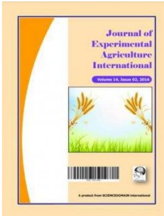

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Economic Opportunity for Investment in Soybean and Sunflower Crop System in Mato Grosso, Brazil

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Authors' contributions

This work was carried out in collaboration between all authors. All authors read and approved the final manuscript.

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ABSTRACT

The economic feasibility of soybean and sunflower crop system on a farm in Diamantino MT Brazil is analyzed. Data were retrieved from the 2017-2018 harvest, even though they were repeated for a six-year span. Project-inherent items were grouped in fixed and variable costs. Main financial indexes comprised total yearly income, current net rate, equivalent uniform yearly rate, internal rate of return, profit index during the period and payback period. In the case of the suggested system, the plantation proved to be viable, with total yearly income of R$ 3,624,000.00 at the end of six years; current net rate at R$ 1,468,920.00; equivalent uniform yearly rate at R$ 334,810.00; 18% internal rate of return; 33% profit index during the period, and payback period of 4.53 years. However, 15% negative variations in price, productivity or income, or positive variation at 30% in real operation costs proved the unfeasibility of the project, with special reference to current negative

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net rate. Supplementary profit (hectare) from sunflower was 33% higher than that of soybean. Fixed costs paid by soybean suggested two annual crops. Method for the application of production costs is highly relevant since it provides a good assessment on the implementation project and presents a good diagnosis for decision-taking with more profitable alternatives in planning soybean production to dilute costs and increase income.

Keywords: Agribusiness; administration of costs; Glycine max L.; Helianthus annuus L.; economic feasibility.

1. INTRODUCTION

Agribusiness is one of the most relevant sectors in Brazilian economy, with special reference to agriculture and its basic role in economic growth. Soybean (*Glycine max* L.) is an oleaginous plant with great relevance in agriculture. Due to increasing food demands, soybean is one of the basic sources for vegetal protein and a prime matter for several products such as animal diet, oil and others [1,2,3,4,5,6,7].

Increase in demand has enhanced the economic importance of soybean and, consequently, cultivated area and production, with greater productivity rates [8], particularly in the state of Mato Grosso, Brazil, as Brazil´s greatest producer (30% of total production). The state is also the greatest national producer (78%) in sunflower (*Helianthus annuus* L.), with special reference to the municipality of Campo Novo do Parecis, due to its excellent soil and climate conditions [9,10]. Owing to demands of the region´s industrial and commercial sectors triggered by high quality oil and bran [11,12,10,13], the sunflower is a relevant economic alternative in crop rotation, intercalation and succession to soybean within a second harvest system. The latter improves soil without competing with other plant species sown during the period, such as corn (*Zea mays* L.), cotton (*Gossypium hirsutum* L.) and popcorn maize (*Zea mays everta* L.) [14,10].

However, agriculture is subjected to high risks and uncertainty due to economic [15] and environmental factors. It is a well-known fact that climate is one of the main factors of uncertainty in agricultural production [16]. Biological and market vicissitudes affect productivity and production costs. Consequently, income from productivity may oscillate when profit margins depend on soil and climate conditions, technology employed and management [17].

The structure and analysis of production costs provide the producer sufficient data for decision-taking within the production cycle and determines the best time for commercializing production with profits [18]. In fact, accounting tools have been more and more frequently employed for elucidations and strategic management, monitoring income and expenses, pinpointing mistakes and the best improvements, and even indicating where financial resources should be applied for a successful entrepreneurship [19,20,21].

Further, costs survey is an asset for the producer to analyze items involving production, costs and benefits, and decision-making, and, coupled to market data, to identify risks and opportunities.

Current study determines the economic viability of soybean and sunflower (in succession) crop system on a plantation in the mid-northern region of the state of Mato Grosso, Brazil.

2. MATERIALS AND METHODS

Current study was based on data from a farm in the municipality of Diamantino MT Brazil (13º37’47.87’’ S and 57º23’51.71’’ W). According to Köppen´s classification, climate type is Aw, or rather, a tropical climate with well-defined dry and rainy seasons. The dry season ranges between May and September and the rainy one between October and April.

The farm´s produce consisted of soybean as the main crop and corn in the inter-harvest period. However, sunflower production as secondary crop (in succession to soybeans) has been proposed to replace corn, with one´s own capital, due to the producer´s eagerness. The total cropped area comprises 1,630 hectares (ha), with 800 ha for crops, 800 ha as legal and mandatory preservation area, and 30 ha with premises, dirt roads, pasture, orchards and others. During the summer, soybean covers the entire crop area and sunflower crop occupies 50% (400 ha) of the area.

