowledge and take advantage of market opportunities (LOPES, 2017).

Contemporary Brazilian agricultural activity has been thriving and, in the first quarter of 2017, there was a 13.4% growth in the GDP of agriculture and cattle ranching in relation to the previous quarter, and Brazil's GDP advanced 1% in the same period. This was the sector's biggest expansion in more than 20 years. The record 2016/2017 grain harvest helped drive the result and theNational Supply Company estimates a production of 232 million tons of grains in this agricultural cycle (MAPA, 2017).

A large extension of agricultural areas can be used safely all year round, producing, in the same space, grains, animal protein, fiber, and bioenergy (LOPES, 2017). The "safrinha" is the "dryland" crop, established after the summer crop in the Brazilian center-south region (LIMA et al., 2009). It is commercially grown in at least ten Brazilian states, especially Paraná, São Paulo, Goiás, Mato Grosso, Mato Grosso do Sul, and Minas Gerais (BOLSON et al., 2009).

According to IBGE, for 2017, Mato Grosso led as the largest national producer of grains, with a 25.7% share of the total produced, followed by Paraná (17.5%) and Rio Grande do Sul (15.1%).

The municipality of Diamantino/MT is located about 200 kilometers north of the capital of the state of Mato Grosso. According to data from IBGE (2017), its main economic activity is agriculture and cattle ranching, which accounted for 54% of the municipal GDP in 2014. Also according to data from IBGE (2017), in 2015, the main agricultural products in the municipality were soybeans (42%), corn (31%), and sugarcane (15%), with sunflower production accounting for about 0.7% of the municipal total.

Sunflower is a crop that adapts to different soil and climate conditions, and can be grown from Rio Grande do Sul to the State of Roraima. Depending on the water availability and temperature characteristics of each region, it can be grown as a first crop, taking advantage of the beginning of the rains (winter-spring), or as a second crop (summer-autumn), taking advantage of the end of the rains (LEITE et al., 2007).

The sunflower crop has a wide adaptability to various conditions of latitude, longitude and photoperiod (EMBRAPA, 2014). In recent years, it has been presented as an option for crop rotation and succession in grain-producing regions, especially after soybeans in the Midwest region.Greater tolerance to drought, lower incidence of pests and diseases, and the cycling of nutrients, especially potassium, are some of the factors that have enabled its expansion and consolidation as a technically and economically viable crop in production systems (EMBRAPA, 2014).

According to the IBGE (2017), through the Systematic Survey of Agricultural Production, the average yield in the 2016 harvest was 1,283 kg/ha. The average Brazilian productivity is around 1,500 kg/ha, above the world average, which is around 1,300 kg/ha. However, under field conditions and in regions with more tradition of cultivation, average yields reach 2,000 kg/ha (EMBRAPA, 2014).

The main destination of this production is to supply the edible oil industry or the agro industry, the bird market, silage, and even the production of biodiesel. And as a source of edible oil,it is the third annual crop with the highest oil production in the world. Among annual crops, sunflower accounts for 16% of the world oil production. On the other hand, considering the main oil-producing crops (annual and perennial crops), sunflower accounts for 9% of oil production (EMBRAPA, 2014).

Historical series data from CONAB (2017) show that sunflower cultivation began in Mato Grosso in 1997/19998, with production of 3.2 thousand tons, with a large increase in production over the years, reaching 81.4 thousand tons of the genus in 2007/2008. In the following years there was a decrease in production, but in the 2011/2012 harvest production resumed growth, reaching itspeak in 2013/2014, when more than 200,000 tons were produced. Since then production has been declining, reaching in 2015/2017 the lowest levels since the 2006/2007 harvest. For the 2016/2017 harvest, the prospect is that production will almost double in relation to the previous harvest.

Brazil is the world's third largest corn producer, behind the United States and China. Of the three countries, it is the only one where there is the possibility of a second crop within the same crop year - the latter currently already accounts for more than half of the total corn produced (CONAB, 2016).

Corn is one of the most important products in Brazilian agriculture as a whole, being produced in practically all major regions and representing about 40% of the current volume of grain produced and 28% of the planted area. The cereal is the strongest input in the animal husbandry sector, also standing out in human food, in the form of its derivatives: cornmeal, flour, oil, starch, etc. With regard to the destination of corn production in Brazil, on average over the past five years, 59% goes to animal feed, industrial consumption corresponds to about 7.5% of total production, exports to 28% and human consumption to 3% (CONAB, 2016).

The second crop already begins to be computed from the 1979/80 crop year and the largest growth in its production begins at the beginning of the 21st century, with strong momentum from 2004/05. The total produced and the area planted in the second crop exceed that of the first crop from the 2011/12 crop year on (CONAB, 2016).

