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## Use of Monte Carlo Simulation for Financial Viability Analysis of Tomato Pomodoro Growing on Agricultural Greenhouse: A Study in the Brazilian Context

<sup>1</sup>Adriana Barbosa de Oliveira, <sup>2</sup>Daiana Cristina Lachowski, <sup>3</sup>Diego Roberto Leal, <sup>4</sup>Anderson Catapan, <sup>5</sup>Luis Carlos Benner, <sup>6</sup>Paulo Fernando Martins, <sup>7</sup>Edilson Antonio Catapan

<sup>1</sup>Pontifícia Universidade Católica do Paraná (PUCPR), Escola de Negócios, Curitiba, Brazil.

<sup>2</sup>Pontifícia Universidade Católica do Paraná (PUCPR), Escola de Negócios, Curitiba, Brazil.

<sup>3</sup>Pontifícia Universidade Católica do Paraná (PUCPR), Escola de Negócios, Curitiba, Brazil.

<sup>4</sup>Universidade Tecnológica Federal do Paraná (UTFPR), Departamento de Gestão e Economia (DAGEE), Curitiba, Brazil.

<sup>5</sup>Pontifícia Universidade Católica do Paraná (PUCPR), Escola de Negócios, Curitiba, Brazil.

<sup>6</sup>Pontifícia Universidade Católica do Paraná (PUCPR), Escola de Negócios, Curitiba, Brazil.

<sup>7</sup>Faculdade das Indústrias (FIEP), Escola de Gestão, São José dos Pinhais, Brazil.

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### ABSTRACT

**Objective:** The aim of this article is to verify the financial viability for the production of tomato pomodoro cultivated in greenhouse with the use of Monte Carlo simulation. **Methodology:** For this, technical visits and interviews were conducted on a small farm producer of this variety of tomato in the city of Colombo, Paraná, Brazil, and the Monte Carlo simulation was used to calculate the viability. **Results:** With this simulation, it was found that  $p(\text{MARR} > \text{IRR}) = p(\text{NPV} < 0) = 0.2676$ , i.e. there is 73.24% chance of generating positive wealth in this project. Also, it was found that if implemented the project, it will be produced 8394 kg of tomatoes more than in the open field growing, resulting in a production increase of 29.38%. **Conclusion:** Based on this, it was found that there is financial viability for the production of tomato pomodoro in agricultural greenhouses.

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## INTRODUCTION

The tomato, according to Page (1988, p.07) is "the growth of one of the most popular vegetables, and is a fruit used as a vegetable. It is one of the few vegetables originated in the American continent, having been discovered in Peru. "Also according to Page (1988, p.8) "[...] the tomato is a perennial vegetable: if time does not reach extreme low temperature and tropical or typical summer conditions remained constant, it will continue to grow for much longer time."

The tomato crop is one of the most important in the consumer's stable according to Folegatti (1999, p. 324) "the tomato is one of the most studied cultures in different markets[...]". In this context, the Brazilian Agricultural Research Corporation-Embrapa (2013) says that "the tomato is one of the main fruits produced in Brazil, hitting the market every year, 1.5 million tons". Also according to Embrapa (2013), the tomato crop is most concentrated in the states of São Paulo, Minas Gerais, Rio Grande do Sul, Rio de Janeiro and Goiás, which account for 80% of the traded volume. However, though on a smaller scale, tomato is grown in other Brazilian states, being estimated that the planted area in the country reaches about 25,000 hectares. The Brazilian average productivity is approximately 50,000 kg per hectare, but there are regions where farmer harvests in reach 90,000 kilograms per hectare.

Thus one has the following research question for this article: is there financial viability for growing of tomato pomodoro in a greenhouse within the Brazilian context?

Within this context, the objective of this work is to verify the financial viability for planting tomato in a greenhouse within the Brazilian context with the use of Monte Carlo simulation. The work is justified since Brazil is today a country with agricultural characteristics (Catapan, Catapan & Catapan, 2011). Thus, studies involving aspects of agriculture are relevant to the development of this country.

**Corresponding Author:** Anderson Catapan, Universidade Tecnológica Federal do Paraná (UTFPR), Departamento de Gestão e Economia, Curitiba, Paraná, Brazil.  
Ph: +5541 99216026; E-mail: andecatapan@yahoo.com.br

This article is divided into three sections, besides this introduction. The following section covers the methodological aspects of the research. Then, the results are presented, and the conclusion is given in the last section.