Machines (tractor 260 CV/191 kW; tractor 75 CV/55 kW and harvester 300 CV/220 kW) and new equipments (22-line sower, sunflower platform, front transporter, self-propelled sprayer, water tank truck, transport truck, 40-disc plowing machine and 64-disc leveler), one unit each, were acquired at the start of the experiment, for the installation, transport and harvesting of crops. Total initial investment reached R$ 2,545,000.00 and R$ 45,096.00 for the preparation and correction of the soil.

Maintenance costs comprise expenses for fuel (diesel), spare parts, lubricants and filters, and eventual salaries to mechanics and electricians. Technical assistance (0.4 + 0.2 sack of soybean and sunflower, per ha^{-1}) was the *pro labore* of the assistant technician and owner (agronomic engineer) of the plantation. Eventual technical assistance provided by agricultural retailers is free. Administration costs comprise telephone bills, electricity, fuel and car maintenance. Freight included in harvest costs is the cost of transporting produce to silos some 45 km distant from the farm. There are no storage costs since the producer delivers the grains to the trading firm, with sales commitment at any time. Insurance of machines and equipments costs 1.2% per annum.

2.1 Production Costs of Soybean and Sunflower

Estimates for soybean and sunflower production costs were undertaken by grouping of items into variable and fixed costs [22], namely: a) variable costs (VC), comprising inputs, seeds, crop treatments, spare parts, fuel, seasonal manpower, technical assistance, harvest, freight, trading taxes (Fethab/Facs and Funrural) and income tax (IT) of presumed profit (15%). Above-mentioned costs plus interest on working capital (WC) composed Total Variable Costs (TVC); b) Fixed costs (FC), wholly attributed to the main crop, comprised Payable Fixed Costs (soil preparation and correction, fixed manpower, management and renting (opportunity costs) and costs of capital stock (CCS) or depreciations and mortgage; leasing was anticipated capital (prior to soybean sowing); c) Total Costs (TC) as TVC plus FC.

Rates in Brazilian Real (R$) for soybean (2017-2018 harvest) and sunflower (2018 harvest) production costs were retrieved during the second semester of 2017 and the first semester of 2018 during agricultural commercialization in Campo Novo do Parecis and with producers of the region. Transgenic soybean (RR and Bt) with zero tillage was featured, with straw and vegetal residues left on the soil surface. Machines and equipments had a 10-year useful life, with a 40% residue rate which returned by the end of the sixth year as profit, when sold. Improvements were estimated at R$ 200,000.00, and included a house made of bricks (90 m^2) and another made of timber (110 m^2), a shed (680 m^2), built some ten years ago, with another ten years of useful life, at 40% residual rate.

Depreciation rate was calculated linearly and land costs were the mean leasing rate of eight sacks of soybeans ha^{-1} $year^{-1}$. WC was the sum of VC + PFC, on the former, interests at 9.75% p.a. and 9.75% p.a. for CCS, composing opportunity costs, or rather, profits at saving account rates and activity risks.

Fethab/Facs was calculated following Technical Information 206/2018 by the Association of Soybean and Corn Producers of Mato Grosso[1] and Decree 217/2017 by the Economy Secretary of the state of Mato Grosso[2] (Table 1). Funrural is the 1.5 % rate on Total Income (TI), according to Act 13606 published on 9/1/2018[3], on the Rural Tax Regulation Program (RTRP).

2.2 Economic Analysis

2.2.1 Costs system

The economic analysis of the costs system assessed mean productivity of crops during the last three harvests (58 sacks ha^{-1} for soybeans and 30 sacks ha^{-1} for sunflower, or equivalent to 3480 and 1800 kg ha^{-1}, respectively) on the plantation and/or region [14] and respective mean prices (R$ 60 $sack^{-1}$ soybean and R$ 70 $sack^{-1}$ sunflower) to constitute TI. TFC comprised

[1] *Association of Soybean and Corm Producers of Mato Grosso [APROSOJA]. 2018. Informe Técnico Aprosoja nº 206/2018. Available at: <http://www.aprosoja.com.br/produtor/informes-tecnicos/2018> on 22/01/2018.*

[2] *State Secretary of Revenues [SEFAZ/MT]. 2017. Decree 217/2017, of 28 Decz. 2017. Dealing with coefficients of monetary correction, applied to fiscal debts and updated rate of UPF/MT during the period and other items. Diário Oficial de Mato Grosso, Cuiabá. Available at: <http://app1.sefaz.mt.gov.br/0325677500623408/7C7B6A934 7C50F55032569140065EBBF/016721B15DCA09EA8425820 A007BA97A> on 22/01/2018].*

