Sustainable performance of honey and propolis production in the countryside of the State of São Paulo, Brazil

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Abstract

Beekeeping can be an alternative source of income for family farmers and, thereby, it can help to improve local development in a sustainable way. However, it requires specialized knowledge on technical and productive levels. In this sense, can there be an implementation of a project for the production of honey and propolis that configures a feasible alternative for sustainable rural development? This study aimed to analyze the financial, economic, and risk viability for the implementation of a project focused on beekeeping activity. The research took place in the city of Taquaritinga, in the countryside of the state of São Paulo (Brazil). This work is characterized as a case study with an exploratory approach, carried out through quantitative data from real scenarios (optimistic - 10%) and pessimistic - -10%), through the liquid revenue of a beekeeper. The project analysis used economic viability indicators such as: Net Present Value (NPV), Internal Rate of Return (IRR) and Payback. The financial analysis was carried out through a Cash Flow (CF), a Profitability Index (PI) and a risk analysis via Monte Carlo Simulation (MCS). The results showed that investment in beekeeping is feasible in all scenarios. In the real scenario, net revenue was US$ 1,424.00/year, Pavback 2.1/year, VPL US$ 3,810.62, and IRR 47%; in the pessimistic scenario, net income was $1,219.00, Payback 2.5/year, VPL $2,915.71, and IRR 38%, and in the optimistic scenario, net revenue was $1,628.00/year, Payback 1.9/year, VPL $4,734.26, and IRR 56%.Finally, IP was 1.19. Risk analysis mentioned a level of certainty that the probability occurs in all scenarios greater than 67%, since the results were higher than the Minimum Rate of Attractiveness (MRA).

Keywords: Economic viability. Cash flow. Investment. Scenario analysis. Risk analysis.

1. Introduction

According to Nunes and Heindrickson (2019), beekeeping is a business that is directly related to the creation of bees for the production of honey, wax, propolis extract, pollen, royal jelly, and other derived products. The by-products of beekeeping are considered as natural and functional foods, being increasingly appreciated in Brazil and in the world.

Patel et al. (2021), Klosowki et al. (2020), Niederle and Grisa (2008) Lourenço and Cabral (2016), and Sordi and Schlindwein (2014) mention that beekeeping is an agricultural activity with great potential to generate social, economic, and ecological impacts, providing relevance to national agribusiness aimed at small rural producers. Rambo and Freitas (2019), emphasizes that, the maintenance of the agroecosystemic biodiversity is put in check.

According to Wratten et al. (2017) and Pippinato et. al (2020), honey is a sustainable product by definition, having ecologically friendly characteristics, including biodiversity conservation and pollination. According to the review prepared by Patel et al. (2021), pollination by bees contributes to the growth and diversity of ecosystems related to water, mountains, and forests. Besides, it is useful in monitoring air quality in urban areas, as pollination of urban flora can improve air quality.

In this context, Paula et al. (2016), Sordi and Schlindwein (2014), Niederle and Grisa (2008) and Park and Youn (2012) report that the aforementioned impacts are related to the concept of sustainability: the economic - which generates income for rural producers; the social - which includes people's labor, as well as the reduction of rural exodus; and the ecological - which concerns the pollination of native and planted varieties, with no need to deforest in order to exercise the activity.

Beekeeping offers economic diversity as a source of income, supporting nature-based tourism initiatives, helping to build resilient livelihoods, while potentially providing equal access to economic and natural resources for men and women in rural areas (Patel et al., 2021). Because of this sustainable aspect, producers are able to obtain premium prices for their goods, guaranteeing a higher income and an incentive to remain in agriculture, thus contributing to achieving the goals proposed by the UN Sustainable Development Goals (SDGs).

The seventeen SDGs of the United Nations provide a global vision and consensus for a more sustainable and prosperous future for the planet by the year 2030, which requires tackling a multitude of environmental, economic, social, and institutional challenges (UN, 2015). Further, according to the UN document, social and economic development depends on the sustainable management of the natural resources of the planet, for which it is crucial to conserve and sustainably use oceans and seas, freshwater resources, forests, mountains, and protect biodiversity and ecosystems.

Brazilian agricultural activities cover 5.07 million rural properties, out of which 89% are considered small or medium properties (<100ha) and are responsible for 38% of the gross value of production (GVP). This demonstrates the importance of strategies that contribute to the economic, environmental, and social strengthening of the agricultural sector (IBGE, 2018).

Brazil is among the main producers of honey and derivatives in the world. Beekeeping, as an activity, can be implemented in practically the whole country, as it has favorable conditions for this activity (Khan et al., 2009; Santos and Ribeiro, 2009; Dorneles et al., 2014). Bendlin et al. (2017) reported that the Brazilian national territory has a large area (8.5 million km^2), mostly with wide and diversified vegetation, water, and climate, which, combined, collaborate with the activity of beekeeping.