### **Research Methodology:**

The construction of the article began with a documental research, in which a survey of the general aspects of conventional tomato production was conducted, with data from the plantation system, collected at Chácara Bertolin, located in the city of Colombo, Paraná, Brazil, which produces tomatoes and other legumes for over ten years. This step also approached academic research for collecting the information needed for the research.

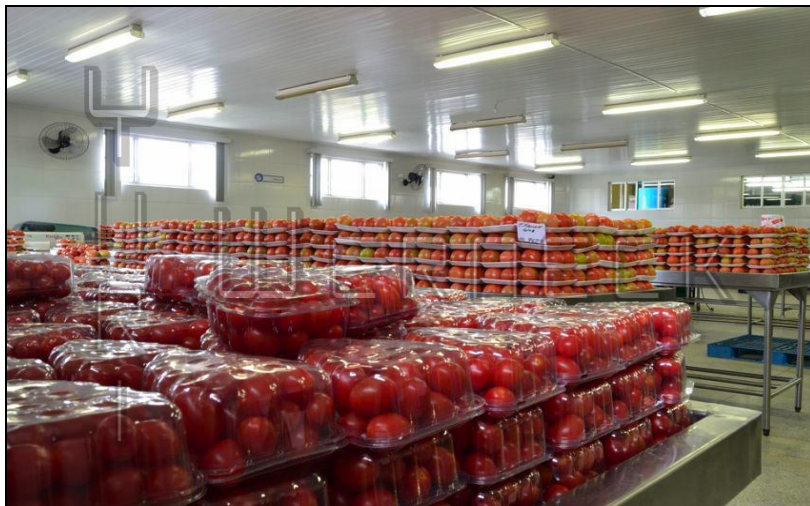
At a second stage, the problems in the production of tomato pomodoro were identified. The identification of these problems was performed by means of unstructured interviews at Chácara Bertolin, and also through academic research.

Then, quantitative data were collected to raise necessary information to calculate the financial feasibility analysis for tomato production in a greenhouse. To calculate the MARR of the project, data on investments in commercial banks from Brazil were searched. Exploratory surveys were conducted to budget the greenhouse implementation expenses. And through unstructured interview sat Chácara Bertolin, the incremental incomeand/ordecremental spending that will exist at the time of agricultural greenhouse implementation were identified.

In possession of all data, the cash flow of the project was designed, the indicators of viability were calculated, and finally, the Monte Carlo simulation was applied. According to Moreira (2010, p. 172), the Monte Carlo simulation "is the artificial generation of values for the variables of interest, with the assistance of random numbers", still according to the author (2010, p, 173) "the numbers are obtained by the so-called random numbers generators. These generators are instruments, tools or procedures, by which random numbers can be determined or selected. Presented methodological issues, the next section shows the results of the research.

### **Results:**

The company object of this case study is called Chácara Bertolin Comércio de Hortifruti Ltda. It was founded inmid-2002, having its greatest growth and expansion in the year2009. With a family structure, it is located in the region of Colombo, State of Paraná, Brazil, and has an area of approximately three hectares. It has been working for more than ten years in the trade of fruits and vegetables in larger tail chains in the region of Curitiba and northern Paraná state. The company trades more than 40 products, including tomato pomodoro, popularly known as Italian tomato, used for sauces, pizza sand salads.



**Fig. 1:** Packaging sector of the company.

Source: the authors, 2014.

The mission of Chácara Bertolin is to provide high quality and taste of each product while main tainingits natural character and an appreciable flavor, providing healthy and tasty foods with the practicality of the products already elected and packed, facilitating the day-to-day lives of its consumers. Their internal processes from the field to the product put on the supermarket chains are performed so that each product has high quality, from the selection of seeds, planting and harvesting.

The products are accompanied by technicians specialized in selecting, packaging and distribution, in order to guarantee satisfaction to consumers. It has a strict, both internal and external quality control, being one of the pioneers in the sector, and in the region of Colombo to obtain traceability of their products. This tracking system occurs with the use of a 2D code. The consultation is done through an application called QR Code that allows the client to decode the 2D code and knowing the origin of the product they consume. Another option is through the consultation of the Chácara Bertolin’s website. At the time when the product reaches the receiving sector of the company, it receives a numeric code that accompanies it until the production sector. After being packed, this numeric code is converted to a 2D code on the label.



