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Financial feasibility study and innovation in robotic milking

Estudo de viabilidade financeira e inovação na ordenha robótica

Estudio de factibilidad financiera e innovación en ordeño robótico

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Abstract

The study aimed to analyze the financial feasibility of implementing robotic milking on a dairy farm in western Santa Catarina/Brazil. This is a descriptive case study with a qualitative basis using semi-structured interviews. Based on cost measurement for implementation of robotic milking in the period of activity of 2022, a comparative analysis was made of the incremental cash flow relative to a transition from conventional to robotic milking. One of the major findings is that the simple payback time is approximately 4.9 years while the discounted payback period is approximately 5.11 years, considering a MARR of 10% as the expected profit per year. The implementation of robotic milking yields an IRR of 28.79%. It was also found that accounting is an important instrument for planning resources and investments for activities developed in rural settings, thus enabling short and long-term planning.
Keywords: Financial feasibility; Robotic milking; Milk production.

Resumo

O estudo teve como objetivo analisar a viabilidade financeira da implantação da ordenha robótica em uma fazenda leiteira no oeste de Santa Catarina/Brasil. Trata-se de um estudo de caso descritivo de base qualitativa com utilização de entrevistas semiestruturadas. Com base na medição de custos para implantação da ordenha robótica no período de atividade de 2022, foi feita uma análise comparativa do fluxo de caixa incremental relativo à transição da ordenha convencional para a robótica. Uma das principais constatações é que o tempo de retorno simples é de aproximadamente 4,9 anos enquanto o período de retorno descontado é de aproximadamente 5,11 anos, considerando uma TMA de 10% como o lucro esperado por ano. A implementação da ordenha robótica rende uma TIR de 28,79%. Constatou-se também que a contabilidade é um importante instrumento de planejamento de recursos e investimentos para as atividades desenvolvidas no meio rural, possibilitando o planejamento de curto e longo prazo.
Palavras-chave: Viabilidade financeira; Ordenha robótica; Produção de leite.

Resumen

El estudio tuvo como objetivo analizar la viabilidad financiera de la implementación de ordeño robótico en una granja lechera en el oeste de Santa Catarina/Brasil. Se trata de un estudio de caso descriptivo con base cualitativa mediante entrevistas semiestructuradas. Con base en la medición de costos para la implementación del ordeño robótico en el período de actividad de 2022, se realizó un análisis comparativo del flujo de caja incremental en relación con una transición del ordeño convencional al robótico. Uno de los principales hallazgos es que el tiempo de recuperación simple es de aproximadamente 4,9 años, mientras que el período de recuperación descontado es de aproximadamente 5,11 años, considerando una TREMA del 10% como la utilidad esperada por año. La implementación del ordeño robótico arroja una TIR del 28,79%. También se encontró que la contabilidad es un instrumento importante para la planificación de recursos e inversiones para actividades desarrolladas en entornos rurales, lo que permite la planificación a corto y largo plazo.
Palabras clave: Factibilidad financeira; Ordeño robótico; Producción de leche.

1. Introduction

Agribusiness has become one of the most important sectors of the Brazilian national economy and it encourages the growth of other sectors, owing to its share in the Gross Domestic Product (GDP) (Gollo et al., 2019). Information for the year 2020 shows that the agribusiness sector reached the mark of 26.6% of the Brazilian GDP. Monetarily, in 2020, the country's GDP was R$ 7.45 trillion, with agribusiness accounting for almost R$ 2 trillion (Center for Advanced Studies in Applied Economics - Cepea, 2021; Confederation of Agriculture and Livestock of Brazil - Cna, 2021). The Brazilian livestock accounted for 10% of the GDP in 2020, considering the added value in the entire production chain, from primary producers to final customers (Associação Brasileira das Indústrias Exportadoras de Carnes - Abiec, 2021).

In Brazil, milk production is one of the main economic activities in the agricultural sector; it creates thousands of direct or indirect jobs. In addition, it generates billions of reais on a yearly basis and is one of the foods most consumed worldwide (Buss & Duarte, 2011; Manske et. al, 2020; Neto & Lopes, 2014). According to data from the Brazilian Institute of Geography and Statistics (2019), Santa Catarina ranks fifth among milk producers, when compared to the other Brazilian states, with 2.97 million liters/year, i.e., 10% of Brazil's production.

However, given the current economic scenario, numerous factors can affect the performance of Brazilian agribusiness, for example, climate change, neglect of government policies, high costs of equipment, product devaluation in periods of high supply, as well as price increases in periods of scarcity. These factors tend to affect the dairy sector, but especially that of primary production (Buss & Duarte, 2011; Pinheiro et. al.2020).