[3] *Planalto. President of the Republic. 2018. Act 13.606, 09/01/2018, dealing with the Program for the Regulation of Rural Tributes (PRR) of the Secretary of Federal revenue of Brazil and General Attorney. Diário Oficial da União, Brasília. Available at <http://www.planalto.gov.br/ccivil_03/_ato2015-2018/2018/lei/L13606.htm> on 22/01/2018].*

Table 1. Monetary rates to Facs, FETHAB and regional FETHAB, January 2018

Description	% FSU[a]	R$ ton^{-1}	R$ sack^{-1}
Fethab[b] soybean	9.605	12.3175	0.7390
Regional Fethab	9.605	12.3175	0.7390
Facs[c]	1.260	1.6158	0.0969
Total (R$)	20.47	26.2507	1.5750

Source: Elaborated by author, based on APROSOJA (2018)

[a] Fiscal Standard Unit FSU/MT = R$ 128.24, [b] State Fund for Transport and Housing, [c] Fund pro soybean crop

FC of CCS + PFC, whereas TC was calculated by VC + interests on WC (TVC) + TFC. Taking leasing into account, Real Operation Costs (ROC) amounted to TVC + PFC. Weighted Average Revenue, weighted TC and weighted LT are, respectively, income from total soybean area + income from total sunflower area divided by available area; TC of total soybean area + TC of total sunflower area divided by available area and total yearly profit divided by available area.

Whereas Gross Contribution Range (GCR) consists of income minus TVC, the True Operational Contribution Margin (TOCR) comprises GCR subtracted from PFC (total yearly profit + depreciations, taking into account opportunity costs – leasing), also known as financial profit; Contribution Range Index (CRI) is the result of GCR divided by income. Profits prior to the removal of interests and depreciations consisted of TOCR + interests on WC. Operational Profit (OP) was income surplus minus TC (including interests on CCS, depreciation and mortgage); Total Profit (TP) is income surplus minus TC (excluding interests on CCS), whereas Profit Range (PR) is the profit percentage with regard to income [(income – COT) / income].

Further, equilibrium points (EP) were determined with regard to area (ha) by dividing TFC (R$) by GCR (R$ ha^{-1}); with regard to productivity (sc ha^{-1}), mean costs (MC, R$ ha^{-1}) divided by selling price (R$ sc^{-1}); with regard to production (sacks), TFC (R$) divided by GCR (R$ sc^{-1}); with regard to income (R$), TFC (R$) divided by CRI; with regard to selling price (R$ sc^{-1}), with TC (R$ sc^{-1}) and equilibrium income (EI) for the activity (association of crops). In addition, Net Current Rate (NCR), Equivalent Uniform Annual Rate (EUAR), Payback Internal Rate (PIR), Profitability Index (PI) during the period and Payback Period (PP) were calculated, following [23].

Simulations for different scenarios were performed to assess the business´s sensitiveness to the market´s natural oscillations, due to the seasonality of agricultural prices. Besides the basic scenario, positive and negative variations of 15 and 30% were defined for ROC, productivity, prices and incomes of soybean and sunflower so that one could register the performance of their respective financial indexes TI, NCR, EUAR, PIR, PI during the period under analysis and PP for each scenario.

3. RESULTS AND DISCUSSION

The 2017-2018 soybean harvest had a total production cost equivalent to R$ 2,450,698.00 divided into R$ 1,291,490.00 as variable costs; R$ 835,789.00 fixed costs; R$ 210,714.00 interests on capital stock; $ 112,703.00 interests on working capital (Table 2), with R$ 2,745,000.00 investments in stock capital with regard to machinery, equipments and improvements. Rates per ha^{-1} amount to R$ 3,063.00; R$ 1,614.00; R$ 1,044.00; R$ 263.00 and R$ 140.00, respectively.

Variable costs in percentage were predominantly represented in production total costs (53%), with inputs ranking first in financial expenditures (39%), mainly fertilizers, (seeding, fertilizers and micronutrients) with 20% and seeds, with 9% (Table 2). The great importance of fertilizers and seeds in production costs may be surmised from the fact that they are responsible for R$ 609.85 and R$ 271.08 per ha^{-1}, respectively. Royalties have been included in seed costs at R$ 144.00 ha^{-1}. Fixed costs amount to 34% of total costs, with 21% of non-payable fixed costs, with the greatest part related to leasing (16%) and 13% to capital stock, specifically depreciation of machines and equipments at (11%).

