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RISKS AND ECONOMIC ANALYSIS OF ORANGE CULTURE: CASE STUDY OF A PRODUCER FROM THE INTERIOR OF SÃO PAULO STATE, BRAZIL

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ABSTRACT

The Brazilian citriculture is one of the activities that generate the most income within the agribusiness, being responsible for providing opportunities for thousands of direct and indirect workers, besides being a sector that moves a great amount of financial resources. The orange crop has been going through great price swings in the recent years, and with this, many farmers are failing to invest in potential, as a result of the risks involved in the activity. A large part of these risks is related to the buyer market, which is controlled by the large juice industries and by the high capital required for the implementation of the new orchards. The objective of this work is to identify the risk factors for attractiveness and to analyze the economic viability of the orange crop in a farm in the municipality of Bauru, in the state of São Paulo. For this, the Monte Carlo method be used to simulate the probabilities of success in the scenarios analyzed and the NPV, IRR and Payback to determine the feasibility of the project. The research is characterized as a case study.

The results obtained showed that the investment is feasible, only in the real and optimistic scenario and will provide a return between the 6th and the 7th year of the project, providing a balance of approximately R$ 4,190,252.94 after 10 years of investment which represents an attractive compared to the initial investment value of R$ 937,500.00.

Keywords: Risk analysis; profitability; citriculture; Monte Carlo method; simulation

1. INTRODUCTION

Among the fruit grown in Brazil, orange occupies the largest area planted (415,232 hectares) and exerts great importance in the trade balance (FUNDECITRUS, 2017). In Brazil, the fruit was introduced early in the colonization, finding in the country better conditions for its development than in its own place of origin and thus expanding throughout the territory (NEVES et al., 2010).

Oranges can have three basic destinations: processing industry, domestic market and external market. In the states of Bahia and Sergipe, 77% of production is absorbed by the fresh fruit market. In the Brazilian citrus belt (including the state of São Paulo, Triângulo Mineiro and northwest of Paraná), 86% of the production is destined for the processing industry (NEVES et al., 2014). According to the latest estimate by FUNDECITRUS (2017), the citrus belt has 191,694,410 plants. The 2017/18 orange crop of Brazil's main citrus park - which includes 349 municipalities in São Paulo and Minas Gerais - is expected to be 364.47 million boxes of 40.8 kg. Production is 14% higher than the historical average of the last ten years.

The 2016/17 crop, considered one of the smallest in history, closed with a production of 245.31 million boxes of 40.8 kg. With this reduction in production, the price paid for the fruit reached high levels during the harvest, where the industry paid on average, R$ 21.24 per box (CEPEA, 2017).

According to Kalaki (2014), despite the Brazilian superiority in the production of orange juice, the country is highly dependent on the foreign market, and this dependence has become the chain's major concern in recent years, ranging from producers to industry. Of the total drinks consumed in the world in 2010, the orange flavor represented only 0.91%, but among fruit drinks, orange juice is the most taken, with a 37% share of juices in 2012.

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As observed by Silva (2016), the greater the surplus of orange in the market, the verticalization of the industry, and the concentrated juice store, the greater the purchasing power of the orange processing industry. Because it is an oligopsony market, the producer usually has no control over the price paid for the fruit, so it is up to him to manage production costs so that the business is viable over time.

For Adami (2010), Brazilian citriculture is seen as a profitable activity in the long term, but characterized by the high level of risk. In addition to the common risks as a market for inputs and products and climatic risks, citriculture is influenced by factors such as soil, age, pests, diseases and cultural management. All of these factors affect the profitability of citrus, as they impact on the costs of production, reducing the income expected by the producer.

The dynamics of these variations make the planning of property extremely complex, where the producer must monitor his production costs, manage the activities of the property and at the same time follow the changes of the buyer market. But often the producer cannot quantify his production costs as well as the profit or loss obtained during the harvest.

The Brazilian citrus agroindustrial system is a consolidated and important system for the economic and social development of the country. There is a clear perception that the sector is devoid of definitive organization, a plan and a policy elaborated by all links and for all links (KALAKI; NEVES, 2017). According to Silva and Marques (2015) the agricultural producer, in this case the citrus grower, is faced with uncertainty both in terms of quantity produced, productivity fluctuations per hectare and prices received for the sale of the orange.

The objective of this work is to analyze the impact of production on costs, as well as to evaluate the viability of the implantation of new orchards.