According to historical series data from CONAB (2017), the cultivation of safrinha corn began in Mato Grosso in the 1991/19992 harvest, with production of 52.5 thousand tons, with a large

production increase over the years, reaching 20,300 thousand tons in the 2014/2015 harvest. For the 2016/2017 harvest, the projection is for a production of about 27,500 thousand tons, which places Mato Grosso as the largest producer of the genus in Brazil, with about double the production of Paraná, which appears as the second largest producer.

According to IBGE (2017), for the year 2017, the 2nd crop corn, planted after the harvest of the summer crop, has an estimated production of 68.2 million tons, with the state of Mato Grosso expected to harvest a record crop of 28.2 million tons of corn at that time.

It is essential to measure the conditions of competition of agriculture with other markets, in addition to identifying competitive differences and evaluating the dimensioning of income and profitability of the agricultural sector. Studies that can assist in understanding the reality in the agricultural segment can have production costs as a reference, because they produce results that indicate the real situation of crop systems and technological packages that are employed by producers (CONAB, 2017).

Adverse weather phenomena, complex and changing markets, health risks, expensive or uncertain credit, marketing, logistics, regulatory framework, and rapidly changing consumption patterns are some of the many risks that plague rural producers. The risks associated with uncertainty about enterprise outcomes highlight agriculture as one of society's most complex activities (LOPES, 2017).

## 2.1 Financial Indicators in Investment Analysis

According to Souza and Clemente (2008), the decision to make a capital investment is part of a process that involves the generation and evaluation of several alternatives that meet thetechnical specifications of investments. After the technically feasible alternatives are listed, it isthen that one analyzes which of them are financially attractive.

The indicators for investment project analysis can be subdivided into two large groups: indicators associated with the profitability (gain or wealth creation) of the project and indicators associated with project risk. In the first category are the Net Present Value (NPV), the Annualized Net Present Value (NPVa), the Internal Rate of Return (IRR), the Benefit-Cost Ratio (BCR) and the Additional Return on Investment (ROIA). In the second category, the Internal Rate of Return (IRR) and the Pay-back Period (SOUZA; CLEMENTE, 2008).

Among the most traditionally used return indicators are the Net Present Value (NPV), the Internal Rate of Return (IRR), the Pay-back (PB) and the Benefit-Cost Ratio (BCR) (OLIVEIRA et al., 2015).

### 2.1.1 Net Present Value (NPV)

Net present value reflects the wealth in absolute values of the investment and is measured by the difference between the present value of all cash inflows and the present value of cash outflows (KUHN, 2012). It measures the earnings generated by the project's discounted future cash flows.

The NPV of an investment project can be defined as the algebraic sum of the discounted values of the cash flow associated with it (SILVA; FONTES, 2009). Thus, it can be said to be the difference of the present value of revenues minus the present value of costs, as illustrated below:

$$VPL = \Sigma_{(j=0)}^{n} Rj \left[(1+i)\right]^{(-j)} - \Sigma_{(j=0)}^{n} Cj \left[(1+i)\right]^{(-j)} \qquad [1]$$

Where:
Rj = present value of revenues; Cj = present value of costs; i = interest rate; j = period in which revenues or costs occur; and n = number of periods or project duration.

The NPV of an investment project can be defined as the algebraic sum of the discounted values of the cash flow associated with it. Conceptually, the financial viability of a project analyzed by this method is indicated by the positive difference between revenues and costs, updated at agiven interest rate (REZENDE; OLIVEIRA, 1993). It measures the gains generated by the project's discounted future cash flows, discounted from the initial investment (SUCHLA et al., 2016).

The project that presents the NPV greater than zero (positive) is economically feasible, and the one that presents the highest NPV is considered the best one. To use this method, it is necessary to define a discount rate (i) (SILVA; FONTES, 2005).

### 2.1.2 Internal Rate of Return (IRR)

The Internal Rate of Return (IRR) is a discount rate that equals the NPV of an investment opportunity to $0 (because the present value of the inputs equals the initial investment). When IRR is used in making accept or reject decisions, the criteria considered are as follows:

- If IRR is greater than the cost of capital, the project should be accepted.
- If IRR is less than the cost of capital, the project should be rejected (GITMAN, 2004).

To correct the limitations of this technique, Modified Internal Rate of Return (MIRR) is used, which measures the project's rate of return in percentage considering reinvestment and/or refinancing in case they are positive and negative cash flows, respectively (SUCHLA et al., 2016).

### 2.1.3 Minimum Rate of Attractiveness (MIR)

The Minimum Rate of Attractiveness is understood as the best rate, with low risk, available for the application of capital under analysis. The decision to invest, therefore, will always have at least two alternatives to be evaluated: invest in the project or invest in the Minimum Rate of Attractiveness (SOUZA; CLEMENTE, 2008).

