Bulgarian Journal of Agricultural Science, 22 (No 6) 2016, 869–874
Agricultural Academy

SUNFLOWER PRODUCTION IN BRAZIL: SENSITIVITY OF THE FINANCIAL VIABILITY IN THE CULTIVATION IN FARMS THROUGH MONTE CARLO SIMULATION

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Abstract

SUCHLA, E. G., A. CATAPAN, B. L. S. BONFIM, M. F. CATAPAN and O. A. SIMÕES, 2016. Sunflower production in Brazil: sensitivity of the financial viability in the cultivation in farms through Monte Carlo simulation. *Bulg. J. Agric. Sci.*, 22: 869–874

The main goal of this article is to investigate the economic viability of the production of sunflowers in the context of the Paraná State in Brazil. In order to do that, there were realized interviews with small producers of the field in the region. From the calculation of the Net Present Value (NPV), the Internal Rate of Return (IRR), and - to repair the limitations of this one - the Modified Internal Rate of Return (MIRR), the elaboration of tables with the initial investment, inflows and outflows (fixed and variable), we have arrived to conclusions, simulating scenarios that varied from 1 to 1,000 planted hectares. The results point that for a crop of 1000 hectares, seeking a net present value of R$ 1 140 238.68 and an internal rate of return of 21.67%, the project is viable. The result confirms a Benefit/Cost Index that presents a return of R$ 4.79 for each Real invested.

Key words: sunflower, financial viability, Monte Carlo Simulation

Introduction

Thanks to the rise of the production, of the interest, of the scientific investigation, the agribusiness is an area that has been exceling in the late years (Bialoskorski and Souza, 2006). John Davis and Ray Golderbeg conceptualized the term agribusiness in 1957, and it has been adopted since then.

In Brazil, the agribusiness area in the economic context is responsible for the elevation of the position of producer and exporter (Novaes et al., 2009). The sunflower includes itself in this perspective and is a good choice for the agricultural producer because it has a bigger potential (among the plants) in the production of biofuel, besides that it's an option for crop rotation/succession (Nobre et al., 2011). It also has great tolerance to draught and heat.

Lira et al. (2011) certifies that the sunflower comes in fourth place – only behind soy, palm and canola – as the most consumed oleaginous in the world. It also achieves the same position as the most seek protein source for animal ration and human consumption – approximately 300 kg of oil, 250 kg of seed husk and 350 kg of cake to feed the cattle.

In order to obtain the best results possible with the crop, and consequently maximizing the profit, there must be a good preparation of the soil to achieve a quick and uniform germination, a deep rooting, and a good use of the nutrients and water (Castro et al., 1996). Wendt et al. (2005) considers that the nutrition of the sunflower depends as well on the care with the soil for the crop rotation and the fertilizing.

The moments of plantation and harvest in the physiological maturity are related and influence the final quality, seen that the determination of the correct momentum provides the preservation of the physiological quality of the sunflower. (Sander and Silveira, 1988). Casto et al. (1996) affirm that

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there is a wide variety of technological devices to assure the development of the plant, and the producer is responsible for finding and applying the adequate method.

The bird attacks, summer crops competition, and the *Sclerotinia* and *Anternari* diseases, however, disturb the evolution of the plant, besides the lack of fulfilment of technological demands such as products to control the growth of weed and other phytosanitary demands (Embrapa, 2014).

In this way the research question of the article is: "is there financial viability for the cultivation of sunflower in the context of Paraná State in Brazil?" Therefore, the goal is to verify such viability in the Paraná context.

The justification of this work is that Brazil still counts on very few producers in the area, occupying about 150 thousand hectares in Brazil (Ventura et al., 2010) and the annual growth of the cultivation area is around 4.4% (Lita et al., 2011). Still, this oleaginous plant has great potential of expansion in Brazil, seen that the country has a large space for production (Castro, 2012).

Cadorin et al. (2012) reports that the main aim of the production of sunflower for a long time has been to prepare bird's food achene, edible oil production and animal ration. However, since 2005 the interest of agriculture producers in producing sunflower for biodiesel production has been rising.