2. THEORETICAL FOUNDATION

Even with the great national production of the fruit, its products and by-products, there are still points in the chain that lack information. For Silva (2016), information on production costs and the economic viability of these investments are not clear and objective. Therefore, it is necessary to prepare economic studies that guarantee the continuation of the expansion of the citrus chain in a sustainable way.

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The cost of production is defined by Matsunaga et al. (1976), as the sum of the values of the productive services of the factors applied in the production, being this value equivalent to the total monetary sacrifice of the firm that produces. For Silva (2016), production costs can be divided into two components: fixed costs and variable costs. The fixed costs do not vary with the increase or decrease of production, since the variable cost varies according to the volume produced.

The activity analysis encompasses the entire production process, from the plant formation phase to the end of the productive cycle. This analysis includes all costs related to production such as: machinery, labor, taxes, diesel oil, electricity, administrative expenses, equipment, improvements, among others (ADAMI, 2010).

The expenses that make up all items of variable costs and fixed costs, which are directly related to the implementation of the activity, are part of the operational cost of production (HORNGREN, 1989). According to Silva (2016), the operational cost is equivalent to the disbursement made for the costing of the activity in a period, that is, the costs incurred during a harvest.

For Silva and Marques (2015), product price fluctuations are causing uncertainty (risk) in agricultural activity. In addition to climate risks, pests and diseases that increasingly impact the cost of production, the citrus farmer faces more price instability than the industry. The orange processing industry is an oligopsonic market structure, that is, with many suppliers (citrus growers) and few demanders (processing industries).

For companies it is very important to measure the risks of an activity, especially the market volatility. According to Adami (2010), investments made in agricultural activity compromise a considerable amount of capital that although there is a probability of return, is subject to partial or total losses. However, there are measures that evaluate these risks as well as assess the feasibility of a project.

According to Adami (2010), the cash flow components that present the greatest variability (risk) are those related to inputs (fertilizers and pesticides), on the cost side; the selling price of the fruit and the productivity of the orange, on the revenue side. These components of the activity's cash flow can affect the profitability of the crop over time.

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According to Zuin and Queiroz (2006), the implementation of a strategic planning becomes fundamental in the search and maintenance of competitiveness in an enterprise, having to count on the participation and commitment of all those involved in the process and sustained by an efficient and clear communication between the managers.

3. MATERIALS AND METHODS

The present work was accompanied by a property located in the municipality of Bauru, in the state of São Paulo (22º 18 '53 "S and 49º 03' 38" W), this municipality has an area of 67,350 hectares, of which 56,062 hectares are belonging to the rural area. The main farms are: Braquiária with 37,291.6 ha, Eucalyptus with 4,011.8 ha and Laranja with 2,293.3 ha (LUPA, 2008).

The area occupied with orange is divided among 38 properties, and even being the third most planted in the municipality is the one that generates the highest production value of R$ 10,124,000.00 against R$ 7,130,900.00 generated by cattle and R$ 8,824. 000.00 of eucalyptus (LUPA, 2008). This shows the importance of citriculture to producing municipalities, generating jobs, raising taxes and moving the local economy.

The property surveyed has an area of 93 hectares and 71.4 hectares are occupied with Orange varieties of Valencia Americana, Pêra Rio and Valencia. The orchards of his property are with an average of 9 years, that is to say, the planting is in production phase. However, the production estimated for the other years was analyzed from other farms of the same owner, with very similar conditions of soil and management.

According to Gitman (2002), Net Present Value (NPV) can be understood as an investment analysis, which discounts the cash flows at a specific rate, referring to the minimum return to be obtained in the project. According to Silva (2016), the investment is considered attractive when the NPV has a value equal to or greater than zero. In situations where this indicator is negative indicate that the return is less than the minimum rate required for the investment, showing that the project is not feasible in the long term.

Another measure used to analyze the feasibility of a project is the Internal Rate of Return (IRR), defined as the discount rate that equals the present value of

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the cash inflows to the project investment (GITMAN, 2002). That is, IRR seeks to synthesize the merits of a project (ROSS et al., 2007). The acceptance or rejection of a given project is defined by comparing the internal rate of return obtained with the minimum profitability required by the company for its investors (SILVA, 2016).

Even if a project proves feasible, the time required to recover the invested capital is undoubtedly a pertinent question for those who wish to make an investment. Payback consists of the time necessary for the capital expenditure to be recovered through the cash benefits (cash flows) promoted by the investment project. Payback is often interpreted as the indicator of the risk level of an investment project. The longer the term, the greater the risk involved in the project (SILVA, 2016).

