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Case Study

Economic analysis of corn culture in integrated crop-livestock-forest system

ABSTRACT

SAMPLE ABSTRACT:

Aims: was to analyze the economic viability of an integrated crop-livestock-forest system area, in the municipality of Pindaré-Mirim, State of Maranhão, Brazil, using the consortium of maize (*Zea mays* L.), forage species *Urochloa brizantha* cv. Marandu and Eucalyptus (*Eucalyptus urograndis*).
Study design: Case study
Place and Duration of Study: The work was developed in a Technological Reference Unit of ICLF of Embrapa Cocais, located in the municipality of Pindaré-Mirim - Maranhão, Brazil, between January 2017 and July 2017.
Methodology: The experimental area was 3 hectares (ha), divided into three subareas: Treatment I - single corn planting; Treatment II – Barreirão system; and Treatment III - Santa Fé system. After the maize harvest, the productivity (P) and the economic outcome measures were calculated: Gross Income (GI), Gross Margin (GM), Net Margin (NM), Profit, Leveling Point (LP) and Producer Return Rate (PRR).
Results: All the treatments presented a profit, being the Barreirão System the one that had better results, presenting P of 163 sacks of maize ha^{-1}, GI of US$ 6520,00, profit of US$ 2576,41, LP in 99 bags of corn ha^{-1} and PRR of 65.33%. Treatments I and III presented, respectively, P of 135 and 143 bags of maize ha^{-1}, GI of R $ 5400,00 and US$ 5720,00, profit of US$ 1666.41 and US$ 1793.37, LP in 94 and 99 bags of corn ha^{-1} and PRR of 44.63% and 45.67%.
Conclusion: The results obtained reinforce the importance of studying the economic feasibility of integrated systems to provide the investor with the conditions for better decision making.

Keywords: Economic indicators, Integrated production systems, Low carbon agriculture.

1. INTRODUCTION

The integrated systems are being spread in various regions of Brazil as a viable alternative, and the Integrated Crop-Livestock-Forest (ICLF) system a production strategy that has no limitations on the size of the property or the technological level of farmers. The possibilities of combining the components of the system are many and the adjustments are necessary, depending on the objective of the producer, property features, edaphoclimatic and market (GONTIJO NETO et al., 2014).

The synergism between the components employed in the system assists in a better environmental suitability and economic viability of the agricultural activity of the property. The use of the ICLF system assists in the implementation of a sustainable agricultural system, based on the principles of rotation, succession and consortium between crops, forages and trees species, to produce grains, meat or milk and wood in the same area (BALBINO et al., 2011).

The ICLF system has contributed to a change in the land use system, based on the integration of the components of the production system, aiming to achieve higher levels of product quality (KAMINSKI, 2013). Besides benefiting the biological interactions between agricultural crops, trees and animals, the ICL system reduce the effects of erosion, maintaining or increasing the reserves of organic matter in comparison with other agricultural models (AGUIAR et al., 2010), thus allowing the rational use of land, in addition to providing higher yield per area than monoculture (SOUZA et al., 2011).

The multiple combinations of resources and activities provided by the ICLF systems make the decision to adopt them extremely complex, especially when a large part of the information disseminated does not include economic information (COSTA et al., 2014). Studying the economic viability of corn in the ILPF system, Rego et al. (2017, 2018), find favorable results for the adoption of the system, obtaining a profitability in the first year of the ICLF system, even with the high costs in the implementation of the system.

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The objective of this work was to analyze the economic viability of an ICLF system, in the municipality of Pindaré-Mirim, State of Maranhão, Brazil, using the consortium of maize (*Zea mays* L.), forage species *Urochloa brizantha* cv. Marandu and Eucalyptus (*Eucalyptus urograndis*).

2. MATERIAL AND METHODS

The study was developed at the Technological Reference Unit (TRU) for the ICLF of Embrapa Cocais, located in the municipality of Pindaré-Mirim-MA (Brazil), Micro-region of Pindaré, at latitude coordinates 3º46′13.60″ S, longitude 45º29′42.00″ W, and with altitude of 28 ~~meters~~ above sea level. According to the classification of Koeppen (1948), the local climate is AW type (hot and humid), with an average annual temperature of 26.0 ºC and average annual rainfall ranging from 1,600 to 2,000 mm (SEPLAN, 2013; ALVARES et al., 2014).