In this context, the Food and Agriculture Organization of the United Nations (FAO, 2018) mentions that the productive chain of this activity is formed by approximately 300 thousand beekeepers who benefit from this product, generating income for more than 500 thousand families. These numbers classify Brazil in the 9^{th} place in terms of production, with 38.8 thousand tons. However, Silva et al. (2020) stated that Brazil has the capacity to significantly increase this production, thanks to the set of characteristics, including plants and climate, and the disposition of Africanized bees (*Apis mellifera L.*). However, Rambo and Freitas (2019) the territorial perspective of sustainable rural development, proposed by the Brazilian State, involves an integrative vision of spaces, social actors, markets, and public intervention policies.

Furthermore, the survey carried out by Patel et al. (2021) shows that beekeeping has the capacity to contribute to the achievement of 15 of the 17 goals indicated in the SDGs, such as the eradication of poverty and hunger, contribution to the maintenance of health and a healthy lifestyle, achieving sustainable production systems and consumption, entrepreneurship development and gender equality, innovation and building sustainable communities.

According to Lourenço and Cabral (2016), the agricultural projects in this activity have been generating sources of income for the rural population, mainly for small producers, as it needs low initial investment compared to other agricultural activities. Despite the possibility of generating income, many producers have difficulty in identifying/verifying the viability of implementing beekeeping on their property. Niederle and Grisa (2008) affirms that it is essential to perceive development as a question of resources and opportunities for access and maintenance of capital assets.

Souza Junior et al. (2019) define that every agricultural project to be accepted needs to present viability and, for this, producers need support and guidance on how to establish or validate whether a project is viable or not.

The Good Agricultural Practices (GAP) found for this type of work is evidenced by few studies (Khan et al., 2009; Santos and Ribeiro, 2009; Lourenço and Cabral, 2016; Klosowki et al., 2020; Lourenço and Cabral, 2016; Sordi and Schlindwein, 2014; Heindrickson, 2019; Kreuz et al., 2008; Bastidas and Esquerdo, 2021; Dorneles et al., 2014) that concern the beekeeping activity with this financial, economic, and risk bias, at the same time.

Thus, the present study aimed to analyze the financial and economic feasibility, as well as the risk factor for the implementation of a project aimed at beekeeping. For this, it was necessary to map the investments needed to implement this project, by building a projected cash flow and performance indicators that serve as a basis for more accurate and assertive decision-making.

2. Literature Review

2.1. Sustainability

The accumulation of capital funds and their effective investment led to the development of the economy of a region or a country. Reconciling the profitability of organizations with the constraints of preserving the environment, for example, is a challenge. In 1987, the publication of the Brundtland Report by the World Commission on Environment and Development, created by the UN in 1972, established that the need for sustainable development in industrialized countries should meet the needs of the present without compromising the ability of future generations to meet their own needs. In 2015, the UN adopted a new set of Sustainable Development Goals (SDGs) to eradicate poverty, establish socioeconomic inclusion, and protect the environment (UN, 2015).

Thus, one of the great challenges of agricultural production is to satisfy the needs of the present, without compromising the productive capacity of future generations and, consequently, the satisfaction of their needs. Therefore, the management of production factors based on the principle of sustainability must consider the connection of economic, social, and environmental issues.

The notion of sustainable development leads to the necessary redefinition of the relations between human society and nature. Therefore, sustainable development leads to a substantial change in the civilizing process itself. Table 1 shows several concepts about this term.

Table 1: Definitions on sustainability

Author	Definitions
United Nations (1987)	Development that meets the needs of the present without compromising the ability of future generations to meet their own needs.
Sachs (2002)	Dimensions of sustainability include: social, cultural, environmental, ecological, territorial, economic, national, and international policy sustainability.
Jacobi (2007)	The idea of sustainability implies the prevalence of the premise that it is necessary to establish a limitation on the possibilities of growth, as well as define a set of initiatives that consider the existence of relevant and active social partners and participants, through educational practices and an informed dialogue process, which reinforces a sense of responsibility and the constitution of ethical values.
Valinhas (2010)	Sustainability is based mainly on the economic, environmental, and social dimensions. However, without the political dimension, it cannot be built.
Elkington (2012)	Sustainability is defined based on what the so-called Triple Botton Line. Sustainability is composed of three pillars (environmental, social, and economic), without prioritizing one over the other.
Bhinge et al. (2015)	Within the study on the optimization of sustainability for decision-making in the global supply chain, the term sustainability is used as social, environmental, and economic parameters.
United Nations (2015)	Sustainable development recognizes that eradicating poverty in all its forms and dimensions, combatting inequality within and among countries, preserving the planet, creating sustained, inclusive and sustainable economic growth, as well as fostering social inclusion are linked to each other and are interdependent.