3.1. Exploratory research

The exploratory research aims to provide greater familiarity with the problem thus making it more explicit. According to Gil (1999), exploratory research has as main purpose to develop, clarify and modify concepts and ideas, in order to formulate more precise problems or searchable hypotheses for later studies.

Exploratory research aims to deepen the knowledge of the researcher on the subject studied. It can be used to facilitate the elaboration of a questionnaire or to serve as a basis for future research, helping to formulate hypotheses, or the more precise formulation of research problems (MATTAR, 2001). According to Cervo and Silva (2006), this form of research establishes criteria, methods and techniques for the elaboration of a research and aims to offer information about its object and guide the formulation of hypotheses.

3.2. Case study

According to Yin (2001), the case study represents an empirical investigation and comprises a comprehensive method, with the logic of planning, collecting and analyzing data. It can include both single and multiple case studies as well as quantitative and qualitative research approaches.

The case study may be understood as exploring a limited system or a case, involving in-depth data collection and multiple sources of information, in a given context. The case can be an event, an activity or even individuals; thus, the notion of a limited system is related to the definition of time and space (CRESWELL, 1998).

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According to Fonseca (2002), for a deeper analysis the case study may follow according to an interpretative perspective, or a pragmatic perspective, that simply aims at presenting a global, as much as possible complete and coherent perspective of the object of study from the researcher's point of view.

3.3. Quantitative analysis

Quantitative research seeks the validation of hypotheses through the use of structured, statistical data, with analysis of a large number of representative cases. It quantifies the data and generalizes the sample results to those interested (MATTAR, 2001). For Richardson (1999), the quantitative research is characterized by the use of quantification, both in the information collection modalities and in the treatment of them by means of statistical techniques.

The quantitative approach is characterized by the formulation of hypotheses, operational definitions of variables, quantification in data collection and information modalities, and use of statistical treatments. The quantitative model establishes hypotheses that demand a relation between cause and effect and supports its conclusions in statistical data, tests and tests. The criteria of scientificity are verification, demonstration, tests and mathematical logic (GRESSLER, 2003).

3.4. Monte Carlo method

According to Nascimento and Zucchi (1997), the probabilistic simulation models had their origin in the Monte Carlo method and are focused on random phenomena, introducing risk analysis, incorporating the environmental variables and, consequently, the elements of inherent uncertainty.

Monte Carlo simulation (MCS), although widely used in project management, gets some exposure in cost management, and is used to promote the quantification of risk and uncertainty levels related to project costs (KWAK; INGALL, 2009). According to Williams (2003), MCS has some advantages over other methods of project analysis that try to incorporate uncertainty, because although there are many analytical approaches to project planning, the problem with these approaches lies in the assumptions required, rendering them unusable in any practical situation.

According to Samanez (2007), the essence of MCS is to simulate ways for the evolution of a phenomenon until an approximation is found that explains it satisfactorily, that is, uncertain situations are simulated to find expected values for

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the unknown variables. According to Yoriyaz (2009), the Monte Carlo technique involves some primary components necessary for any kind of simulation: probability density functions; random number generator; and sampling techniques.

In cost management, the project manager can use MCS to better understand the project budget and estimate the final budget at completion. These estimates are directed toward consolidating a probability distribution of the final cost of the project, with project managers often using this distribution to reserve a project budget reserve to be used when contingency plans are required to respond to events of risk (KWAK; INGALL, 2009).

Thus, a projective financial model using MCS would be converted from a deterministic model, which does not incorporate any probabilistic element, to a stochastic, which incorporates probabilistic components essential for decision making in uncertain environments (OLIVEIRA; MEDEIROS NETO, 2012).

According to Yoriyaz (2009), all Monte Carlo simulation is performed by means of samplings of the probability density functions and the use of cumulative probability functions. These samplings are performed using random numbers, so any computer program that uses the Monte Carlo method requires a random number generator.

It should be emphasized that the analyzed populations should have certain parameters, such as mean and standard deviation, and may present several behaviors such as Normal, Exponential and Uniform, and it is important to note that the samples obtained should be random. For this, a sequence of random numbers must be obtained (GARCIA et al., 2007).

Random number generators are based on mathematical algorithms that generate numbers, whose occurrences follow a randomness, and which simulate the true randomness found in nature. In this sense, the numbers generated by these algorithms are formally called pseudorandom numbers (YORIYAZ, 2009).