Among the various methods of investment analysis that exist, the Net Present Value (NPV), the Internal Rate of Return (IRR) and the Payback (PB) are among the most used. These methods demand, for their calculations, a reference rate or minimum rate of attractiveness (TMA) (FENSTERSEIFER; SAUL, 1993).

The minimum rate of attractiveness (TMA) is used as a parameter for the acceptance or rejection of a particular investment project, which is the minimum to be achieved by the investment for it to be economically viable (REBELATTO, 2004).

### 2.1.4 Pay-back (PB)

Pay-back periods (PB) are commonly used in investment evaluation. It is the time required for the company to recover its initial investment in a project, calculated with its cash inflows (GITMAN, 2004).

Also known as the Payback Period, the pay-back assumes importance in the investment decision process. It represents the number of periods necessary for the flow of benefits to exceed the invested capital. As the trend is that of continuous and accentuated changes in the economy, one cannot wait too long to recover the capital invested under penalty of being excluded from the next investment opportunities (SOUZA; CLEMENTE, 2008).

Pay-back (PB) is the most widely used method as the second criterion, after Internal Rate of Return (IRR), despite the restrictions placed on it by financial theory (FENSTERSEIFER; SAUL, 1993).

### 2.1.5 Cost-Benefit Ratio (CBI)

The BCI is a relative indicator and measures the expected return for each unit of capital immobilized in the project. Like the NPV, the BCI should not be used to compare projects with distinct planning horizons, because it measures the profitability of the project for its entire planning horizon (KREUZ et al., 2008).

According to Souza and Clemente (2008), the Benefit-Cost Index is a measure of how much one expects to gain per unit of invested capital. The implicit hypothesis in the calculation of the Benefit-Cost Index is that the resources released over the project's useful life are reinvested at the minimum rate of attractiveness. Generically, the BWI is a ratio between a project's Expected

Benefit Stream and theExpected Flow of Investments necessary to realize it. Based on this formula, the analysis of theIBC, for the purpose of accepting or rejecting an investment project, is analogous to that of theNPV. It is easy to verify that if NPV > 0, then, necessarily, one will have IBC > 1. The primary reference rule for analyzing this indicator is the one that considers the IBC > 1 to proceed with the analysis of the project (SOUZA; CLEMENTE, 2008).

## 2.2 Multi-index Methodology

The classical methodology is the most widely known, the most commonly taught in universities, and the most widespread and used in the executive environment. It uses, for the Net Present Value (NPV) and Discounted Pay-Back calculations, a Minimum Rate of Attractiveness (MRAP) that is interpreted as the best preferred investment alternative. One of the main criticisms of this methodology, although not the only one, is the internal rate of return, henceforth called IRR. (JOHANN et al., 2014).

The Multi-index methodology, used in this research, seeks to support the decision-making process regarding the acceptance or rejection of a certain investment project through the use of several indicators. The joint use of several indicators results in more consistent information than the isolated use of any of them or a subset of them and is characterized by the deepening of the risk assessment and its confrontation with the return expectation (SOUZA; CLEMENTE, 2008).

According to Souza and Clemente (2008), the Multi-index methodology uses two groups of indicators. The first group, composed of PV, NPV, NPVa, BWI, and ROIA indicators, is used to evaluate the perception of return. The second group, consisting of TMA/TIR, Pay-back/N, Degree of Revenue Commitment (GCR), Management Risk and Business Risk indicators, is used to improve risk perception.

The Multi-index method indicators are measured with values ranging from 0 to 1, with the closer to 1, the higher the associated risk. In the context of this methodology, all these risk indicators are confronted with the additional return on investment (ROIA) (OLIVEIRA et al., 2015).

The essence of the Multi-index methodology is that it does not incorporate the risk premium as a spread over the AAR. It also expresses the project's profitability through ROIA as an additional return beyond what would be earned by investing capital in low-risk securities. Moreover, it uses the environmental analysis to deepen the evaluation about the risks involved and confront the expected gains with the perception of the risks of each project (SOUZA; CLEMENTE, 2008).

### 2.2.1 Revenue Commitment Ratio (RRC)

The Revenue Commitment Ratio can be interpreted as a measure of the project's operational risk, in which the operational break-even point is analyzed in its position relative to the revenue at its maximum level of activity. The Break-even point (OPE) corresponds to the minimum quantity

to be produced and sold, in a certain period. In the PEO, all costs are paid, but there is no profit (SOUZA; CLEMENTE, 2008).