Nowadays the sunflower is responsible for 16% if the world production of oil – being it full of nutrients, fatty acids (essential to human diet but not synthesized in human body), and oxidative stability (Embrapa, 2015). Thus, considering the current worldwide sustainable appeal, there is a need of growing the utilization of biofuels and this fact corroborates the justification for the elaboration of this research.

Materials and Methods

After the choice of the theme, a bibliographical research took place to contextualize the subject and orientate the study to the area in specific. The delimitation of an objective that requires a literature review was the second stage of the research, which was an exploratory stage (Gehardt and Silveira, 2009).

The third stage of the research comprehended the collection of data on the field. It had begun with a research at the Brazilian Agricultural Research Corporation (Embrapa) through semi-structured questionnaires sent electronically to them. These questionnaires were classified as open, which according to Nogueira (2002) have as advantage the characteristic of exploring all possible answers to each item. The objective of this stage was to learn more about this culture and to prepare for the interviews carried on the next stage.

The interviews – which were non-structured – selected farms that had sunflower crops in Paraná, Brazil. The questionnaires utilized in these interviews were classified as assisted, which according to Nogueira (2002) allows the researcher to follow and coordinate directly the questions to the interviewed. There were conducted three interviews with owners of different farms. Preference for this country and for this state is proximity to the proprietors and consequently to the data needed.

These interviews had the objective to delimitate the factors that interfere the production of the sunflower, the investments, inflows, and outflows. This type of technique of data collection is important to the development of the article, seen that it gives value to words, expressions, and human relations, seeking to diminish the uncertainty of the answers (Fraser and Godim, 2004).

The answers were recorded and transcribed for further analysis of their content. During the visits carried to interview the proprietors, we had access to spreadsheets concerning the control of revenue, costs and expenses of the production. All of this data was crossed with the data obtained from Embrapa and the data obtained from the interviews.

From that, we elaborated tables to present the data in the clearest way possible, as it should be according to Swerts et al. (2014). There tables were the basis for the calculation of the net present value (NPV), which measures the earnings generated by the future discounted cash flows of the project, discounted from the initial investment; the internal rate or return (IRR) – which measures the rate of return of the project in percentage; and, in order to correct the limitations of this one, the modified internal rate of return (MIRR), which measures the rate of return of the project in percentage considering the reinvestment and/or refinancing in case there are positive and negative cash flows respectively. After that, the Monte Carlo Simulation takes place in order to verify the variability of the input parameters in the calculation of the NPV.

Results and Discussion

The results of the research are analysis of the information provided by Embrapa and the interviews realized with the producers, which, for Britto Júnior and Feres Júnior (2001), is a widely used method and that when associated with data collection performs a great role in enhancing the quality of the work. Looking for better precision and understanding we divided the simulation of financial viability in two sizes of properties: 1 hectare and 1000 hectares.

Projections for 1 and 1000 hectare plantations

The initial investments with the plantation of the sunflower comprehend the expenses with the seeds, tractors and fertilizer, totalizing a cost of R$ 300.31 per hectare approximately. The total initial investment for the plantation of 1000 hectares of sunflower was R$ 300 310.00. It was verified in interviews of this paper, that many stages of sunflower cultivation in Brazil are outsourced, for example, machines use and harvest. Thus, economy of scale was not considered in this context. Table 1 presents these values.

Table 1
Initial investments

Descritpion	Value	Value
Seeds/ha	R$ 95.40	R$ 95.40
Tractors and harversters/ha	R$ 37.80	R$ 37.80
Fertilizer/ha	R$ 167.11	R$ 167.11
Total per hectare	R$ 300.31	R$ 300.31
Planted hectares	1	1000
Total investment	R$ 300.31	R$ 300 310.00

Source: elaborated by the authors (2015)

Table 2 presents the memory of calculation for the revenue for 1 and 1000 hectares. The productivity of 2000 kg per planted hectare was measured with basis on the questionnaire sent to Embrapa, and confirmed on the interviews.