In the case of the property studied the project was done considering a period of useful life of the orchards of 15 years. The culture begins its production relatively early, however this production begins to be expressive from the 4 years of age, period known as formation. The implantation of the culture, demand of great volume of investment, needing a long period for the recovery of the same.

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4. RESULTS AND DISCUSSIONS

In a market highly dependent on the juice-producing industries, the producer usually cannot impose the price to be paid for his production, and it is his function to reduce his production cost to the maximum, as well as to seek the increase of productivity by area. As observed by Adami (2010) the producer is a price taker, that is, not influence by the prices that he pays of the inputs, nor, on the prices of his production.

The analyzed property divides its expenditures by cost center, which is the logical and segmented organization of different sectors and activities within the property. The division of sectors and activities by cost center helps to understand in a simplified way where the biggest expenses are located.

Table 1: Production cost referring of the 2015/2016 harvest

Cost center	Value
Labor force	R$ 132.145,20
Machining	R$ 63.715,00
Inputs	R$ 135.160,20
Irrigation	R$ 42.617,60
Outsourced services	R$ 8.863,40
Administration	R$ 41.457,80
Harvest	R$ 312.724,80
TOTAL	R$ 736.684,00

Cost control in a segmented way shows in a simplified way where the most significant production costs are, and is an important source of information for decision making. This type of control allows us to focus on the expenses that have an impact on production, having a larger share of the operational cost of production, which is shown in Graph 1.

As can be seen in the graph above, harvesting is the largest expense in fruit production, accounting for 42% of expenditures, followed by inputs with 18% and labor with 18%. The sum of these three accounts corresponds to 78% of the total cost of production, thus requiring more attention from the producer on the actual expenses with each cost center.

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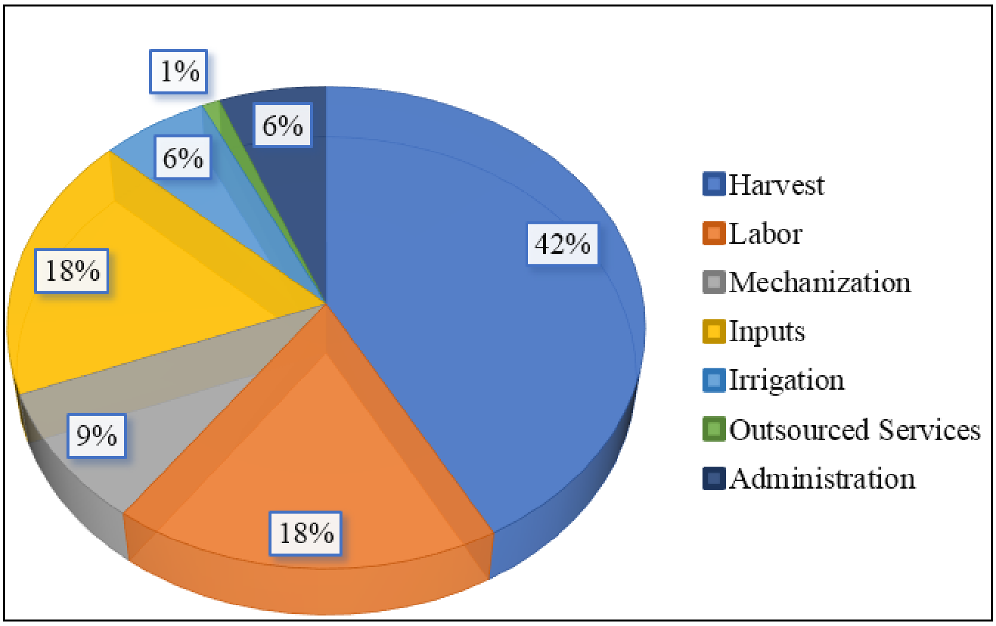

Graph 1: Cost production analysis by cost center

Even with less participation, the costs of mechanization, irrigation, administration and third-party services must also follow a control criterion, in order to ensure that they do not influence negatively the cost of ownership. Especially irrigation, where inadequate management of the system can generate unnecessary expenses with electricity.

The productivity of the property in the 2015/2016 harvest closed with an average of 1231 boxes of 40.8 kg per hectare, far above the average of the citrus belt that closed in 745 boxes of 40.8 kg per hectare (FUNDECITRUS, 2017). This high productivity is due to the use of irrigation as well as management techniques that allows more efficient control of pests and diseases.