The soil class of the farm where the experiment was installed is classified as Hapless Plinth (Santos et al., 2013). In relation to its relief, this one has variations of soft-waved to waved, being covered originally by vegetation of tropical forest subperenifolia dabótilo-palmácea babaçual, dominant in the Mid-North region of the State of Maranhão (Maranhão, 2003; SEPLAN, 2013).

The work was carried out in the agricultural year 2016/2017, in an experimental area of three hectares (ha), divided in three subareas for the formation of the treatments. The treatments evaluated was: Treatment I - Planting of single corn (monoculture); Treatment II - Barreirão System - the planting of corn intercropped with pasture was carried out. The planting of the pasture seed was carried out at the same time as the corn. The sowing of pasture is made between the lines of the maize. The mixture of the seeds of the grass is fertilize with (NPK) at the time of planting; Treatment III - Santa Fé System - the planting of corn intercropped with pasture was carried out. Planting of the grazing seed was carried out at the same time as the maize crop, with no sowing between maize lines and no mixing of grass seeds with fertilizer (NPK).

For the implementation of the experiment, soil analysis was carried out throughout the area and fertilization recommendations were applied according to the soil analysis results. A no-tillage system was used. Is a technique of conservationist cultivation, where sowing is carried out in a soil that is without the conventional tillage and no harrow. In this technique, it is necessary to keep the soil always covered by crops remains at least 80% of the soil surface or to maintain six tons per hectare of dry organic matter (CRUZ, 2017).

In all treatments, KWS 9304 hybrid corn was used, differing in the spreading of maize lines. In treatment I was used a spacing of 0.50 m between rows and 0.25 m between plants, and in the other treatments a spacing of 0.60 m between rows and 0.25 m between plants. For treatments II and III were used for the pasture seeds of Urochloa brizantha cv. Marandu, in order to establish a consortium according to the molds of the operations used.

In relation to the tree component used in the consortium, eucalyptus was used to provide income for the long-term system, animal welfare at the moment of grazing and source of organic matter and soil cover. In relation to the arrangement used for eucalyptus, these were planted in double rows spaced 3 m x 2 m and 28 m long (3 m between rows, 2 m between plants), and they were planted in the first fortnight of February of 2016, the trees had approximately 2.5 m of height.

Corn planting was carried out on the straw of *Urochloa brizantha* cv. Marandu, which was desiccated with the pre-emergent herbicide, Glyphosate, in the dosage of 4.5 L ha^{-1} and adhesive for drying up, in the dosage of 0.9 L ha^{-1}. Planting was carried out with the aid of a no-till planter with separate compartment for grass seed distribution. In planting, was used 400 kg ha^{-1} of NPK fertilizer (5 - 30-15 + Zn), and their distribution grooves with a depth of 0.05 m and beside the corn seeds. The first cover fertilization was performed 10 days after emergence (DAE) of corn with 120 kg ha^{-1} of urea and 85 kg ha^{-1} of potassium chloride. In 15 DAE, the application of the post-emergent herbicides Atrazine and Nicosulfuron, with a dosage of 3 and 0.5 L ha^{-1}, respectively, was carried out for the initial control of pasture and broadleaf development. The second cover fertilization occurred 20 DAE with 200 kg ha^{-1} of urea. In the 25 DAE, was applied of 3.5 L ha^{-1} of Grap Nitro foliar fertilizer, 0.35 L ha^{-1} Abacus fungicide and 1.5 L ha^{-1} Bazuka insecticide.