When production costs and profitability of soybean (2013-2014 harvest) for southeastern Mato Grosso are taken into account, [8] reported total costs at R$ 2,609.90 ha^{-1}, with R$ 1,868.52 for real operational costs (R$ 1,355.14 for inputs; R$ 460.23 for activities, and R$ 53.14 for labor) and R$ 741.40 for other costs (depreciation, general expenditure, technical assistance, taxes on labor, contribution to social security, financial changes, taxes and trading expenditures). Inputs had the highest percentage (52%) in total costs, with fertilizers ranking first (26%), followed by insecticides (9%), fungicides (7%) and seeds (6%).

Table 2. Annual production costs for soybean crop for 2017-2018 harvest. Diamantino MT Brazil, 2018

Item	R$ ha^{-1}	Total (R$ 800 ha^{-1})	%[a]
I – Variable costs			
Inputs			
Seeds	271.08	216,864.00	8.85
Seed treatment	35.00	28,000.00	1.14
Inoculants	8.00	6,400.00	0.26
Fertilizer, seeding and coverage	586.68	469,344.00	19.15
Micronutrients	23.17	18,536.00	0.76
Herbicides	67.49	53,992.00	2.20
Insecticides	45.00	36,000.00	1.47
Fungicides	70.01	56,008.00	2.29
Adjuvants	37.75	30,200.00	1.23
Periodic maintenance	20.00	16,000.00	0.65
Kitchen expenses	18.75	15,000.00	0.61
Total inputs	1,182.93	946,344.00	38.62
Mechanized operations			
Fertilization and seeding	18.07	14,456.00	0.59
Application with machines	23.22	18,576.00	0.76
Harvest and transport	170.00	136,000.00	5.55
Post-harvest management	3.87	3,096.00	0.13
Total mechanized operations	215.16	172,128.00	7.02
Other costs			
Seasonal labor	30.00	24,000.00	0.98
Divers costs[b]	18.72	14,976.00	0.61
Technical assistance	24.00	19,200.00	0.78
Fethab/Facs[c]	91.35	73,082.03	2.98
Funrural[d]	52.20	41,760.00	1.70
Total costs (others)	216.27	173,018.03	7.06
SUBTOTAL I	1,614.36	1,291,490.03	52.70
II – Fixed costs			
Payback of fixed costs			
Lime placed on the farm	52.50	42,000.00	1.71
Fixed labor	82.94	66,349.66	2.71
Management	20.00	16,000.00	0.65
Leasing (opportunity costs)	480.00	384,000.00	15.67
Total payback of fixed costs	635.44	508,349.66	20.74
Fixed costs CCS			
Insurance machines and equipments	41.18	32,940.00	1.34
Depreciation of machines and equipments	343.13	274,500.00	11.20
Depreciation of premises	25.00	20,000.00	0.82
Total fixed costs CCS	409.31	327,440.00	13.36
Interests on CCS	263.39	210,714.67	8.60
SUBTOTAL II (except interests on CCS)	1,044.75	835,789.66	34.10
TOTAL (I+II) (except interests on CCS)	2,659.11	2,127,279.69	86.80
Interests on WC	140.88	112,703.92	4.60
III – Interests (CCS + WC)	404.27	323,418.59	13.20
TOTAL COSTS (I+II+III)	3,063.38	2,450,698.28	100.00

Source: original results of research

[a] % of item on total costs; [b] relative costs to soil correction; [c] State Fund for Transport and Housing/Fund pro soybean crop; [d] Fund for the Assistance of the Rural Worker

[24] analyzed soybean production costs in the state of Mato Grosso, Brazil, for the 2014-2015 harvest, and underscored a total cost of R$ 2,295.98 ha^{-1}, with R$ 1,484.97 for inputs and R$ 811.01 for other fixed and variable costs. In the case of intakes, with 65% of total production costs, the items with the highest percentages were fertilizers (39%), insecticides (19%), seeds (14%), fungicides (11%) and herbicides (10%).

In the case of the second crop (sunflower/2018 harvest), total production costs reached R$ 582,803.38 (Table 3), divided into R$ 535,168.00 for variable costs and R$ 47,635.38 for interests on working capital alone, due to the fact that fixed costs were allotted to the main crop. Rates per ha^{-1} were R$ 1,457.01; R$ 1,337.92 and R$ 119.09, respectively.