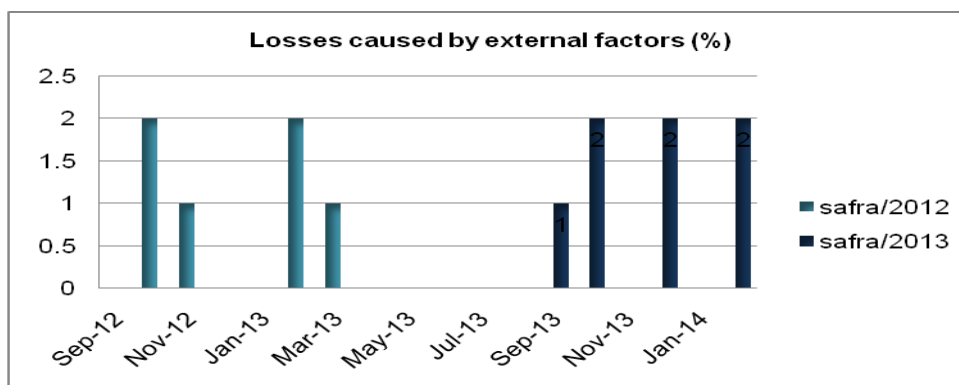
**Fig. 2:** Packed product.  
Source: The authors, 2014.

Chácara Bertolin has the following number of employees with their respective base wages, shown in Table 1.

**Table 1:** Employees of the company.

Sector	Job title	Employees	Base wage
Production	Production assistant	45	R\$ 900,00
Production	Production responsible	2	R\$ 2.000,00
Production	Production manager	1	R\$ 3.500,00
Commercial	Promoters	17	R\$ 1.100,00
Commercial	Sales supervisor	1	R\$ 4.000,00
Commercial	Sales responsible	1	R\$ 2.000,00
Commercial	Driver	6	R\$ 2.000,00
Administrative	General positions	5	R\$ 1.500,00
Planting	Open field	15	R\$ 1.000,00
Planting	Greenhouse	11	R\$ 1.000,00
TOTAL		104	

Source: the authors, 2014.



**Fig. 3:** Planting losses.  
Source: the authors, 2014.

Employee salaries are expressed in Reais (R\$), currency adopted in Brazil. Analyzing Table 1, it is seen that the company has more than one hundred employees of which 47% are concentrated in the area of production, being responsible for the selection and packaging of products, and 24% are in the commercial

sector, responsible for sales, promotion of products and adequate replacement on the shelves. The production in a protected environment was justified by an increased demand for production and sales.

The company has as its main activity the production and distribution of fruits and vegetables. Due to external factors, the farm has difficulties in ensuring the planting in open field. The crop is damaged, leading to product loss, resulting in lack of goods to supply the supermarket chains.

Based on data provided by Chácara Bertolin, it is observed in Figure 3 that the 2013 harvest had a total loss of 6%, related to a plantation of 2,500 plants, resulting in 1% less than in 2012. Typically, the harvest period occurs between the months of September and March, and these losses are caused by diseases or pests. Between the months of April and August, the shortage of the product occurs due to climatic factors.

**Table 2:** Relation of Produced Quantity vs Lost Quantity.

Description	Quantity	Average price	Total
Produced quantity (plants)	2,500		
Quantity in kg	15,000		
Quantity in pack (500gr) - Total	30,000	3.5	105,000.00
Quantity in pack(500gr) - Sold	28,200	3.5	98,700.00
Quantity in pack(500gr) - Lost 6%	1,800	3.5	6,300.00

Source: the authors, 2014.

The damage caused in planting reflects the company's income, as shown in Table 3. In the 2013 harvest, the total production was 30,000 packs, but only 28,200 were in good condition for consumption and could be marketed, causing a loss of R \$ 6,300.00. In contrast, the lack of product causes an increase in the price, benefiting firms that can produce tomatoes during these periods. In a research done by SEABE/PR (Department of Agriculture and Supply of Paraná), in 2013, the tomato was one of the villains of inflation:

The high temperatures of recent weeks, and prolonged drought in almost all Paraná and neighboring states, committed much of the production of horticultural. The reflection that came to manifest at wholesale of Ceasas of Paraná. Out of the 30 main products in Ceasa of Curitiba, 18 showed an increase in prices [...] the high temperatures affected the growth and product quality.

As a result, Table 3 illustrates the increase in the price of products, considering the context of the year 2013 in Brazil.

**Table 3:** Increase in the product prices (2013).

Product	Sale price	Increase (%)
Long-life tomato	60	100%
Italian Tomato	100	100%
Common Potato	65	30%
Zucchini	60	20%
Beet	45	50%
Green pepper	35	75%

Source: SEAB, 2013.

With Table 3, it can be proved that the price rise in 2013 had great impact and as noted, the tomato had a 100% increase.