Source: Prepared by the authors.

Table 1 showed that the concept of sustainability with an environmental tendency was referenced to by practically all the aforementioned authors. However, in the social sphere, sustainability is concerned with the future of new generations, fearing the attitude that current society has been playing and how consumption influences this scenario.

In the economic sphere, sustainability also appears in all concepts, but not very explicitly in some of them. Goal eight (08) of the SDGs seeks to promote, among other objectives, sustained, inclusive and sustainable economic growth, stimulating policies that support productive activities, sustainable agriculture, entrepreneurship, creativity, and innovation, stimulating the formalization and growth of micro, small, and medium enterprises, including through access to financial services (UN, 2015).

Rahimi et al. (2020), in turn, shows that due to its direct impact on the livelihood of current and future generations, economic sustainability has attracted more attention when compared to other dimensions of sustainability. In this sense, according to a survey carried out by the authors, several criteria are identified to measure economic development, namely: average production costs, productivity, revenue from farm production, revenue generated outside the farm, number of jobs generated, market access, and variety of produced goods.

2.2. Performance indicators economic and financial analysis

Every investor, entrepreneur, or manager needs to measure the economic and financial viability, validating whether a project, business, or activity will bring any return on investment continuing to expand the invested capital (Vian et al., 2019). An analysis provides the basis for the decision-making process related to the investment or raising of capital and its return, showing whether its revenue is possible or not.

For this purpose, Table 2 below shows the conceptual description of: Payback, Internal Rate of Return (IRR); Minimum Attractiveness Rate (MAR); Net Present Value (NPV), and the Profitability Index (PI) (Vian et al., 2019).

Table 2: Financial and economic performance

Indicators	Author Description
Cash Flow (CF)	Araújo et al. (2015), is a financial instrument that makes it possible to monitor the inflows and outflows of financial resources (money) during a specific period, enabling planning and decision-making based on operational activities, sales, application of resources and making of investments. According to Itikawa and Gozer (2017), the CF provides data related to the operational activity of the business, or project, thus allowing the correct decision to be made on paths (behaviors) and strategies that will be developed.
Discounted Payback	Souza Júnior, Baldissera and Bertoloni (2019, p. 257) conceptualize: “Payback as the period of time necessary to recover the invested capital”. For Vian et al. (2019); Amorim et al. (2019), this indicator measures the time it will take for discounted cash flows adjusted by MAR to reach the revenue or not.
Internal Rate of Return (IRR)	Vian et al. (2019); Barbosa and Gimenes (2020) understands that the IRR is the indicator that shows the return on investment during the period. Souza Júnior, Baldissera and Bertoloni (2019) mention that the IRR is a rate that adjusts the NPV to zero, being a percentage that updates a set of future payments/receipts of a project or investment.
Minimum Attractiveness Rate (MAR)	According to Vian et al. (2019), the MAR is the percentage expected by the investor in relation to the capital that will be invested in the project, considering risk, liquidity, and gain. In the view of Souza Júnior, Baldissera and Bertoloni (2019), it is a rate that the investor considers as the minimum return that is wanted with a given investment.
Net Present Value (NPV)	According to Souza Júnior, Baldissera and Bertoloni (2019) and Vian (2019), it is an investment indicator that pinpoints the feasibility of a project, by adjusting the future cash flows of an enterprise through a pre-established MAR. Silva and Fontes (2005); Rosa et al. (2018); Amorim et al. (2019) the NPV can be defined as the algebraic sum of the discounted values of the cash flow associated with it. In other words, it is the difference between the present value of revenues minus the present value of costs.
Profitability Index (PI)	Souza et al. (2012, p. 323) define PI as: “the proportion of gross revenue that constitutes available resources, after covering the total operating cost of production”. Operating profit is divided by gross revenue and multiplied by one hundred. Sabbag, Nicodemo and Oliveira (2013) relate PI to a percentage found in the result that is obtained through the operating profit divided by the gross revenue that must be multiplied by one hundred to determine the percentage value.

Source: Prepared by the authors.

According to Santos et al. (2020), a feasibility analysis through its indicators evaluates the profitability of a project. Its use is essential, since it presents a set of answers about the invested capital. Through answers, in this case, returns that can be desirable or not, pointing out whether the possibilities are viable or not. Furthermore, it has the purpose of making projections of a capital to be invested in one or more projects, as well as its future results.

2.3. Monte Carlo Simulation

Although the Monte Carlo Simulation Method (MCS) formulation is relatively simple and capable of adapting to the analysis of a wide range of problems, regardless of their complexity, this approach has not received overwhelming acceptance when proposed, much due to the excessive computational effort required to conduct the simulations (Papadrakakis and Lagaros, 2002). However, methods of solution and parallel processing have been implemented over the years, thus promoting a positive effect both in the acceptance and in the feasibility of the simulations (Tsompanakis and Papadrakakis, 2004).