Table 2
Revenues

Descritpion	Value	Value
Productivity in kg/ha	2000	2000
Sales price/kg	R$ 1.40	R$ 1.40
Planted hectares	1	1000
Total revenue	R$ 2800.00	R$ 2 800 000.00

Source: elaborated by the authors (2015)

The budgeted sales price for the sunflower was R$ 1.40 per kilogram. The sales price varies according to how the product is going to be commercialized and takes into consideration the inventory level, production costs, among others (Embrapa, 2015). To project this value, it was calculated the mean of the values obtained through the interviews along with a market research concerning the sunflower market.

The Table 3 presents the outflows (involving costs, fixed and variable expenses) for the plantation of 1 and 1000 hectares. The costs of bigger representation are the ones with fertilizers, which, for Camargo (2012), besides being a source of nutrients, are indispensable for the plants to complete their cycle.

Table 3
Monthly outflows

Description	Value	Value
Fertilizers	R$ 68.68	R$ 68.68
Pesticides	R$ 39.73	R$ 39.73
Operational cost	R$ 66.72	R$ 66.72
Machinery depreciation	R$ 5.37	R$ 5.37
Fixed costs of cultivation	R$ 5.41	R$ 5.41
Herbicide	R$ 12.58	R$ 12.58
Other materials	R$ 39.46	R$ 39.46
Total per hectare	R$ 237.94	R$ 237.94
Planted hectares	1	1000
Total monthly outflow	R$ 237.94	R$ 237 944.00

Source: elaborated by the authors (2015)

With the data taken from the interviews, the costs go from pesticides to the machinery depreciation, resulting in an outflow of R$ 237.94. Besides the fertilizers, the monthly outflow includes pesticides that destined to use in production, storage and processing of agricultural goods (Ministério do Meio Ambiente, 2015). The total value of the monthly outflows for 1 000 hectares is R$ 237 944.00. Thus, with in initial investment, projected inflows and outflows, Table 4 presents the cash flow for 1 hectare.

The measurement of the cash flow is important because it allows an evaluation of the risk of a certain project and can be used as base for entrepreneurial decisions (Santos et al., 2010). The time for the harvest of the sunflower is five months, so from month 1 to month 4 there is not an income for the product that cannot be sold by then. It happens at the fifth month for a value of R$ 2800, as shown in Table 2.

To calculate the indicators of return of the project, we used a discount rate of 13.75% per year, which represents the SELIC index (Special Clearance and Escrow System, *Sistema Especial de Liquidação e Custódia* in Portuguese) that is used as base for investments and financing in Brazil. Being the project monthly, the calculated composed tax is 1.0794% per month.

Thus, from the cash flow, and for 1 hectare, we measured a NPV of R$ 1,140.24, IRR of 21.67%, and MIRR of 19.04%. The BCR (Benefit-Cost Rate) shows that for each Real invested, the project returns R$ 4.79. In order to calculate the MIRR, the considered reinvestment rate was the SELIC index (13.75%) and the considered refinancing rate was 18.75% per year based on the interest rate for the Brazilian market in 2015. The Table 5 shows the cash flow for 1,000 hectares.

Table 4
Cash flow for 1 hectare

	Initial Investment	Months				
		1	2	3	4	5
Inflows						R$ 2800.00
Outflows	R$ 300.31	R$ 237.94	R$ 237.94	R$ 237.94	R$ 237.94	R$ 275.74
Cash	R$ -300.31	R$ -237.94	R$ -237.94	R$ -237.94	R$ -237.94	R$ 2524.26
Net Cash	R$ -300.31	R$ -237.94	R$ -237.94	R$ -237.94	R$ -237.94	R$ 2392.33
MIRR Cash	R$ -300.31	R$ -241.38	R$ -244.86	R$ -248.39	R$ -251.97	R$ 2267.29
NPV	R$1.140.24					
IRR	21.67%					
MIRR	19.04%					
BCR	R$ 4.796872166					

Source: elaborated by the authors (2015)