Variable costs almost reached total production costs (92%), with inputs impacting crops (70%) with highest rates for fertilizers (32%) and seeds (11%) (Table 3); remaining costs comprised interests on working capital (8%), corroborated by [12]. In fact, fertilizers and seeds amounted to R$ 468.07 and R$ 155.17 ha^{-1}, respectively.

Table 3. Annual production costs for sunflower crop in the 2018 harvest. Diamantino MT Brazil, 2018

Item	**R$ ha^{-1}**	**Total (R$ 400 ha^{-1})**	**%[a]**
I – Variable costs			
Inputs			
Seeds	155.17	62,068.00	10.65
Seed treatment	18.72	7,488.00	1.28
Fertilizer seeding	256.67	102,668.00	17.62
Covering fertilizer (N)	149.00	59,600.00	10.23
Micronutrients (B)	62.40	24,960.00	4.28
Herbicides	107.75	43,100.00	7.40
Insecticides	141.33	56,532.00	9.70
Fungicides	112.63	45,052.00	7.73
Periodic maintenance	10.00	4,000.00	0.69
Kitchen expenses	9.40	3,760.00	0.65
Total inputs	1,023.07	409,228.00	70.22
Mechanized operations			
Pre-seeding management	30.00	12,000.00	2.06
Fertilization and seeding	45.00	18,000.00	3.09
Applications with machines	100.00	40,000.00	6.86
Harvest and transport	85.00	34,000.00	5.83
Total mechanized operations	260.00	104,000.00	17.84
Other costs			
Diverse Costs[b]	9.35	3,740.00	0.64
Technical assistance	14.00	5,600.00	0.96
Funrural[c]	31.50	12,600.00	2.16
Total costs (others)	54.85	21,940.00	3.76
SUBTOTAL I	1,337.92	535,168.00	91.83
II – Fixed costs	-	-	-
Payback fixed costs	-	-	-
Payback total fixed costs	-	-	-
Fixed costs CCS	-	-	-
Total fixed costs CCS	-	-	-
SUBTOTAL II (except interests on CCS)	-	-	-
TOTAL (I+II) (except interests on CCS)	1,337.92	535,168.00	91.83
III – Interests on WC	119.09	47,635.38	8.17
Total costs (I+II+III)	1,457.01	582,803.38	100.00

Source: original results of research

[a] % item on total costs; [b] relative costs to soil correction; [c] Fund for the Assistance of the Rural Worker

Silva et al. [25] analyzed the technical and economic viability of irrigated sunflower crop in Lavras region in the state of Minas Gerais, Brazil, and reported that the most relevant factors for increased fixed costs (25%) were machines and equipments (17%), followed by alternative costs (7%), labor (5%) and general expenditure/administration (3%). In the case of variable costs (75%), the most relevant were fertilizers (41%), general expenditure/post-harvest (7%) and alternative costs (4%).

Further, [26] assessed costs and profitability in sunflower production in the state of Mato Grosso, Brazil, for the 2013-14 harvest and calculated total costs at R$ 1,385.65 ha^{-1}, with relevant costs for fertilizers (53%), followed by machine (34%) and manual (3%) activities, transport and a month payment for storage (3%). In total expenditure for inputs (R$ 737.99 ha^{-1}), fertilizer expenses reached almost 64%, whereas expenditure in pesticides and seeds were 30% and 7%, respectively. In the case of expenditure with machinery (R$ 467.50 ha^{-1}), the harvest had the biggest share (32%) and expenditure with sowing and fertilizing reached 25%.

Further, the economic analysis of soybean and sunflower production determined several economic indexes, together and alone (Table 4). For example, mean income reached R$ 3,480.00 per ha^{-1} for soybean and R$ 2,100.00 for sunflower, with total yearly income at R$ 2,784,000 and R$ 840,000, respectively. Costs per soybean sack produced were composed of R$ 30.26 total variable cost and R$ 21.38 total fixed cost, with R$ 51.64 total costs, and a profit of R$ 8.36 (R$ 484.73 ha^{-1}).

In case of sunflower, each sack comprised R$ 48.57 of total variable costs, or rather, total costs, with a profit of R$ 21.43 (selling price R$ 70,00 sack^{-1}) or R$ 642.99 ha^{-1} (Table 4). The above demonstrates a 33% complementary profit per ha^{-1} with sunflower crop higher than that of soybean. Since the above was due to the fact that all fixed costs belonged to soybean, producers have to exploit maximum economic return of this activity, with two crops per year (investment in fixed capital will not change). Further, soybean and sunflower crop system (in succession) has the best environmental performance when compared with monocultures, due to possible synergies, sharing land use and other resources, such as the advantages of associating nitrogen-fixing legumes (soybean) with other plant species [27,10].