Monte Carlo Simulation (MCS) promotes the recursive approximation of a sequence of distributions, since they are used in filtering on state variable models (Alvares et al., 2021). Briefly, the MCS is based on repeated random sampling (Valencia et al., 2013), promoting an approximation of an expected result about a total population, simulating a large new sample based on the input data reported in the computational tool (Giner et al., 2019; Vetter and Vetter, 2019).

Therefore, in the MCS, at each iteration, the result is stored, and, at the end of all interactions (completion of the recursive cycle), a frequency distribution is generated through the sequence of results obtained. This allows the calculation of descriptive statistics, such as: average (expected value), minimum value, maximum value, and standard deviation. Thus, the executor of the simulations would be responsible for devising future scenarios for the operation of the investigated system (Saraiva Júnior et al., 2011).

Although MCS is widely used in project management, it can also be easily adopted in cost management, in order to provide the quantification of the levels of risk and uncertainty related to costs in a given project (Kwak and Ingall, 2009). When used in economic feasibility analysis studies, it is possible to associate the MCS with variables such as CF, for example, in order to calculate the risk of an investment. Based on the variance and covariance matrix of the IRR, it is possible to determine its attractiveness and find an optimal investment index, as shown in the study by Togashi (2018).

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3. Material and Methods

In accordance with the general objective, the present work is exploratory and based on a quantitative analysis. Augusto et al. (2013) establish that this is a scientific research methodology and has significant relevance for decision making in business and projects in general.

For Rosa et al. (2018), the focus of the quantitative method is on the possibility of answering a problem, in which, mathematical or general quantitative methods attested in data capture are used. And for that, the systematic collection of numerical data is made, allowing a systemic and practical view, that is, a modeling is done with the data that are directly linked to the proposed problem. The exploratory method is presented using exact values.

Collection case, an interview was conducted with a rural producer to implement 50 hives in the city of Taquaritinga, which has the following geographical coordinates: latitude 21º24'21 "south and longitude 48º30'18" west, located in the mesoregion of Ribeirão Preto, countryside of the state of São Paulo, Brazil.

Data analysis was initially performed using a (CF). Armed with this information, the entrepreneur can choose alternatives with more quality, guarantee the effectiveness of the business, and obtain a return.

According to Gulart et al. (2017, p. 987), ‘there are several methods that can be used to make an investment analysis via projected Cash Flow (CF)’, which can be: Net Present Value (NPV); Internal Rate of Return (IRR), and the Profitability Index (PI). Together, these indicators, which were used in this article, can guide whether or not a project or business is viable. Thus, it is shown in Equation 1 below:

$$\text{NPV} = \sum_{j=0}^{n} R_j (1+i)^{-j} - \sum_{j=0}^{n} C_j (1+i)^{-j}, \qquad (1)$$

where:

R_j = current revenue value;

C_j = current cost value;

i = interest rate;

j = period in which the revenues or costs occurred, and

n = number of periods or duration of the project.

According to Nardelli and Macedo (2012), a viable project must, therefore, have the NPV > 0. The best alternative is the one with the highest NPV, among those with positive NPV.

This indicator shows a percentage and seeks to reach the expected inputs and outputs in the CF projection, bringing the NPV to zero. It is represented by Equation 2, below:

$$\text{IRR} = I_0 + \sum_{t=1}^{n} \frac{I_t}{(1+K)t} - I_0 + \sum_{t=1}^{n} \frac{FC_t}{(1+K)t}, \quad (2)$$

where:

I_0 = investment amount at zero time;

I_t= estimated amounts of investment at each subsequent moment;

K = annual rate of return equivalent to the period, and

FC = estimated cash inflows in each project life span.

Still according to Nardelli and Macedo (2012), the IRR represents the profitability of the project. Any project that presents an IRR > MAR is viable.

In this case, the value of the Minimum Attractiveness Rate (MAR) used in this article was 3%. This value was compared to the Basic Interest Rate of the Brazilian economy (Selic Interest Rate), based on the values referring to the year 2020 (BRASIL, 2021).

The projected period was five (5) years, from 2019 to 2024. Simple Payback was also used, in order to identify the time required for capital recovery.