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In this work, the methodology of operational costs was used, according to Matsunaga et al. (1976) and Lopes et al. (2004). The following economic performance measures were calculated: Gross income, Gross margin, Net margin, Profit, Leveling point and Producer return rate, according to methodology of Martin et al. (1998) and Rego et al. (2017). The economic indicators calculated were: Net Present Value (NPV), Internal Rate of Return (IRR) and Benefit-Cost Ratio (RBC), according to the methodology of Evangelista (2006) and Muniz et al. (2007). The data collected from the costs and revenues of each treatment were tabulated and treated with the help of Microsoft Office Excel.

3. RESULTS AND DISCUSSION

In table 1 we present the costs, revenues and economic efficiency indicators for the implantation of 1 hectare of corn in the municipality of Pindaré-Mirim - MA.

Table 1. Data of costs, revenues and indicators of economic efficiency among treatments for the agricultural year of 2016/2017 in the production of 1 hectare of maize.

Discrimination	Treatments		
	I	II	III
Effective Operational Cost – US$/ha/year	794.02	854.01	849.17
Depreciation - US$/ha/year		53.15	
Remuneration of the producer - US$/ha/year		164.62	
Total Operating Cost - US$/ha/year	1011.79	1071.78	1066.93
Opportunity Cost - US$/ha/year	118.82	122.42	122.12
Total Cost - US$/ha/year	1130.60	1194,19	1189.06
Productivity (bags / ha)	135	163	143
Price of the 60 kg bag - US$		12,11	
Leveling point (Total cost / price of bag)	94	99	99
Gross Revenue (Price of the bag * Productivity) - US$/ha/year	1635.22	1974.38	1732.13
Gross Margin - US$/ha/year	841.21	1120.37	882.96
Net Margin - US$/ha/year	623.44	902.60	665.19
Profit - US$/ha/year	504.62	780.19	543.07
Producer return rate - in %	44.63%	65.33%	45.67%
Benefit / Cost Ratio	1,45	1,65	1,46

The percentage of the Total Cost (TC) that represents the Effective Operating Cost (EOC) is 70.23% for treatment I, 71.51% for II and 71.42% for III. Because the EOC represents the majority of the costs of the initial acquisition of inputs required for production. These results are well below those reported by Rego et al. (2017, 2018) for all the evaluated systems, indicating that there is a decrease in EOC, which is explained by the purchase of inputs carried out in partnership with other producers, which resulted in a higher discount on the price of inputs.

Regarding the composition of the total operating cost (Table 1), taking into account depreciation and producer remuneration, these corresponded to only 19.26%, 18.24% and 18.31% of TC, respectively, for treatments I, II and III per hectare. The opportunity cost found for treatments I, II and III were, respectively, 10.51%, 10.25% and 10.27% of TC.

The TC of 1 hectare of maize according to data obtained by the Instituto Mato-Grossense de Economia Agropecuária, IMEA, (2016), for the Northeast region of Brazil, is US $ 773.27 and US $ 652.33 with the high and medium investment technology respectively. In our case (Table 1), the TC of the three Treatments were higher. Evaluating the implantation of the ICLF system, the high TC for the study region in all treatments is justified by the predominance of livestock farming in the region of Pindaré-Mirim according to Rego et al. (2018 Some factors influence such as the high costs with the acquisition of inputs and the lack of machines for agricultural activity. In addition, the region doesn´t have its own local distribution center, and the producer have to pick them about 300 km away from the property.

In relation to productivity (Table 1), treatment II presented the best yields, producing a total of 163 bags per hectare, followed by treatment III with 143 bags and treatment I with 135 bags. The productivity found for all treatments was higher than that estimated by Conab (2017), for the state of

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Maranhão in the 2016/2017 harvest, which was 70 bags per hectare and was similar to that found by Teixeira et al. (2012).

For the agricultural year of 2017 the selling price of the 60 kg maize bag was US$ 12.11 and according to the yields obtained, treatment II presented higher gain followed by treatments III and I. Analyzing the economic viability of the implementation of an ICLF system for the agricultural year 2015/2016, Rego et al. (2018) obtained similar results in relation to yield and profitability of the integrated systems in relation to single maize cultivation.