Silva et al. [25] investigated the technical and economic viability of sunflower production in irrigated and non-irrigated conditions and reported that payback in productivity increase was due to irrigation. In non-irrigated conditions, mean total cost was R$ 32.71 sacks^{-1}. If the land were to be left fallow during the between-harvest period, it would be an asset to invest in sunflower crop. The producer would be paying the crop´s variable costs and part of the fixed ones already invested in the main activity. This would contribute towards soil coverage and decrease in weed infestation, enhancing the soil´s conservationist system. Further, [26] reported a gross income of R$ 1,590.00 ha^{-1}, operational profit of R$ 204.35 ha^{-1} and a 13% profit index for a mean productivity of 30 sacks ha^{-1} at a unit selling price of R$ 53.00. The above data corroborated profitability in sunflower production worldwide [18,28,12].

Gross contribution range for soybean reached R$ 1,379,806.05 (R$ 1,724.76 ha^{-1}), with a 50% contribution range index and a real operation contribution range of R$ 880,516.40 (Table 4). In the case of sunflower crop, rates reached R$ 257,196.62 (R$ 642.99 ha^{-1}), 31% and R$ 257,196.62, respectively. Producer will earn R$ 753,713.02 when total real operational contribution range (soybean and sunflower) minus opportunity costs with leasing is calculated. Likewise, [8] obtained a gross income for soybean of R$ 2,815.98 ha^{-1} (54.42 sacks ha^{-1} x R$ 51.75 sacks^{-1}), with a gross range of 8%, operational profit of R$ 206.08 ha^{-1} and profit index of 7%.

Discarding interests, taxes, depreciation and mortgage (EBITDA), profits were R$ 880,516.40 and R$ 257,196.62 respectively for soybean and sunflower (Table 4). However, after tabulating interests, taxes, depreciation and mortgage, profits were R$ 387.785,73 and R$ 257,196.62, respectively with 22 and 31 % profit ranges.

The highly important equilibrium point should be analyzed and performed since production at the equilibrium point is sufficient to cover costs of activities, or rather, profit amounts to zero. In this case, the equilibrium point with regard to area, productivity, production, income and price for soybean amounted to 575.17 ha, 49.92 sacks ha^{-1}, 33,359.57 sacks, R$ 2,001,574.48 and R$ 51.64 sack^{-1} (Table 4), whereas for the equilibrium points for sunflower were 20.81 sacks ha^{-1} and R$ 48.57 sacks^{-1}, respectively, and income from combined equilibrium (soybean +

sunflower) reached R$ 3,076,215.47. Carvalho et al. [8] elaborated an economic analysis for soybean and reported equilibrium points 50.43 sacks ha^{-1} and 47.96 R$ $sacks^{-1}$, respectively, for productivity and selling price.

The above variations corroborate current study and that by Tarsitano et al. [26]. The later stated that the producer must produce at least 26 sacks to cover total costs or produce 30 sacks ha^{-1}, and receive at least R$ 48.41 $sack^{-1}$ to cover costs.

It is a well-known fact that production costs of any activity are one of the issues with which rural producers have to cope with. In fact, they have to determine the manner of production within a determined range of production costs that would be an asset according to market prices. The results demonstrate that the producer has to efficiently manage the acquisition of fertilizers (with high representativeness in the costs sheet) and harvest not merely on costs but also in efficiency and minimization of field losses, as insisted upon by Tarsitano et al. [26].

Table 4. Economic analysis (costs and profit) for soybean and sunflower crops for 2017-2018 harvest. Diamantino MT Brazil, 2018