Table 5
Cash flow for 1000 hectares

	Initial Investment	Months				
		1	2	3	4	5
Inflows						R$ 2 800 000.00
Outflows	R$ 300 310.00	R$ 237 944.00	R$ 237 944.00	R$ 237 944.00	R$ 237 944.00	R$ 275 744.00
Cash	R$ -300 310.00	R$ -237 944.00	R$ -237 944.00	R$ -237 944.00	R$ -237 944.00	R$ 2 524 256.00
Net Cash	R$ -300 310.00	R$ -237 944.00	R$ -237 944.00	R$ -237 944.00	R$ -237 944.00	R$ 2 392 325.00
MIRR Cash	R$ -300 310.00	R$ -241 376.10	R$ -244 857.71	R$ -248 390.00	R$ -251 972.00	R$ 2 267 289.00
NPV	R$ 1 140 238.68					
IRR	21.67%					
MIRR	19.04%					
BCR	R$ 4.796872166					

Source: elaborated by the authors (2015)

Table 6
Simulation for plantation in varied hectares

Hectares	NPV	IRR	MIRR	BCR
1	R$ 1140.24	21.67%	19.04%	4.796872
2	R$ 3457.76	21.67%	19.04%	4.796872
3	R$ 5775.28	21.67%	19.04%	4.796872
4	R$ 8092.81	21.67%	19.04%	4.796872
5	R$ 10 410.33	21.67%	19.04%	4.796872
6	R$ 12 727.85	21.67%	19.04%	4.796872
7	R$ 15 045.37	21.67%	19.04%	4.796872
8	R$ 17 362.90	21.67%	19.04%	4.796872
9	R$ 19 680.42	21.67%	19.04%	4.796872
10	R$ 21 997.94	21.67%	19.04%	4.796872
20	R$ 45 173.16	21.67%	19.04%	4.796872
30	R$ 68 348.39	21.67%	19.04%	4.796872
40	R$ 91 523.61	21.67%	19.04%	4.796872
50	R$ 114 698.84	21.67%	19.04%	4.796872
100	R$ 230 574.96	21.67%	19.04%	4.796872
500	R$ 1 157 583.93	21.67%	19.04%	4.796872
1,000	R$ 2 316 345.15	21.67%	19.04%	4.796872

Source: elaborated by the authors (2015)

The cash flow shows that for an area of 1000 hectares the IRR is 21.67%, the MIRR is 19.04%, and the BCR is R$ 4.79. All the values remain the same from the 1 hectare plantation simulation. The reinvestment and refinancing rates used were the same of those used in the 1 hectare simulation as well. The net present value calculated for 1000 hectares was R$ 1 140 238.63. Finalized the presentation of the results for the 1000 hectares, the next section simulates the results for varied areas of production.

Projections for varied hectares

We projected cash flows for plantations of sizes of 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 20, 30, 40, 50, 100, 500 and 1,000 hectares. Table 6 presents the results for NPV, IRR, MIRR and BCR.

As the number of planted hectares increases the NPV increases as well but the IRR, MIRR and CBR remain the same despite the size of the area. Therefore, according to Silva and Fontes (2005), the project is considered economically viable because it has a NPV higher than zero (positive), so the plantation of sunflower is considered viable. Also, as evidenced by the calculation of the NPV, the higher the number of planted hectares, higher is the financial return of the project. After the presentation of this projection, the next section approaches the Monte Carlo Simulation.

Monte Carlo Simulation

The productivity and the quantity of seeds per hectare, as the fertilizers and pesticides used, are variable parameters. This information was taken from the interviews, and it was decided that they had a variability of ± 10% for all the parameters, whic means that their values can rise or diminish during the period of analysis, causing fluctuations on the cash flow. All the other parameters were considered as fixed. Thus, with this information into account, we generated a Monte Carlo Simulation for the 1,000 hectare plantation scenario. Other authors (Greca et al.; Ogata et al.; Catapan et al., 2015) already used this same technique to analyze other investment projects. Thus, we used the triangular distribution with the variables aforementioned, as well as the values calculated and shown before. With 10 000 interactions and a confidence interval of 95%, the Figure 1 presents the graphic results and the values for the NPV.