Due to external factors that harm the production of tomato pomodoro, Chácara Bertolin has difficulties in ensuring production when planting in open field, thus causing financial losses to the company, resulting in low quality of the tomatoes produced. Because of the climatic variation that occurs in the region of Colombo, especially the intense cold in the months from May to August, there is a constant concern with the effects generated by these weather events on production.

This concern is justified by the vulnerability of production in the open field because there is a high incidence of frost, excessive rain, hail, strong winds and high temperatures. Other major concerns in growing tomatoes in open field are pests, diseases and insects.

Other factors hindering the cultivation of tomatoes in open field are pests. According to interviews conducted at Chácara Bertolin, different pests attack the plant at different stages of its development. The production cycle of tomatoes in open field is 6 months, in the first three months there is more risk of pests, diseases and insects, requiring 25 applications of preventive defensive. For the three months following a weekly application will be required, being performed 12 applications during the harvest period, totaling a cost of R \$ 4,514.00. During the production cycle the product is susceptible to insect infestations, diseases and pests. Because of this, it is necessary to treat the planting in stages.

At planting time of tomato, applying preventive defense against the whitefly, aphid and tripods is required. In the first ten days one must fight the caterpillar and in the remaining 170 days must combat late blight, early blight, earworm, fruit borer and bacteria, totaling 37 applications in total production cycle, until the harvest. The price of pesticides used is on average R\$ 122.00.

These costs can range from R \$ 20.00 to R \$ 700.00, the turnover of chemicals used in the spraying is necessary, since this practice prevents pests, diseases and insects of creating resistance to pesticides used. These diseases cause reduction in productivity and product quality, a frequent inspection of the crop and preventive treatment is required, increasing the cost of production of tomato pomodoro.



**Fig. 4:** Early blight and late blight.

Source: SEAB / PR, 2014.

In Figure 4 two diseases that affect most frequently in planting field were illustrated. Another factor that contributes to the damage in conventional plantations in the region of Colombo is the weather. During the year there are various climatic phenomena that affect the tomato crop. Among them are the frosts, excessive rain, hail, wind and excessive heat.

Frosts can occur from late autumn to early spring, with more frequency and intensity in the winter months. The damage it causes is not limited to the volume of production that will be harvested in crops affected, but also the shortage of trade and price fluctuations.

After presenting all the external factors that affect planting in open field and consequently the financial losses that these problems cause to the company, it will be presented a new alternative for planting: an agricultural greenhouse for the production of tomato pomodoro, satisfying the need to ensure the product quality and profitability for the business.

For this project, it will be considered a MARR of 8.77% based on the data of the investment plans offered by Brazilian financial institutions, already discounted the value of income tax in this country, and added a risk premium of 2%.

The budget amount for implementing a greenhouse will be the initial investment of the project and the cash flow along with additional gains of the project, plus the financial expenses. The project will be analyzed for ten years, even a greenhouse having an upper lifetime, it will also not be considered the residual value (suggested replacement of equipment after this time, according to interviews). The project time of 10 years was based on previous work (Catapan *et al*, 2012; Catapan *et al*, 2013; Catapan, Cardoso & Veiga, 2014). Based on the projected cash flow for the project, the return indicators calculated are shown in Table 4.

**Table 4:** Return Indicators.

MARR	8.77%
PV R\$ (NPV)	R\$ 404,259.17
NPV R\$ (PV+(-CF <sub>0</sub> ))	R\$ 269,446.97
NPVa R\$ (payment)	R\$ 41,561.17
BCR (PV/CF <sub>0</sub> )*(-1)	2.99
ROIA % (tax)	11.57%

Source: the authors, 2014.

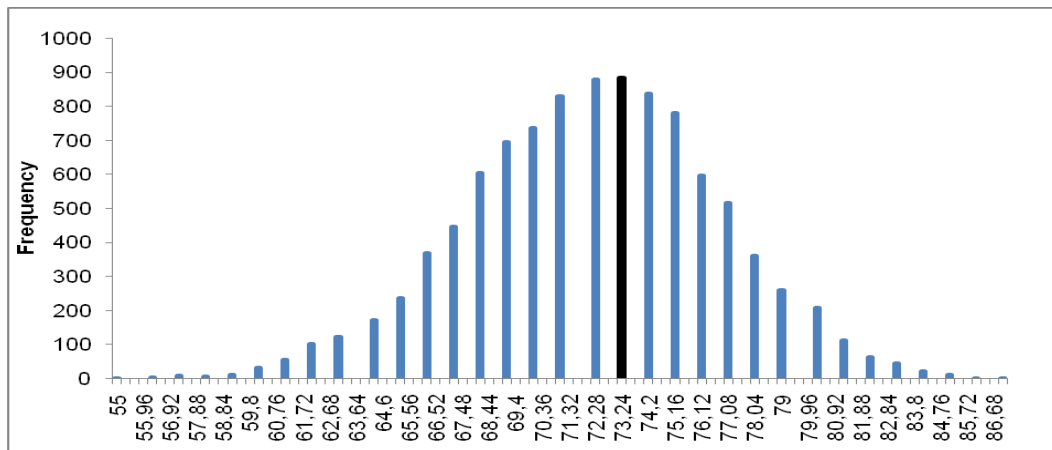
Also, the calculated IRR of the project was 40.10%. After taking there turn indicators, the Monte Carlo simulation was applied, which expresses in a probabilistic manner, a condition of certain event occur starting from random samples.