With a total cost of R$ 736,684.00, the farm has a cost of R$ 10,317.00 per hectare. The commercialization of orange occurs through boxes of 40.8 kg, where the industry considers this weight as a fruit box. The cost per box is diluted according to the increase in production, and the higher the productivity per area, the higher the revenue per box.

Kalaki (2014) shows that the cost of production per hectare in the year of 2012 was around R$ 9,355.00, of which R$ 3,241.00 of this amount refers to the harvesting and transportation of the fruit, and the rest corresponds to the operating cost. In the case of the property analyzed, the cost with the harvest is the one that

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has the greatest impact within the production, being responsible for 34.64% of the expenses with the crop.

According to Adami (2010), there is great concern in the citrus production sector, because it is believed that it can be a decisive factor for the producer's permanence in the activity. With an average productivity of 1237 boxes per hectare at a cost of R$ 10,315.00, the property has a cost per box of R$ 8.34. The average selling price of the carton in the last two years (2015 and 2016) in the industries of the region of Araraquara was R$ 16.45, obtaining a profit of R$ 8.11 per box.

The Table 2 presents the comparison between productivity and selling price.

Table 2: Selling price vs. Productivity per hectare (revenue per hectare)

Value per box (R$)	**Productivity box/ha**					
	700	**800**	**900**	**1000**	**1100**	**1200**
13	9100	10400	11700	13000	14300	15600
13,5	9450	10800	12150	13500	14850	16200
14	9800	11200	12600	14000	15400	16800
14,5	10150	11600	13050	14500	15950	17400
15	10500	12000	13500	15000	16500	18000
15,5	10850	12400	13950	15500	17050	18600
16	11200	12800	14400	16000	17600	19200
16,5	11550	13200	14850	16500	18150	19800
17	11900	13600	15300	17000	18700	20400

Damage
Point of Equilibrium
Gain

As can be seen in Table 2, productivity and sales price directly influence revenue. However, if the productivity of the property is in the citrus belt average (745 boxes per hectare), the producer will only cover his production costs, with the orange box price at R$ 15.00 remaining at break even.

For the implementation of orchards, it is necessary to acquire machines suitable for the conduction of the plantation throughout the productive cycle. In this initial investment, drip irrigation was also recorded, which was installed immediately after planting the seedlings.

The Table 3 describes the initial investment with equipment.

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Table 3: Investment with machines and irrigation

Item	Quantity	Unit Value (R$)	Total Value(R$)
Tractor 85 HP	2	90.000,00	180.000,00
Bilateral atomiser 4.000 liters	1	47.000,00	47.000,00
Feeding machine	1	40.000,00	40.000,00
Double Splitter 3,2 m	1	29.000,00	29.000,00
Unilateral herbicide bar	1	5.000,00	5.000,00
Sprayer 2000 liters	1	14.500,00	14.500,00
Agricultural trailer 4.000 kg	1	5.800,00	5.800,00
Light utility	1	45.000,00	45.000,00
Irrigation (/ha)	71,4	8.000,00	571.200,00

The producer invested R$ 937,500.00 at the beginning of the project with acquisition of machines and irrigation system, this investment increases what is necessary for the return of the applied capital (Payback). The return on capital is undoubtedly one of the factors that makes investments in culture more difficult, in the current scenario where the great increase of pests and diseases that diminish the useful life of the orchard, besides the instability in the prices received by the fruit box discourages the entrance of new citrus producers.

Because it is a perennial crop, the orange needs time to develop and go into production during this period known in the citriculture as formation, at this stage the plant for not producing in a way means the constant investment in the planting is necessary.

Table 4 below presents the IRR, NPV and Payback indicators in each of the three investment assessment scenarios (Pessimistic, Real and Optimistic).

Table 4: Feasibility indicators in each of the scenarios

	Optimistic	Real	Pessimistic
TIR	18%	16%	14%
VPL	R$ 310.513,63	R$ 98.531,95	-R$ 113.449,59
PAYBACK	6 years	7 years	7 years

The period for the recovery (Payback) of the investment in the Real scenario is 7 years, that is, it takes practically half the useful life of an orchard, so that it acts the return of the invested capital. With the delay in return on investment, and an increasing rate of pests and diseases, citrus farming has become a risky business.

The internal rate of return (IRR) obtained in the Real scenario was 16%, which is only 1% above the minimum calculated rate of 15%. In this case, the investment may not be attractive, leaving the producer waiting for better scenarios to sell his

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production, or the move to the fresh fruit market, which may be more profitable in some cases. In addition, a NPV of R$ 98,531.95 was obtained in the Real scenario, where the project can be considered acceptable, however, the risks present in the cultivation activities should be considered, as they may result in the project not being viable.