According to Souza and Clemente (2008), to obtain the GCR, the following formula is used:

$$GCR = \frac{\text{Balancing Revenue}}{\text{Revenue at Maximum Level of Activity}}$$

The Break Even Revenue (RE) is obtained by the following formula:

$$\text{Break-even Revenue} = \frac{\text{Fixed Costs} + \text{Fixed Expenses}}{1 - \frac{\text{Total Variable Cost} + \text{Total Variable Expense}}{\text{Revenue at Maximum Level of Activity}}}$$

If the company shows profit only at high levels of capacity utilization, it is concluded that the risk involved in the project is considered high (SOUZA; CLEMENTE, 2008).

### 2.2.2 Business Risk and Management Risk

Management Risk is associated with the degree of knowledge and competence of the management group in similar projects. The accumulated knowledge and experience about the production process, the commercialization process, distribution channels, and mainly, in the conduction of negotiations, help the company in turbulent and unfavorable periods. To determine the Management Risk, it is essential that an assessment of the managers of the company's functional areas is carried out (SOUZA; CLEMENTE, 2008).

Business Risk is associated with cyclical and uncontrollable factors that affect the project environment. These include the degree of competition, barriers to entry and exit, and economic and industry trends. The Business Risk information is derived both from expert opinion and from the classic PEST analysis (Political, Economic, Social and Technological factors, Porter's 5 Forces (Competition, New Entrants, Substitutes, Relative Power of Large Suppliers and Relative Power of Large Customers and Consumers) and SWOT (*Strengths, Weaknesses, Opportunities and Threats*) (SOUZA; CLEMENTE, 2008).

## 3 METHOD

To answer the research problem, an economic analysis was chosen, applying a combination of traditional indicators of financial viability and risk indicators, represented in this case by the multi-index methodology.

As for the approach, the research is characterized as exploratory. The case study is most useful in exploratory research. Because of its flexibility, it is recommended in the early stages of research on complex topics, for the construction of hypotheses or reformulation of the problem. The stimulus for new discoveries, the emphasis on totality, and the simplicity of the procedures are among the main advantages of the case study. On the other hand, the difficulty of generalizing the results obtained is among the major limitations of this research procedure (GIL, 1991).

From the point of view of the problem's approach, a quanti-qualitative approach was chosen. In this sense, it was used as sources of data collection scientific articles, journals, official government portals that help in better understanding the subject studied, in addition to the adoption of semi-structured interviews with a local producer whose property served as a basis for application of the calculations and that contributed to the measurement of the indicators of financial viability and production costs. The financial viability calculations adopted to analyze the research problem bring the quantitative character of the research.

### 3.1 Research design

The elaboration of the article started with a documental research, in which we tried to find out aspects about the production of grains in the state of Mato Grosso, about sunflower and corn crops, about the peculiarities of the so-called "safrinha" and about financial viability analysis methods.

For the composition of production costs for the Mato Grosso region, we sought studies from the National Supply Company - CONAB, which is a reference in the area. A producer from the city of Diamantino/MT was interviewed in order to understand how production costs were measured, their distribution over the safrinha period, and the estimated sales values. The aspects related to business risk, which are not financial, were also addressed with the producer, namely Management Risk and Business Risk.

Next, a quantitative survey of financial market products offered by traditional financial institutions of the fixed income type was carried out, surveying their yields in the 12-month period prior to the research, as well as the savings yields for the same period. After obtaining the products' average yield, the Project's Minimum Rate of Attractiveness was established, including an additional risk premium.

Once the AAR was established, the return and risk indicators were calculated, which served as a basis for applying the Multi-Index Methodology, which relates project risk and return.

## 4 RESULTS AND DISCUSSIONS

This section presents the comparison between the perspectives of economic results between sunflower and corn crops in the city of Diamantino/MT, aiming to analyze which of the alternatives generates greater profitability for the business. Thus, the section is divided into budget and investment analysis of the project, using the indicators of the Multi-Index Methodology.

### 4.1 Budget

To establish production costs we used the study Production Costs - Dry Crops, by CONAB, with reference values for the month of March 2017. CONAB has accumulated knowledge and experience in the preparation of agricultural production costs, and its methodology is observed by state and non-state entities for studies and as a source of information for administrative, economic, financial and operational decision-making (CONAB, 2017).

For sunflower, the Girassol-MT reference was used, disregarding the costs of type VI - factor income, because it is a matter of production on own land. The cycle considered was from February to May and the costs stipulated by CONAB were distributed by months according to the information indicated by the producer.

With this information we arrived at a production cost for the 50 hectares of R$71,466.50, which, considering the estimated yield of 1,800 kg/ha, leads to a cost of R$47.67 per 60 kg bag.