This simulation was used to verify the probability of the IRR of 40.10% per year, exceed the MARR 8.77% per year. Ten thousand of random conditions were simulated, thus generating a standard deviation of 4.51, amplitude of 32 and an average of 72. Figure 7 expresses the results generated after the inserted condition.

By analyzing Figure 7, it is noticed that the probability of the company to have negative cash generation, is 26.76%, i.e., the probability of the IRR is less than the MARR is 0.2676. Thus the project is demonstrated attractive for investors, given the low risk of prejudice. The Monte Carlo simulation was also used to analyze the increase in production.

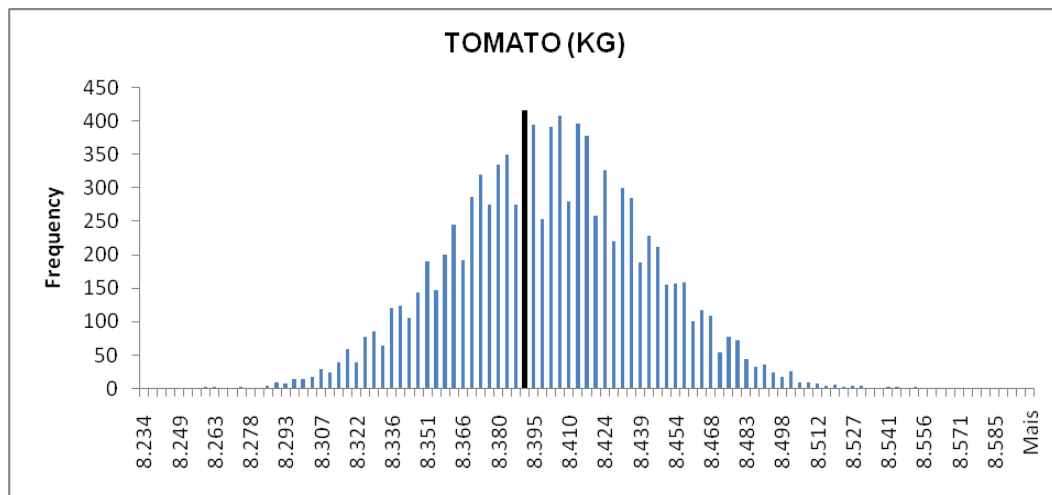
By analyzing Figure 8, it can be stated that the greenhouse will produce 8394 kg of tomatoes more than in the open field production, resulting in a production increase of 29.38%, thus the project will ensure a considerable increase on incomes.





**Fig. 5:** Probability of IRR be superior to MARR.

Source: the authors, 2014.



**Fig. 6:** Production (Kg).

Source: the authors, 2014.

### Conclusion:

The objective of this research has focused on verifying the financial viability for the production of tomato pomodoro variety in a greenhouse, with the use of Monte Carlo simulation. Therefore, the results showed that there is 73.24% of chance that the IRR is greater than the MARR, or the NPV is greater than zero. Thus,  $p(\text{MARR} > \text{IRR}) = p(\text{NPV} < 0) = 0.2676$ , i.e., the risk of losing money on this project is 26.76%.

Also, if one chooses to implement the project under study, 8394 kg of tomatoes more than in open field will be produced, resulting in a production increase of 29.38%. Answering the research question, there is the financial viability for planting tomatoes in greenhouses for the Brazilian context. Also, planting in the greenhouse compared to open field has a higher profitability for the context of the Chácara Bertolin.

This case study reflects the financial viability of the project applied for Chácara Bertolin. Therefore attention should be paid to generalize the results described in this project, one should respect the particularities of each company. Within this context, it is suggested for future work that similar studies be conducted in similar or different business, expanding knowledge in this field of study.

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