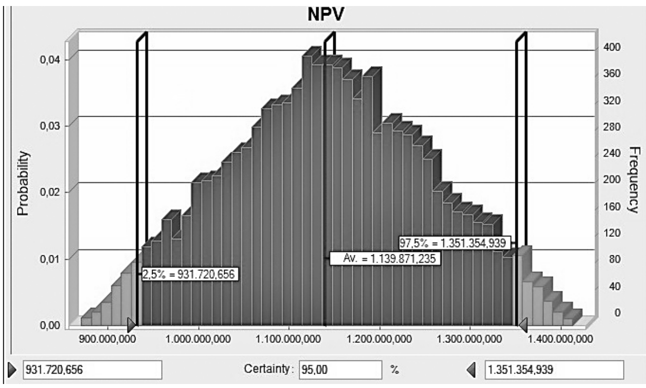

Fig. 1. Monte Carlo Simulation for the NPV
Source: elaborated by the authors (2015)

The results presented by the Crystal Ball software shown in Figure 1 demonstrate that the probability of the NPV of being higher than zero is 99.9%, since the minimum and maximum values for this variable are respectively R$ 870 323.30 and R$ 1 412 959.05. The mean is R$ 139 871.24 and the median is R$ 1 139 428.19. Still, it can be affirmed with 95% of certainty that the NPV will be located between R$ 913,720.66 and R$ 1,351,354.94. The values found through the Monte Carlo Simulation are close to the calculated value presented of R$ 1 140 238.63, which validates the present study. After that, Figure 2 presents the analysis for the IRR of the project.

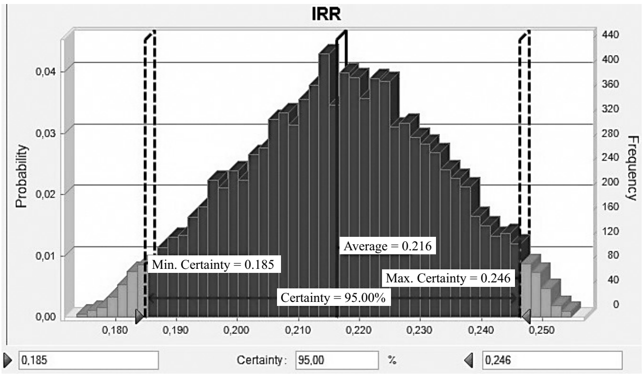

Fig. 2. Monte Carlo Simulation for IRR
Source: elaborated by the authors (2015)

Observing Figure 2, the probability of the IRR being higher than the minimum acceptable rate of return (MARR) is 99.9%, since the minimum and maximum values are located respectively between 17.4% and 25.5%, with mean of 21.6% and median of 21.7%. Even so, it can be affirmed with 95% of certainty that the IRR will be situated between 18.5% and 24.6%. The calculated value presented before was 21.67%, so the values presented by the Monte Carlo Simulation confirm the viability of the project.

Conclusion

The objective of this research was to investigate the financial viability of the production of sunflower in São José dos Pinhais, Paraná. Simulating a plantation of 1000 hectares, in view of a NPV of R$ 1 140 238.68 (which varies according to the planted area) and an IRR of 21.16% (fixed for every planted area), we concluded that the project is viable, confirming the Benefit-Cost Rate of R$ 4.79 for every Real invested.

Thus, even though the cash flow will be negative during the four months before the harvest, on the fifth month, besides recovering all the invested value, it will obtain profit, proving the project viable.

This research is limited in verifying the financial viability of the sunflower plantation for the context of the Paraná State, in Brazil. Therefore, the results shown here cannot be generalized because they can suffer influence from the climate and productivity of the region, among other factors. Hereafter, we suggest that in future works the study should be expanded to consider other regions in Brazil and other regions in other countries.

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Received March, 7, 2016; accepted for printing November, 1, 2016