In the case of corn, the same period and pattern of monthly cost distribution was used, the municipality of Campo Novo do Parecis/MT being used as a cost reference, the same reference used by CONAB for sunflower. We conclude that the production cost for 50 hectares of corn is R$98,200.50, which considering the estimated yield of 6,000 kg/ha leads to a cost of R$21.26 per 60 kg bag.

### 4.2 Estimated Revenues

To establish the commercialization prices of the products, there are two possible scenarios: market prices and minimum purchase prices established by the National Supply Company - CONAB.

Market prices can be obtained from specialized agribusiness portals, and the authors chose, after comparing the breadth of information among a number of specialized portals, the quotations from the Agrolink portal, which offers daily quotations for a number of agricultural commodities, inmost cases at the municipal level. The average prices for the period from August 08, 2017 to September 06, 2017 for sunflower, for the state of Mato Grosso, were R$68.00 per 60-kilogram bag, and for corn, for the municipality of Diamantino/MT, were R$11.81 per 60-kilogram bag.

CONAB is responsible for planning, regulating and executing the Minimum Price Guarantee Policy (PGPM), an important tool for reducing fluctuations in rural producers' incomes and ensuring them a minimum remuneration, acting as a guide for the supply of food, encouraging or discouraging production and ensuring the regularity of the national supply. Each year, the Company prepares the minimum price proposals and sends them to the Ministry of Agriculture, Livestock and Supply (MAPA), which together with the Ministry of Finance, the Ministry of Planning, Budget andManagement and the National Monetary Council, defines the minimum prices for marketing agricultural products (CONAB, 2017).The analysis and discussion of the results should characterize the context of the research, either by describing the environment, conjuncture or economic sector. Present the development of the research. Structure subsections in order to "answer" the objectives that the work proposes. It can be structured in subsections in order to respond to the objectives that the work proposes.

**Table 1:** Estimated Revenues

| Item | Sunflower - market | Sunflower - CONAB | Corn - market | Corn - CONAB |
|---|---|---|---|---|
| **Unit Price** | R$ 68,00 | R$ 34,74 | R$ 11,81 | R$ 16,50 |
| **Bags/ha** | 30 | 30 | 100 | 100 |
| **Total bags** | 1500 | 1500 | 5000 | 5000 |
| **Total Revenue** | **R$ 102.000,00** | **R$ 52.110,00** | **R$ 59.050,00** | **R$ 82.500,00** |

**Source:** elaborated by the authors, 2017

When market prices are below the minimum, the federal government can use one of the PGPM's operational instruments - Federal Government Purchase (AGF), the Federal Government Loan (EGF), the Premium for Product Flows (PEP), the Equalization Premium paid to the producer (PEPRO), the Sale Option Contract - in order to offer support to rural producers.

In the case of sunflower, the minimum price in force for the 60-kilogram bag, through Ordinance No. 92/2016 - MAPA, until June 2017 was R$34.74 (MAPA, 2016), with CONAB suggesting maintenance of minimum prices for the subsequent period (CONAB, 2017).

For corn, the minimum price in force for the 60-kilogram bag, through Ordinance No. 123/2016 - MAPA, until December 2017 is R$16.50 for the state of Mato Grosso (MAPA, 2016).

### 4.3 Definition of the Minimum Rate of Attractiveness

Table 2 illustrates some investment options currently available in the Brazilian market. We chose fixed income products, offered by traditional banking institutions, in addition to savings. Considering the project period, with a duration of less than 180 days, the return on investments was discounted by 22.5% income tax, except savings, which is exempt from this taxation (RECEITA FEDERAL, 2015).

**Table 2:** Establishing the Minimum Rate of Attractiveness

| Active | Yield 12 months (%) | Discounted Income |
|---|---|---|
| BB Renda FIxa Short Term 200 FIC FI | 9,71% | 7,53% |
| BB Renda FIxa LP 50 Mil FICFI | 11,77% | 9,12% |
| Bradesco FIC DE FI Ref DI Federal | 11,39% | 8,82% |
| Itaú Renda FIxa FI | 12,82% | 9,93% |
| Itaú Uniclass RF Refer DI FICFI | 10,43% | 8,09% |
| Savings | 7,73% | 7,73% |
| Santander FIC FI Conservador Renda Fixa | 12,91% | 10,00% |
| Santander FIC FI Corporate Income FIxa CP | 10,30% | 7,98% |
| **Average** | **10,88%** | **8,65%** |

**Source:** elaborated by the authors, 2017

Besides the yields of the market products evaluated, an additional risk premium of 3.35% was stipulated, considering the risks inherent to the agricultural activity to which the producer is not subjected when opting for fixed income financial investments, with the Minimum Rate of Attractiveness then established at 12% per year.