Another type of index used was the Profitability Index (PI), which lists the projected net cash benefits over the life of the project, that is, for each monetary unit invested, how much value the company was able to generate. In this case, for the project to be viable, the index must be greater than 1, otherwise, the project should be rejected (Barbosa and Gimenes, 2020). Equation 3 of the PI is represented below:

$$\text{PI} = \frac{\text{Present value of benefits}}{\text{Present value of cash disbursements}}. \quad (3)$$

According to Giner et al. (2019, p. 839) the MCS possible values for the variable of interest are simulated, and then, the average result of the process is obtained in the following manner:

$$a_m = \frac{1}{r}\sum_{i=1}^{n} x_i, \quad (4)$$

where: a_m is the average result of the MCS for the variable of interest a, x is the individual result of each simulated iteration, and n is the number of simulations (iterations). A sufficient number of iterations is necessary to obtain meaningful and reliable results (De Amorim et al. 2020).

In the present article, 50,000 iterations were performed, which is believed to be a relevant value for the problem of interest. It is worth mentioning that the simulations were carried out using the tool Oracle Crystal Ball, which can be understood as an extension (Add-on) for the Microsoft Excel software. As in the study by Silva et al. (2019), Amorim et al. (2018) and De Amorim et al. (2020) triangular distributions were defined for the values (real, optimistic, and pessimistic) of entry in this article.

According to Amorim et al. (2018), the conduct of a MCS must respect the following requirements/steps: Define the variables involved in the systems of interest based on previous data or subjective estimates; Build the frequency distributions (absolute, relative, and accumulated) for each of the defined variables; Define, for each variable considered, the class or rang of incidence of random numbers, based on projected cumulative frequency distributions; Generate random numbers; Assess the random numbers of incidents generated at intervals for each class at each level, and Simulate the experiment.

In the following tables, the variables that were determined for the investment in the production of 50 hives are presented.

Table 3 shows the materials used for beekeeping production, the quantity per unit, their lifespan, residual value in dollars (US$), residual value in percentage, and the depreciation of the materials.

Table 3: Expenses with installation, equipment, and tools (investment) in (US$)

Components	Unit	Amount	Unitary value (US$)	Total value (US$)	Lifespan (years)	Residual value (%)	Residual value (US$)	Annual depreciation (US$)
Complete Beehive with 2 water hoses	unit	50	22.30	1,115.24	5	10%	111.52	22.30
Swarm collection nucleus	unit	5	8.74	43.68	5	10%	4.37	0.87
Easels	unit	50	0.74	37.17	5	10%	3.72	0.74
Knife	unit	1	2.23	2.23	5	10%	0.22	0.04

Ribbon/rubber bands (for collection)	meter	37	0.04	1.38	5	10%	0.14	0.03
N° 24 wire	meter	1	3.72	3.72	5	10%	0.37	0.07
Core transport screen	unit	5	2.60	13.01	5	10%	1.30	0.26
Smoker	unit	1	14.87	14.87	5	10%	1.49	0.30
Overall	unit	1	13.01	13.01	5	10%	1.30	0.26
Boots	pair	1	5.58	5.58	5	10%	0.56	0.11
Broom	unit	1	1.58	1.58	5	10%	0.16	0.03
Gloves	unit	3	0.74	2.23	5	10%	0.22	0.04
Feeder	unit	50	1.30	65.06	5	10%	6.51	1.30
Chisel	unit	1	1.86	1.86	5	10%	0.19	0.04
Nest Transport Screen	unit	50	3.07	153.35	5	10%	15.33	3.07
Queen excluding screen	unit	50	3.35	167.29	5	10%	16.73	3.35
Rustic shed	M²	50	11.15	557.62	30	10%	55.76	1.86
Uncapping fork	unit	2	1.81	3.62	5	10%	0.36	0.07
Extractor centrifuge	unit	1	137.36	137.36	5	10%	13.74	2.75
Stainless steel strainer	unit	1	19.33	19.33	5	10%	1.93	0.39
Stainless steel decanter	unit	1	88.48	88.48	5	10%	8.85	1.77
Plastic bucket	unit	2	1.25	2.51	5	10%	0.25	0.05
Wax Melter (30L)	unit	1	46.47	46.47	5	10%	4.65	0.93
Wax inlay	unit	1	13.01	13.01	5	10%	1.30	0.26
Honeycomb cylinder (manual wax)	unit	1	65.06	65.06	5	10%	6.51	1.30
Plastic water tank	unit	1	7.06	7.06	5	10%	0.71	0.14
TOTAL	-	-	476.71	2,581.77	-	-	258.18	42.34

Source: Prepared by the authors.

Table 3 specifies the operations, the inputs used in the system (in specified quantities) with 10% of residual value and 5 working years, with the exception of the rustic shed that is 30 years old, using the dollar quotation at US$ 5.38.

Table 4 presents the revenues that are the effectively realized gains with the products of the hives.

Table 4: Revenue obtained for the production of honey and propolis

Revenue					
Product	Beehives	Production (Kg)	Total	Value (US$)	Total Value (US$)
Honey	50	35	1750	1.12	1,961.57
Propolis	50	0,2	10	11.15	111.50
		Total			2,063.17

Source: Prepared by the authors.