In the Optimistic scenario, a revenue increase of 10% was established, which directly interferes with IRR and NPV, making the project more attractive. With the increase in revenue, the period for the recovery of the investment reduces to 6 years, and the internal rate of return rises from 16% to 18%, as well as the NPV that more than triples in relation to the Real scenario, making the investment more attractive for future investors. The 6-year repayment obtained in this scenario significantly reduces the risk in relation to production, in addition to requiring a smaller investment in the training period, where revenue from the sale of production helps to cover expenses with the culture.

In the Pessimistic scenario, with a decrease of 10% of revenue in relation to the Real scenario, the investment with the orange crop proves impracticable, with a IRR of 14%, which is lower than the minimum rate imposed on the project, and with a NPV negative in the amount of R$ 113,449.59. In this case, the project would not be accepted, and the investment should not be made.

It is possible to compare the work of Bruni et al. (1998), where the authors carried out the analysis of three investment projects and obtained NPV of R$ 40,359.49, R$ 49,074.06 and R$ 53,107.61 for projects that presented IRR equivalent to 100.8%, 37.7% and 23.34%, respectively. Thus, it is evident that the cases presented by the authors present a large variation in the IRR, which does not occur in the present work, in which the IRR presented a small amplitude of variation among the three scenarios (of only 4%).

The investment treated in the present work presents an IRR to those provided in the Pagliuca study (2014), where the author obtained IRR indicators of 4.1% and 6.6%, respectively, for small and large-scale production. In the same study, Pagliuca (2014) obtained an NPV of R$ 1,066,164.74 and an IRR of 13.36% for medium-scale production, with an analysis period of 49 months.

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Bendlin et al. (2016) analyzed two forms of investment, reaching a NPV of R$ 3,400.00 and a 40% IRR for the first planting scenario, together with a NPV of R$ 20,193.00 and a 30% IRR for the according to the investment model.

In the study by Alcantara (2017), the author analyzed the orange cultivation carried out by medium producers, where she obtained 0% IRR in scenarios where NPV was negative and, with NPV positive, IRR ranged from 10% to 11%. In addition, Alcantara (2017) also analyzed the case of large producers, where it was verified that the investment proves feasible, because the crop provides a positive NPV and IRR values between 21% and 22%.

In order to analyze in a stochastic way, the feasibility of the investment in question, the Monte Carlo simulation was applied using the values established in each of the scenarios, where they were structured in tabular form for the definition of the input variables of the simulation. According to Rodrigues et al. (2010), the essence of MCS is: to establish a probability distribution (model) that responds to the random variables for the risk analyzed; to simulate events from these variables, with a number of iterations large enough to provide the desired confidence; and to analyze the results obtained statistically.

The software used to run the simulations was *Oracle Crystal Ball*, which acts as an extension of *Microsoft Excel*. According to Damasceno and Couto (2008), a determinant factor for the application of MCS is its number of iterations, which, the larger, favors the convergence of the result to a probability distribution closer to the real. Therefore, it was established that they would be performed 50,000 iterations for the generation of estimates about the investment. According to Souza (2004), this number of iterations is already more than sufficient to allow the results (mean and standard deviation of the output variables) to stabilize and that graphs are provided with a high density of points to be analyzed.

In order to promote the generation of estimates for the analysis of cultivation scenarios in the property analyzed, triangular distributions were defined for each of the project years, starting from the initial investment value and the previously established cash flow projections. The assumptions adopted for the deterministic model were replicated for the stochastic model.

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According to Machado and Ferreira (2012), to consolidate the use of triangular distributions, it is necessary to define three distinct points of distribution for each input variable, that is, to estimate the individual or partial costs or deadlines of the project: the lowest possible value, the most probable value, and the estimated maximum possible value. These three values represent the opinion of the experts and the possible scenarios will be randomly generated based on these estimates.

Table 5 presents the cash flow analysis according to each of the scenarios previously raised. In addition, the table presents the assumptions and forecast cell for MCS application. It is worth mentioning that the forecast cell is characterized by the sum of the investment value and the stipulated cash flows for each of the scenarios, and *Crystal Ball* will generate the random numbers through the defined distributions for the simulation.