Since the project costs are measured in monthly periods, for the application of the financial analyses, the compound interest rate was converted to the monthly period, and the applied AMT was then 0.95% per month.

### 4.4 Financial feasibility analysis

Next, the cash flow projections for the scenario analyzed are presented, applying the traditional investment analysis indicators: TMA, NPV and Payback. The scenarios presented are respectively: sunflower at market prices, sunflower at CONAB minimum prices, corn at market prices and corn at CONAB minimum prices.

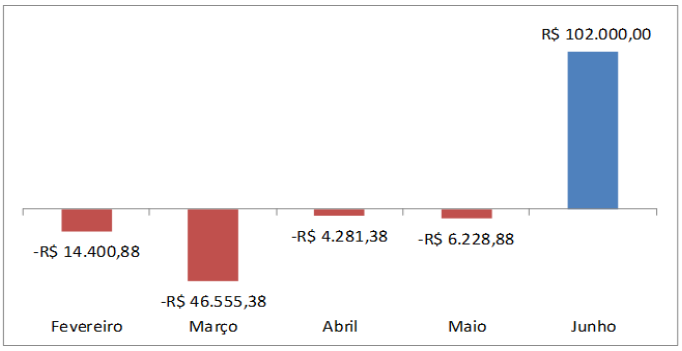


**Figure 1:** Cash Flow Projection - Sunflower at Market Prices
**Source:** elaborated by the authors, 2017.

Through the results obtained in the cash flow of Figure 1, we obtain an IRR of 12.58% p.m., which compared to an AAR of 0.95% p.m. demonstrates that there is financial return in this scenario, besides a NPV of R$ 27,440.35, demonstrating that the expected flow of revenues exceeds the investments. As for the Payback, it is verified that the project pays itself off at the end of the period. For this scenario, the muti-index methodology was applied for additional verification of the risks related to the project.

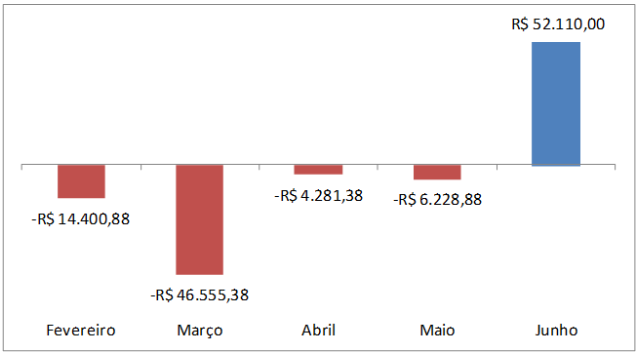


**Figure 2:** Cash Flow Projection - Sunflower at CONAB Minimum Prices
**Source:** elaborated by the authors, 2017.

The cash flow of Figure 2 presents an IRR of -10.21% p.m., which shows that there is no financial return in this scenario, besides a NPV of -R$20,598.01, demonstrating that the expected flow of revenues does not exceed the investments. As for the Payback, it is verified that the project does not pay itself off at the end of the period. The analysis of these indicators shows that, at the minimum CONAB prices, planting sunflower in the safrinha season does not generate a financial return.

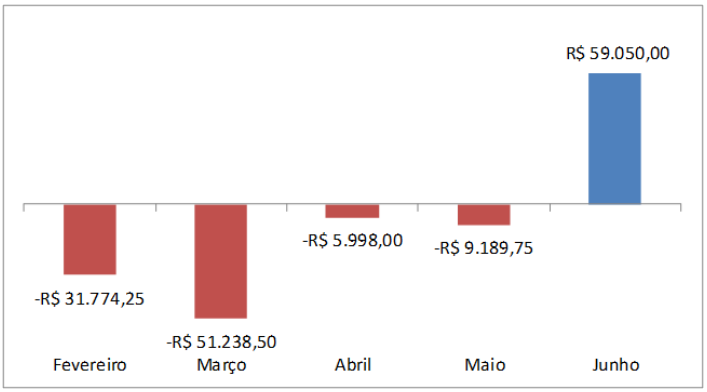


**Figure 3:** Cash Flow Projection - Corn at Market Prices
**Source:** elaborated by the authors, 2017.

The cash flow of Figure 3 presents an IRR of -15.55% p.m., which shows that there is no financial return in this scenario, and a NPV of -R$40,490.55, demonstrating that the expected flow of revenues does not exceed the investments. As for the Payback, it is verified that the project does not pay itself off at the end of the period. The analysis of these indicators shows that, at market prices for the period between August and September 2017, the planting of corn in the safrinha does not generate a financial return.