Items	Soybean	Sunflower
Area (ha)	800	400
Productivity (sacks / kg ha^{-1})	58 / 3480	30 / 1800
Production (sacks)	46,400	12,000
Price (R$ $sack^{-1}$)	60.00	70.00
Mean income (R$ ha^{-1})	3,480.00	2,100.00
Mean weighted income (R$ ha^{-1})	4,530.00	
Total income (R$)	2,784,000.00	840,000.00
Initial mean VC (R$ ha^{-1})	1,300.81	1,221.42
WC (R$)	1,155,937.66	488,568.00
Interests on WC (R$)	112,703.92	47,635.38
Total VC (R$)	1,404,193.95	582,803.38
PFC (R$)	499,289.66	-
FC CCS (R$)	2,790,096.00	-
ROC (R$)	1,903,483.60	582,803.38
Total FC (R$ ha^{-1})	1,240.03	-
TC (R$ ha^{-1})	2,995.27	1,457.01
Weighted TC (R$ ha^{-1})	3,723.78	
TC (R$ sc^{-1})	51.64	48.57
TP (R$ ha^{-1})	484.73	642.99
Weighted TP (R$ ha^{-1})	806.23	
Total FC (R$ sc^{-1})	21.38	-
Total VC (R$ sc^{-1})	30.26	48.57
TVC (R$ ha^{-1})	1,755.24	1,457.01
GCM (R$)	1,379,806.05	257,196.62
GCM (R$ ha^{-1})	1,724.76	642.99
CMI (%)	49.56	30.62
TOCM (R$)	880,516.40	257,196.62
TOCM without leasing (R$)	753,713.02	
EBITDA (R$)	880,516.40	257,196.62
Total annual profit (R$)	387,785.73	257,196.62
Profit range (ML) (%)	21.50	30.62
Annual total WC + interests (R$)	1,268,641.59	536,203.38
Total Investments (R$)	5,186,310.27	582,803.38
Equilibrium point area (PEA) (ha)	575.17	-
Equilibrium point productivity (PEProd) (sack ha^{-1})	49.92	20.81
Equilibrium point production (PEPr) (sack)	33,359.57	-
Equilibrium point income (PER) (R$)	2,001,574.48	-
Equilibrium point price (PEP) (R$ $sack^{-1}$)	51.64	48.57
Equilibrium income (REq) (R$)	3,076,215.47	

Source: Original research results

Table 5. Synthesis of financial indexes for the analysis of sensitiveness with regard to variations (Δ) for soybean (S) and sunflower (F) crops. Diamantino MT Brazil, 2018

	ΔPr[a] (R$ sc^{-1})		------------------------- Financial Indexes[e] -------------------------					
Δ (%)	PrS	PrF	TI (R$) (1000)	NCR (R$) (1000)	EUAR (R$) (1000)	PIR (%)	PI (%)	PP (years)
-30	42.0	49.0	2,536.8	-2,061.47	-469.87	-2.91	-46.56	6.40
-15	51.0	59.5	3,080.4	-296.27	-67.53	7.98	-6.69	5.77
0	*60.0*	*70.0*	*3,624.0*	*1,468.92*	*334.81*	*18.37*	*33.12*	*4.63*
15	69.0	80.5	4,167.6	3,234.11	737.14	28.40	72.87	3.21
30	78.0	91.0	4,711.2	4,999.30	1,139.48	38.18	112.55	2.59
	ΔProd[b] (sacks ha^{-1})							
	ProdS	ProdF						
-30	40.6	21.0	2,536.8	-2,442.95	-556.82	-5.31	-55.09	6.75
-15	49.3	25.5	3,080.4	-487.01	-111.00	6.83	-10.98	5.90
0	*58.0*	*30.0*	*3,624.0*	*1,468.92*	*334.81*	*18.37*	*33.12*	*4.63*
15	66.7	34.5	4,167.6	3,424.85	780.62	29.49	77.23	3.07
30	75.4	39.0	4,711.2	5,380.78	1,226.43	40.32	121.34	2.44
	Δ ROC[c] (R$ ha^{-1})							
	ROC S	ROC F						
-30	1,665.55	1,019.91	3,624.0	4,250.51	968.81	34.09	95.85	2.92
-15	2,022.45	1,238.46	3,624.0	2,859.72	651.81	26.31	64.49	3.50
0	*2,379.35*	*1,457.01*	*3,624.0*	*1,468.92*	*334.81*	*18.37*	*33.12*	*4.63*
15	2,736.26	1,675.56	3,624.0	78.12	17.81	10.22	1.76	5.52
30	3,093.16	1,894.11	3,624.0	-1,312.68	-299.20	1.79	-29.60	6.51
	Δ I[d] (R$ ha^{-1})							
	I S	I F						
-30	2,435.00	1,470.00	2,536.0	-2,585.53	-589.31	-6.22	-58.30	6.88
-15	2,958.00	1,785.00	3,080.4	-558.30	-127.25	6.40	-12.59	5.95
0	*3,480.00*	*2,100.00*	*3,624.0*	*1,468.92*	*334.81*	*18.37*	*33.12*	*4.63*
15	4,002.00	2,490.00	4,197.6	3,496.14	796.87	29.89	78.84	3.02
30	4,524.00	2,730.00	4,711.2	5,523.36	1,258.93	41.10	124.55	2.39

Source: Original research results.