Each hive produces 35 kilos of honey and 200 grams of propolis per year. The result is superior to the data mentioned by Dorneles (2014), when stating that 80% of beekeepers produce an average of 15 kg/honey/hive/year. However, these same authors mentioned that beekeepers with good handling techniques can produce between 30 and 120 kg/honey/hive/year. Bastidas and Esquerdo (2021) stated that these good management techniques are characterized by the wide network of social relationships between family farmers through empirical knowledge.

4. Results and Discussion

Honey can be sold in bulk for US$ 1.12 a kilo (Kg). The propolis value is around US$ 11.15/kg. The hives produce 1,750 kilos of honey and 10 kilos of propolis annually, yielding a revenue of US$ 2,063.17 (dollar quotation at R$ 5.38).

The MCS evidenced that the level of sensitivity concluded from the real values referring to: the percentage of revenue, profit from honey and propolis and expenses, costs with labor and packaging, was: 93.9%, 0.3%, -5.2%, -0.6%, respectively.

Table 5 shows the cash flow breakdown for the production of honey and propolis over a 5-year period.

Table 5: Cash flow for the production of honey and propolis over a 5-year period in US$

Discrimination	Year 1	Year 2	Year 3	Year 4	Year 5
Investment (depreciation)	-243	-243	-243	-243	-243
Packaging and other costs	-130	-130	-130	-130	-130
Labor costs	-465	-465	-465	-465	-465
Total cost	-838	-838	-838	-838	-838
Gross Revenue	2,063.00	2,063.00	2,063.00	2,063.00	2,063.00
Rural Social Security Contribution Spending (CSSR)	-47.4	-47.4	-47.4	-47.4	-47.4
Net Revenue (Dollar)	1,424.00	1,424.00	1,424.00	1,424.00	1,424.00
0.1% * Net Revenue (Dollar)	204.5	204.5	204.5	204.5	204.5
NET REVENUE -10%	1,219.50	1,219.50	1,219.50	1,219.50	1,219.50
NET REVENUE +10%	1,628.50	1,628.50	1,628.50	1,628.50	1,628.50

Source: Prepared by the authors.

For the analysis of the economic viability of the investment, a Cash Flow (CF) was created, reflecting the values of the inflows and outflows of resources and products.

Table 6: Cash Flow in US$ (dollar quotation at R$ 5.38)

Cash flow							
Year	Inputs	Outputs	Net revenue	Accumulated	Discounted net	VP Inputs	VP Outputs
0	-	-3.021	-3.021	-3.021	3.021	-	-3.021
1	2,063.17	642.40	1,420.77	-315.43	1,291.61	1,875.61	584.00
2	2,063.17	642.40	1,420.77	2,390.14	1705.10	1,705.10	0.00
3	2,063.17	642.40	1,420.77	3,810.92	1067.45	1,550.09	482.64
4	2,063.17	642.40	1,420.77	5,231.69	970.41	1,409.17	438.77
5	2,063.17	642.40	1,420.77	6,652.46	882.19	1,1281	398.88
Total	10,315.86	3,212	7,103.86			7,821.05	1,904.29

Source: Prepared by the authors.

Cash Flow shows that the return on invested capital takes place in the second year, with an outflow of US$ 642.40 per year, and a net revenue amount of US$ 1,420.77 per year. Below, Table 7 shows the real, optimistic, and pessimistic cash flow predictions for the 5-year period.

Table 7: Cash Flow: Real, Optimistic (+ 10%), and Pessimistic (-10%), for a 5-year period

Years	Real CF	Optimistic CF	Pessimistic CF
0	2,581.77	-2,581.77	-2,581.77
1	1,420.77	1,628.50	1,219.50
2	1,420.77	1,628.50	1,219.50
3	1,420.77	1,628.50	1,219.50
4	1,420.77	1,628.50	1,219.50
5	1,420.77	1,628.50	1,219.50
Total	4,522.08	5,561.33	128.388.33
PAYBACK	2,1	1,9	2,5
NPV	3,810.62	4,734.26	2,915,71
IRR	47%	56%	38%

Source: Prepared by the authors.

The results were feasible in all scenarios (real, optimistic, and pessimistic). The IRR result for the real scenario (47%) was higher than the one presented in the work of Kreuz et al. (2008), where 28% was obtained. Although the study pertains to the same sector, it was carried out under different climatic conditions, attractiveness, and production rates.

Another important result is obtained through the analysis of the Profitability Index (PI). This index identifies the return according to the amount invested, being more indicated in a situation of capital restriction. For this reason, many companies use the Profitability Index method, whose objective is to make the NPV relative to the initial investment.