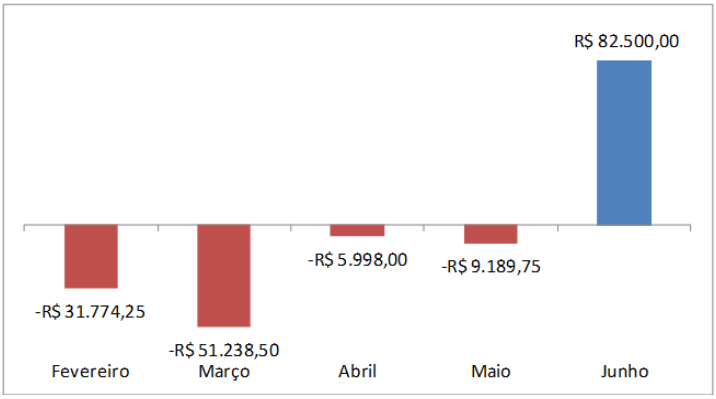


**Figure 4:** Cash Flow Projection - Corn at CONAB Minimum Prices
**Source:** elaborated by the authors, 2017.

As for the cash flow in Figure 4, the IRR is -5.55% p.m., which shows that there is no financial return in this scenario, besides a NPV of -R$17,910.88, demonstrating that the expected flow of revenues does not exceed the investments. As for the Payback, it is verified that the project does not pay itself off at the end of the period. The analysis of these indicators shows that, at CONAB's minimum prices, the planting of corn in the safrinha does not generate a financial return.

### 4.4.1 Analysis of the indicators

The consolidated analysis of the indicators shows that, of the four scenarios evaluated, only the sunflower planting with market sales prices proved to be financially viable, with the other three scenarios generating deficit scenarios, which would make it more beneficial to maintain the land unused for the safrinha period. Due to the results, the Multi-index methodology was applied only to the first scenario.

## 4.5 Multi-index methodology

The multi-index methodology involves the indexes TMA/TIR, Payback/N, Degree of Revenue Commitment (GCR), Management Risk and Business Risk. These indexes were calculated based on the data obtained from the producer interviewed and allow the risks of the project to be verified.

As presented in the previous sections, we used an IRR of 12% per year and the calculated IRR for the sunflower scenario at market prices was 12.58%. For the project to be viable, the degree of risk should be less than 1, being less risky as the indicator approaches 0. The IRR/ARM ratio for this scenario was 0.08, considered extremely low.

The payback ratio, divided by the number of project periods (PB/N) results in 1, since all investments are made before revenue is generated, which represents a high degree of risk.

The Revenue Commitment Ratio (RG), which indicates the degree of risk of revenue commitment in relation to fixed expenses, being more favorable to the extent that it tends to zero, already represents lower risks of loss if the revenue is not confirmed. Table 5 shows the project's GCR, which, for measurement purposes, was considered in the totality of fixed costs for the period, since it is not possible to compare costs and revenues on a monthly basis because they do not coincide. The GCR for the project is 0.08, considered extremely low.

**Table 3:** Degree of Revenue Commitment

| Description | Project |
|---|---|
| **Billing** | **R$ 102.000,00** |
| Fixed costs | R$ 1.280,00 |
| Fixed Expenses | R$ 6.506,00 |
| **Total f i x e d expenses** | **R$ 7.786,00** |
| **GCR** | **0,08** |

**Source:** adapted from Souza e Clemente, 2008

The Management Risk is used to assess the degree of knowledge and competence of managers, and the closer the values are to 0, the higher the risk. Chart 1 presents the assessment for the farm studied, which showed a medium/high degree of knowledge and, consequently, medium/low risk.

**Table 2:** Business Risk

| PEST | | Porter's Five Forces | | SWOT | |
|---|---|---|---|---|---|
| **Aspects** | **Perception** | **Aspects** | **Perception** | **Aspects** | **Perception** |
| Political-legal | 0,5 | Incoming | 0,4 | Strengths | 0,5 |
| Economic | 0,6 | Substitutes | 0,5 | Weaknesses | 0,6 |
| Sociocultural | 0,3 | Suppliers | 0,6 | Opportunities | 0,4 |
| Technological | 0,4 | Customers | 0,6 | Threats | 0,6 |
| | | Competitors | 0,5 | | |
| **Average** | **0,45** | | **0,52** | | **0,53** |
| **Total Average** | | | **0,50** | | |

**Source:** adapted from Souza e Clemente, 2008.

To apply the multi-index methodology it is necessary to calculate the ROIA, which will serve as a comparison parameter against the risks to verify the viability of the project. Table 6 presents a summary of the project's return indicators.