Table 5: Disposition of cash flow scenarios for simulation application

	Optimistic	Real	Pessimistic	Simulation
	R$ (937.499,85)	R$ (937.500,00)	R$ (937.500,00)	R$ (937.500,00)
Crop 2017/18	R$ (381.383,10)	R$ (423.759,00)	R$ (466.134,90)	0
Crop 2018/19	R$ (349.135,89)	R$ (387.928,77)	R$ (426.721,64)	0
Crop 2019/20	R$ (99.220,01)	R$ (110.244,46)	R$ (121.268,90)	0
Crop 2020/21	R$ 174.330,53	R$ 158.482,30	R$ 142.634,07	0
Crop 2021/22	R$ 469.929,95	R$ 427.209,05	R$ 384.488,14	0
Crop 2022/23	R$ 666.996,24	R$ 606.360,22	R$ 545.724,19	0
Crop 2023/24	R$ 716.262,81	R$ 651.148,01	R$ 586.033,21	0
Crop 2024/25	R$ 796.687,77	R$ 724.261,61	R$ 651.835,45	0
Crop 2025/26	R$ 766.528,41	R$ 696.844,01	R$ 627.159,61	0
Crop 2026/27	R$ 665.997,21	R$ 605.452,01	R$ 544.906,81	0
Crop 2027/28	R$ 617.729,67	R$ 561.572,42	R$ 505.415,18	0
Crop 2028/29	R$ 567.464,07	R$ 515.876,42	R$ 464.288,78	0
Crop 2029/30	R$ 469.929,95	R$ 427.209,05	R$ 384.488,14	0
Crop 2030/31	R$ 420.663,38	R$ 382.421,26	R$ 344.179,13	0
Crop 2031/32	R$ 322.130,24	R$ 292.845,67	R$ 263.561,10	0
TOTAL	R$ 4.887.411,37	R$ 4.190.249,79	R$ 3.493.088,37	R$ (937.500,00)

According to the Table 5, in the first three years since the investment, the producer continues to invest in the orchard, although the investment decreases in the second year due to the start of production. However, in each scenario, this production starts to be profitable from the fourth year where productivity reaches about 650 boxes per hectare.

Through the application of the simulation and the execution of the interactions with the values raised, the cumulative frequency graph of the total investment project balance, which is presented in Figure 1.

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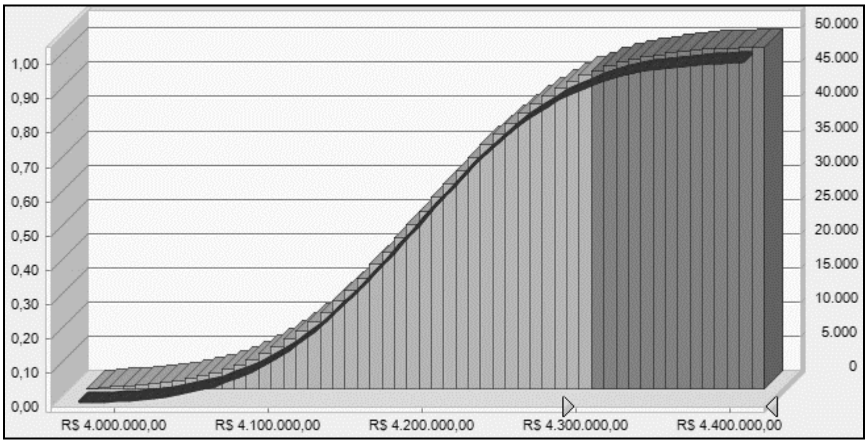

Figure 1: Cumulative frequency graph of the total investment balance

When carrying out the simulation and analyzing the estimates provided, it is necessary to point out that the minimum balance was R$ 3,877,963.15, which is R$ 384,874.78 higher than the sum of the Pessimistic scenario. The maximum balance obtained in the simulation was R$ 4,506,761.17, which is R$ 380,650.20 lower than the sum of the Optimistic scenario. The average balance provided by the simulation was R$ 4,190,252.94, which is only R$ 3.15 higher than the sum of the Real scenario, evidencing a high equivalence in the sample distribution between the input variables and the output variables provided by the stochastic model. In addition, the simulation obtained a standard deviation of R$ 78,525.27 and a median of R$ 4,190,588.75.

Through interval analysis, it was found that the probability of the project being finalized with a total balance above R$ 4,300,000.00 is only 8.1%. In order to analyze another interval for the total balance of the project, the amounts R$ 4,150,000.00 and R$ 4,300,000.00 were defined as being the minimum and the maximum to be portrayed in the cumulative frequency graph represented in Figure 2.