It is adopted as a decision criterion, that if PI ≥ 1, the project is accepted, otherwise, it is rejected. Considering the discount rate equal to 10% per year, there is:

$$\text{PI} = \frac{\sum VP_{ret}}{\sum VP_{inv}} = \frac{3{,}074}{2{,}581} = 1{,}19. \quad (5)$$

Therefore, the PI indicates that the project is viable.

Then, the MCS was performed, making it possible to obtain the graph of profit frequency referring to the real value, represented in Figure 1.

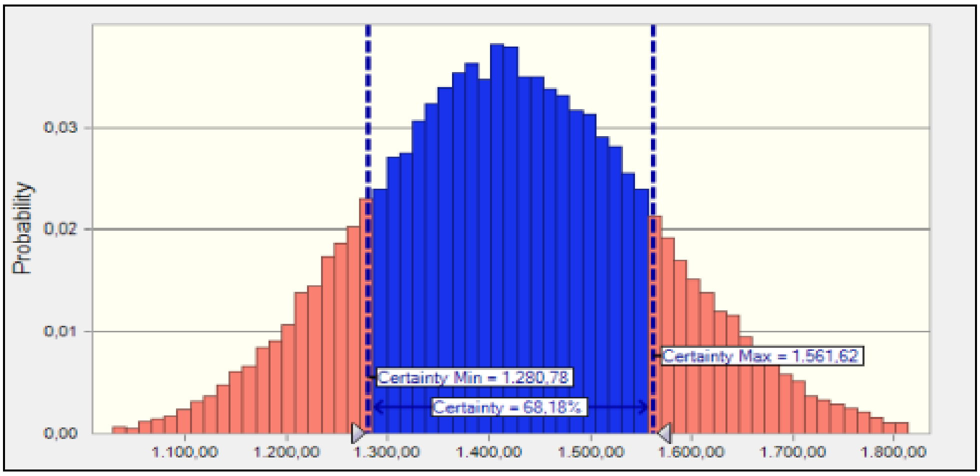

Figure 1: Graph of frequency for the real value of profit (honey and propolis production)
Source: Prepared by the authors.

The results in Figure 1 show that the level of certainty of the beekeeper's probability of making a profit of US$ 1,421.20 was 68.4%. This value is very close to the value of the real cash flow of US$ 1,420.77. The level of certainty is between the minimum values (R$ 1,280.78) and maximum values (R$ 1,561.62).

Regarding statistical values, especially dispersion measures, the standard deviation was US$ 140.42, and the coefficient of variation was 0.0988, a value considered as low dispersion.

Figure 2 shows the MCS, evidenced in the profit frequency graph referring to the optimistic value.

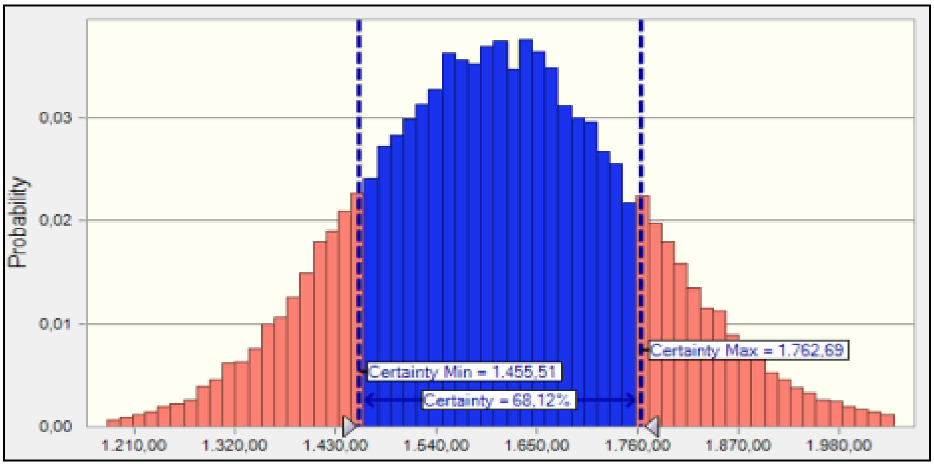

Figure 2: Frequency graph for the optimistic profit value (honey and propolis production)
Source: Prepared by the authors.

The results in Figure 2 show that the level of certainty of the beekeeper's probability of making a profit of US$ 1.609.10 was 68.12%. This value is 13.22% above the expected real FC value (US$ 1,421.20). The level of certainty is between the minimum (US$ 1,455.51) and the maximum (US $ 1,762.69).

Regarding statistical values, especially dispersion measures, the standard deviation was US$ 153.59, which is 9.38% higher than standard deviation of the real simulation. The variation coefficient was 0.0955, a value very close to the real value and was also considered as low dispersion.

Finally, the MCS was performed for the profit frequency graph referring to the pessimistic value, represented in Figure 3.