[a] (ΔPr) = variations in price; [b] = (ΔProd) = variations in productivity; [c] = (ΔROC) = variations in Real Operational Costs; [d] = (ΔI) = variations in income; [e] TI = total annual income, NCR = Net Current Rate, EUAR = Equivalent Uniform Annual Rate, PIR = Payback Internal Rate, PI = Profit Index during the period and PP = payback period

In case of analyses of sensitiveness through simulated scenarios (the best and the worst) to compare with the real scenario (base), one should note the behavior of the financial indicators (TI, NCR, EUAR, PIR, PI) and define the limit of variation so that the activity could be still worthwhile. Therefore, for a combined analysis (soybean + sunflower) at the base scenario (Table 5), indicators show a retrieval of R$ 3,624,000.00 per year; R$ 1,468,917.29; R$ 334,807.04; 18%; 33% and 4.63 years, respectively.

When there is a -15% (worst scenario) variation in the prices of agricultural products, the sensitiveness of the activity is revealed. In other words, financial indexes have a negative behavior (Table 5), with the exception of TI (decrease) and NCR (8%) which decrease somewhat below the minimum attractiveness rate (MAR). This shows that the activity covers costs but fails to recompense entirely the investor at the rate of 9.75% p.a. Or rather, the activity should be discarded or, at least, the investor may opt for a lower MAR or equal to PIR. Moreover, PP reached 5.77 years. It goes without saying that a -30% scenario makes conditions more negative still.

However, for the best scenarios (15 and 30%), profits with regard to base scenario were encouraging, at TI = R$ 4,711,200.00 for a 30% variation, featuring NCR, EUAR, PIR, PI during the period, and PP at R$ 4,999,299.80; R$ 1,139,479.25; 39%; 113% and 2.59 years, respectively (Table 5).

Although income for productive variation was stable with regard to price and income variations (Table 5), there was a change in other financial indexes. This may be due to the fact that taxes Fethab/Facs (for soybean) + Funrural are applied on productivity/production. Therefore, in the case of a -15% variation, there was a lack of attractiveness for the activity: NCR, EUAE and PI were negative, in contrast to the best scenarios. In fact, rates reached R$ 5,380,780.62; R$ 1,226,429.32 and 121% for the above-mentioned indexes, besides PIR at 40% and PP of 2.44 years.

When the worst variation (15%) was taken into account in the real operational costs (ROC), activity remained feasible (Table 5), albeit with reduced paybacks (NCR, EUAR, PIR and PI, during the period) and increased PP (5.52 years) with regard to base scenario. However, the activity should be disregarded when the scenario changes from 15 to 30%, due to the negativity of the indexes. However, this was not reported for the best variations at scenarios (-15 and -30%). Regardless of these scenarios, incomes were constant since they did not depend on ROC but merely on productions and on grain prices.

Negative variations (-15 and -30%) in the crop income demonstrated a lack of attractiveness of the activity (Table 5), whereas positive variations improved paybacks, with NCR and EUAR increasing 3.7 times for the 30% variation with regard to base scenario. Moreover, NCR, PI and PP increased to 41%, 125% and 2.39 years, respectively.

Each and every plantation has its own peculiarities with regard to topography, physical conditions, soil fertility, type of machines, planted area, technological level and even management. All these items differentiate the structure and rates of production costs. Costs may be different and the equilibrium point may vary according to alterations in production costs or in the product´s price, with greater or lesser profitability. Every producer must calculate his production costs, even though assessments as analyzed in current study may contribute for decision-taking.

4. CONCLUSIONS

Within the proposed system, a farm may be feasible with a total annual income of R$ 3,624,000.00, net rate R$ 1,468,920.00, annual equivalent uniform rate R$ 334,810.00, internal payback rate 18%, profitability index at 33% and payback period of 4.63 years, at the end of a six-year period.

However, a 15% negative variation in price, productivity and income and a 30% positive variation in real operational costs of the two crops make the project unfeasible, especially due to negative net rate.

Sensitivity analysis is of extreme importance in the correct decision making by the farmer, since it clearly demonstrates how the financial performance of the proposed activity will be if there is an oscillation in the main economic and agronomic indicators of the activity, mainly in the agricultural activity, whose production presents seasonality during the year because the weather conditions are different in each month.

Complementary profit per ha^{-1} for sunflower crop is 33% higher than that of soybean, since fixed costs are paid by soybean, suggesting two crops per year.

The method for the application of production costs employed in current research is highly relevant since it provides a good evaluation on the implementation project with an adequate diagnosis for decision-taking by the producer. In fact, current research is a contribution to the producer since it provides more profitable alternatives to the planning of soybean production, with dilution of costs and income increase.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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