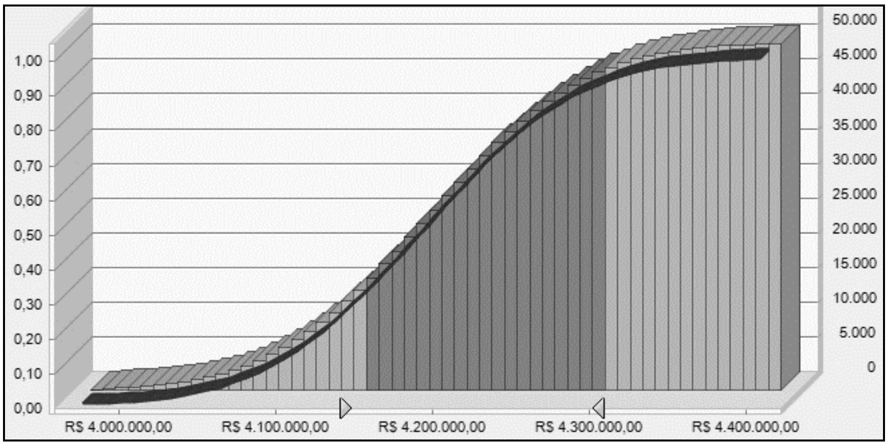

Figure 2: Cumulative frequency graph of the total investment balance

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As shown in Figure 2, the range of R$ 4,150,000.00 and R$ 4,300,000.00 is responsible for 61.4% of the simulation figures, which is an important range to be considered for decision making, considering the high probability of materializing. In this way, it is possible to state that the sum of the 15 triangular distributions exerts a tendency for the total value to be located in a centrally standardized range according to the limits established in the distributions, and the larger the number of iterations, the higher the percentage of output variables located in the central sampling interval.

Table 6 shows the percentiles provided by the simulation, according to the forecast values for the total investment balance.

Table 6: Percentiles of the simulation of the total investment balance

Percentiles	Forecast values
0%	R$ 3.877.963,15
10%	R$ 4.089.526,70
20%	R$ 4.123.661,02
30%	R$ 4.149.004,73
40%	R$ 4.170.395,91
50%	R$ 4.190.588.50
60%	R$ 4.210.382,55
70%	R$ 4.231.559,58
80%	R$ 4.256.263,91
90%	R$ 4.290.832,72
100%	R$ 4.506.761,17

By analyzing the percentiles of the total investment balance, it is possible to investigate the forecast intervals, which complement the estimates provided by the simulation and help in defining parameters about the success and viability of the project. It is clear that the balances defined in the Pessimistic and Optimistic scenarios were not reached in the simulation and consequently are not included in the percentiles intervals, however, they should be regarded as important specifications about the success of the project, since they originate from variables which have individually manageable distributions.

In this way, it is possible to affirm that the probability of the total investment balance reaching the most pessimistic or optimistic indexes within the MCS is 0%. On the other hand, it is worth mentioning that each simulation in *Crystal Ball* will present different output variables and estimates among them, even if they are performed with the same input values.

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5. FINAL CONSIDERATIONS

Orange can be a profitable crop in the long run, especially when high productivity is achieved, and the producer manages to keep his costs low. However, the investment in the crop presents a series of risks to be considered for the decision making in the face of the instability of the price of the orange box in the last years, since the commercialization of the orange occurs in an extremely centralized market.

The orange juice market signals a new phase in which the production chain must pass, as world juice stocks are currently low, and production expectations for the next harvest (2018/2019) are relatively low, which should keep the price of the fruit at levels higher than those found in recent years.

After analyzing the cash flows and the NPV, IRR and Payback indicators in each of the scenarios, it was possible to determine that the investment is attractive only in the real and optimistic scenario, as it would provide a value above the stipulated financial return, besides providing a final balance of nearly R$ 700,000.00 provided in the optimistic scenario, when compared to the Real scenario.

Through the Monte Carlo simulation, it was possible to obtain estimates of the probabilities of viability of investment success, being that the project presents a 61.4% chance of providing a total balance between R$ 4,150,000.00 and R$ 4,300,000.00, being this a decisive indicator for the decision making, considering that it would be the most probable to materialize.

As a suggestion for future works, it is possible to indicate the performance of studies aimed at the economic analysis of the systems of application of fixed rate and variable rate of fertilizers and agrochemicals in the orange crop, comparing multicasts that relate different productive scenarios to the crop comparing their respective operating costs.

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