**Table 6:** Return Indicators

| | |
|---|---|
| **Minimum Rate of Attractiveness (%)** | 12% |
| **Net Present Value (R$)** | R$ 27.440,35 |
| **Present Value of Benefits (R$)** | R$ 98.214,33 |
| **Present Value of Investments (R$)** | R$ 71.466,50 |
| **Cost-Benefit Ratio (VPB/VPI)** | 1,37 |
| **ROIA %** | 8,19% |

**Source:** the authors, 2017.

The estimated ROIA for the project is 8.19% beyond what would be obtained by applying inthe market the TMA of 12% p.a. Other studies in the agribusiness area that use the same methodology indicated ROIA of 6.47% for honey cultivation (KREUZ, SOUZA, CLEMENTE, 2008), 4.23% for hydroponic lettuce cultivation (RAMOS et al., 2016) and 11.47% for tomato cultivation (OLIVEIRA et al., 2015), generating an average return of 7.39%, which positions the profitability of sunflower planting in the safrinha season in Diamantino/MT as average.

**Table 3:** Risk indicators

| | | Bass | B/M | Medium | M/A | High |
|---|---|---|---|---|---|---|
| **Indicators** | **Index** | **0 à 0,2** | **0,2 à 0,4** | **0,4 à 0,6** | **0,6 à 0,8** | **0,8 à 1,0** |
| ROIA | 8,19% | | | | | |
| TMA/TIR Index | 0,08 | | | | | |
| *Pay-Back/N* ratio | 1,00 | | | | | |
| GCR | 0,08 | | | | | |
| Management Risk | 0,32 | | | | | |
| Business Risk | 0,50 | | | | | |

**Source:** the authors, 2017.

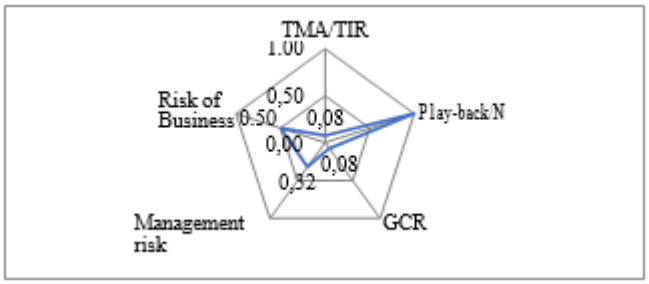


**Figure 5:** Project Radar Graph

Table 3 presents a summary of the project's risk indicators, which, in conjunction with Figure 5, the project's radar chart, demonstrate that the project presents moderate risk and istherefore feasible.

## 5 CONCLUDING REMARKS

Any economic activity aims for profit, and those who practice it are always looking for better alternatives to obtain the best profitability while running the least possible risks. Agricultural activities usually involve a high level of risk because they are subject to climatic factors, pests, and international price fluctuations, among others.

Besides this, the regions are usually quite traditional in terms of the crops exploited, and in the case of the state of Mato Grosso the traditional binomial is the planting of soybeans in the first harvest and corn in the second or "safrinha" harvest.

This study aimed at analyzing an alternative that has been adopted as an alternative to corn in the off-season, the sunflower. What this study brought as a novelty was the analysis of financial viability and risk for the sunflower crop for planting in the off-season, making a comparison with the main genus cultivated, aiming to verify whether it would be interesting for the producer, in economic terms, to migrate to a new product.

The viability of both crops was studied considering sales scenarios at market prices and at CONAB's minimum prices, showing only one of the alternatives as viable through traditional financial analysis indicators, that of sunflower sales at market prices.

The planting of corn in the "safrinha" period proved to be unfeasible both at market prices and at CONAB's minimum prices, proving that it would generate negative IRR and NPV and that it would not generate payback of the initial investment. Despite being the most traditional crop for the "safrinha" period, in the current situation of prices and costs it would be preferable to adopt the planting of an alternative crop or even keep the soil free during the period.

In relation to sunflower, the planting of this crop proved to be viable only at market prices, with NPV and IRR being negative at CONAB's minimum prices. The multi-index methodology was used to evaluate the risks of the project and verify whether it would be interesting to adoptsunflower

planting with commercialization at market prices, concluding that in the scenario of the moment studied it would be worth adopting the sunflower crop because it presents positive IRR andNPV results and moderate risk according to the indicators adopted in the methodology applied.

Research limitations include: the risk that the projected scenario may change due to fluctuating agricultural commodity prices or even changes in government purchasing policies; and the projected cost composition, which may be different at the time of production.

As for potential studies that could be developed from this study, the possibilities of studying the use of sunflower as a crop for the first harvest, since it generates good profitability, and the possibility of establishing a small sunflower processing plant to produce sunflower oil on the property, since it is a product with higher added value, were highlighted.

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