In relation to the leveling point (Table 1), which is the level of production in which the sales value equals the total cost, in all treatments were found values above the minimum, that is, all treatments had positive profit for the adoption of any of the systems analyzed. This results corroborate with those found by Rego et al. (2018) and Teixeira et al. (2012) and can serve as the basis for the ICLF system's recommendation.

The gross margin (Table 1) found in all treatments was positive, meaning that in any production system adopted, the producer will be compensating. The net margin (Table 1) for each treatment was positive, meaning that the adoption of any of the productive systems has stable activity, allowing the expansion of the activity.

Regarding the profit margin results (Table 1) found by treatment, all were positive, meaning that the producer is paying all costs. Treatment II was the one with the highest profit margin per hectare. However, all the treatments obtained gains per hectare, having paid the formation of the pasture that will serve as complementary income in the off-season moments.

When a positive result is obtained for the profit margin, according to Rego et al. (2018), this indicates that the producer will be able to maintain itself in the long term, besides honoring its commitments, serving as an indicator of equilibrium which it compensates all factors of production.

Regarding the rate of return of the producer (Table 1), treatment II obtained the highest return with 65.33%, followed by treatments III and I with 45.67% and 44.63%, respectively. This indicator indicates the financial return that the producer can obtain if invests in any of the treatments analyzed. These results differ from those reported by Rego et al. (2018), where the conventional corn system indicated a better rate of return, but are similar to those found by Teixeira et al. (2012). The results obtained in the present work indicate that the ICLF system for the Pindare-Mirim region, after the first year of implantation, is more advantageous than the introduction of maize monoculture.

The benefit-cost ratio (RBC), (Table 1), for all treatments was greater than zero, meaning that the benefits outweighed the costs. These results resemble those found by Teixeira et al. (2012). CBR is consistent as a method for defining decisions to strategically achieve relevant data about desirable and undesirable outcomes. In this way it is possible to measure these elements in a comparative way, thus controlling for cost to not exceed the benefits (DIAS, 2014).

According to Marquezan (2006), seeking a profitable and sustainable return is the basis of the reasons for the realization of investments with wealth generation, so that there is value or wealth creation, the costs of the capital employed must be lower than the returns of these investments, making the net values of the results positive, adding wealth to the investor and to the investment itself.

Table 2 shows the results of the Net Present Value (NPV) with different minimum Adjustable-Rate Mortgage (ARM) for treatment implantation. The NPV and the Internal Rate of Return (IRR) take into account the ARM. According to Casarotto and Koppitke (2000), the ARM represents the attractive rate that investors expect to obtain from a project and that is equivalent to the profitability of other applications, that is, it is an interest rate that represents the minimum that an investor proposes when he make an investment.

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Table 2. Statement of Net Present Value.

ARM	Treatment		
	I	II	III
6%	1360.75	2207.36	1469.60
19%	804.23	1535.41	880.10
27%	518.38	1190.27	577.31
40%	123.56	713.56	159.09

All NPV results were favorable, this indicates that the inverter can opt for any of the treatments that there will be financial benefits, and all results were greater than zero. The positive NPV, at a given ARM, confirms the economic viability, being able to observe that all the evaluated treatments are economically viable.

Table 3 shows the results of the internal rate of return (IRR) for the treatments analyzed. The IRR found in all the treatments was positive. In all production systems adopted, the farmer recovers his initial investment and obtains benefits, because its results were higher than the ARM. According to Maya (2003), the IRR is a useful indicator to analyze high initial investments and that provide production several years, as is common in agricultural enterprises.

Table 3. Internal Rate of Return Statement.

	Treatment		
	I	II	III
IRR	44.63%	65.33%	45.67%

4. CONCLUSION

The economic indicators of all treatments obtained positive results. The ICLF system, following the model of the Barreirão system, obtained better economic results than the others. Regarding NPV and IRR in all treatments, the results were positive, with superior attractiveness to the savings account investment. This shows that the integrated systems obtained higher returns on invested capital and profitability compared to the single system for the study region.

This research reaffirms the importance of continuing in studies within the ICLF production system, not only to prove its economic viability, but also for its contributions to the environment and the reduction of investment risks through the diversification of production.

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