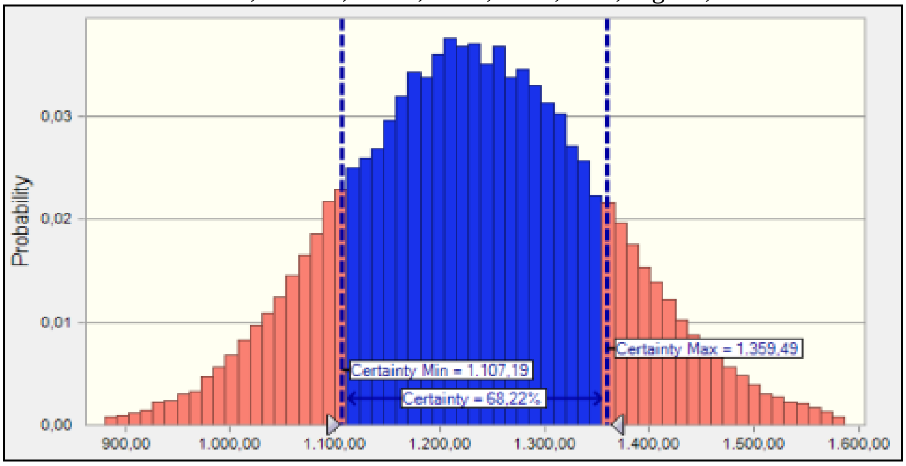

Figure 3: Frequency graph for the pessimistic profit value (honey and propolis production)

Source: Prepared by the authors.

The results in Figure 3 show that the level of certainty for the beekeeper's probability of making a profit of US$ 1,233.34 was 68.22%. This amount was close to the value of the pessimistic cash flow of US$ 1,219.50. The level of certainty is between the minimum values (US$ 1,107.19) and maximum (US$ 1,359.49).

Regarding statistical values, especially dispersion measures, the standard deviation was US $ 126.15. This value was 11.32% lower than the standard deviation of the real values, and 21.75% lower, considering the standard deviation of the optimistic value. The coefficient of variation was 0.1023, a value close to both real and optimistic values, being also considered as low dispersion. Therefore, Rambo and Freitas (2019) emphasizes that, the maintenance of the agroecosystemic biodiversity is put in check.

This conception has its ethical principles and seeks to empirically rescue the relationship between man and nature, which preserves local knowledge, and goes against the supports of conventional agriculture. Corroborating the statement that Cardoso, Lourenzani e Amorim (2020), policies with agricultural subsidies have as one of their features the strengthening of family farming, collaborating with accounting indicators and ensuring food security for people employed in rural and urban areas, through production of the weighty costs of food.

Based on these results, it is possible to state that the research objectives previously defined were achieved, since it was possible to identify that beekeeping is characterized as economically viable for all projections: normal, pessimistic, and optimistic. It was also found that this activity is directly related to the local social services, by contributing to the reduction of rural exodus and consequently, unemployment, thus supporting the local market. Finally, and perhaps most importantly, it is an activity that brings enormous environmental benefits.

5. Conclusions and Recommendations

The results show that the presented project is economically viable in all indexes: NPV, IRR, Payback, and PI, for all proposed scenarios (real, pessimistic, and optimistic).

One of the positive points of this work was the amounts paid for the price of honey and propolis in the Brazilian market and production (revenue) mentioned by the interviewed family farmer, when compared to other studies. However, one of the alternatives to reduce the risks of the activity (less price fluctuation) would be the insertion of honey as a school food in the school lunch of the analyzed municipality.

In this case, the Brazilian National School Feeding Program (PNAE), through Law No. 11,947 of 2009, establishes that 30% of its resources should be destined to the purchase of products from family farming (CARDOSO, LOURENZANI, AMORIM, 2020). Therefore, it can be an option to improve the sustainable local development of this *locus*.

It is important that project planning is carried out to obtain possible results in the short and long term. The results presented in this study show that beekeeping is highly profitable if it is well planned. Beekeeping can encourage the development of new techniques, encourage small rural producers to supplement their income, or even make them into defined supporters of this very promising activity.

Therefore, the analysis of economic and financial sensitivity and risk concluded that, despite being considered an undertaking with little investment, beekeeping provides a good considerable return for family farmers from the countryside of the state of São Paulo (Brazil), proving itself to be a feasible option for income diversification on rural properties.

Thus, it can be said that this work contributes to the knowledge area of activities related to family farming, thus strengthening the PNAE by deepening the understanding of this economic activity through the analysis of its financial aspects. Results lead us to conclude that beekeeping behaves as a low-cost activity with low economic risk since it requires little investment. In the social aspect, it contributes to local development, generating jobs. In the environmental aspect, beekeeping proves to have a remarkably positive impact, thus being an altogether sustainable activity.

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