To remain in a competitive market, given the changes demanded by the new economic context and the problems inherent in the sector, primary producers are supposed to adopt new attitudes towards traditional methods of managing productive resources. Moreover, the use of technologies is essential for greater efficiency in the face of increased consumption of the product, and the need for maintenance and expansion of dairy farming (Buss & Duarte, 2011; Meinl et.al, 2022; Neto & Lopes, 2014; Zanin et. al, 2020).

Associated with new requirements and increased consumption, dairy production becomes more efficient by adhering to the use of technologies, whose purpose is to make life easier for producers and increase productivity (Maculan & Lopes, 2016). For Córdova (2014), the process of implementing the use of technologies began with the adoption of mechanical milking in place of manual milking - a factor that, back then, limited the production of milk on a larger scale and resulted in questionable quality. However, more recently, some of the technologies available in conventional milking machines have been adapted to robotic milking, and computers have become a valuable tool for the modernization of dairy production and an important advance for the development of the robotic milking system.

In this context, amid numerous innovative technologies, milking robots have been gaining momentum in the market (Maculan, 2016). A robot corresponds to a mechanical arm that autonomously performs milking activities (Maculan, 2016), which include: automatic processes of entry and exit of animals; availability of feed during milking; cleaning of the udder and teats; placement and removal of teat liners; recording of production data; diagnosis of mastitis and post-milking teat disinfection without direct human intervention. In short: it is an intelligent system that performs all cow-related activities (Botega et al., 2008; Maculan, 2016).

In the robotic milking system, cows must volunteer. To this end, according to Maculan (2016), the main stimulus for the animals is concentrate feed with good palatability that must be provided at the time of milking. The good functioning of the robot depends on the good management of the owner, since the high number of animals to be milked can cause queues and increase competition at the entrance to the milking site. The great advantage of complete automation in milking is the reduction of employee-related costs, as there is a reduction in the need for labor and greater control of milk quality monitoring (Neto & Lopes, 2014).

Therefore, robotic milking emerges as an alternative to alleviate problems concerning the cost and quality of labor. In addition, it enables adequate and hygienic handling, since it does not require the use of individuals to milk cows, which can be milked at any time of the day or night, according to their needs (Neto & Lopes, 2014). The approach to the theme of innovation in dairy farming refers to the adoption of automation in milk production, reducing human labor and increasing productivity, as well as monitoring the quality of the product (Pereira & Malagolli, 2017).

In view of the above, this article seeks to answer the following research question: is it financially feasible to implement robotic milking on a family-run dairy farm? Therefore, the objective of this work was to analyze the financial viability of implementing robotic milking on a dairy farm in western SC/Brazil.

The present study is relevant because of the topicality of the subject and the high costs of robotization, which call for an analysis of the viability of the business. It is essential to quantify the profitability of the business and identify possible barriers to the production process with a view to increasing production efficiency. These actions can also help farm managers to allocate production factors more adequately and make better plans and decisions (Buss & Duarte, 2011; Salomão et. al. 2020). Moreover, this study is expected to provide further insights into the theme and assist other milk-producing farms in implementing robotization, as substantial investment in equipment is required.

2. Methodology

This study takes a descriptive approach, since it has the purpose of describing the characteristics of a certain group and shedding light on opinions, attitudes and actions of certain cases to provide an overview of the problem. Standardized data collection techniques can be used - for example, questionnaires and systematic observation (Gil, 2010).

In turn, as regards methodological procedures, it is a case study, as it focuses on the study of a single farm and its conclusions are limited to the context of the research object. Data can be collected through interviews, document analysis and observation (Gil, 2010; Yin, 2005). This study was carried out on a small family-run dairy farm in western Santa Catarina, which was chosen because data could be easily retrieved by the researchers.

Data collection used semi-structured interviews with the farm manager and representatives of companies that sell robotic milking systems. Interviews allow researchers not only to define the major research focus, but also to describe social phenomena and explain and understand them thoroughly (Manzini, 2004). In addition, documental collection was used to analyze documents, reports and notes of managers who have information that is relevant to the study, and of the companies that supply the robots. The collection period took place in July 2022. The data on costs, expenses, investment, income and productivity refer to the year 2022.

After the data were collected, they were transcribed and/or tabulated, and then organized in electronic spreadsheets for use as a basis for calculations, measurements of financial viability and financial analysis. The next session presents the analysis and discussion of such data.

3. Results and Discussion

Agriculture grows and develops in different ways, thus generating income, creating jobs and reducing costs. In this way, accounting can help management by means of information, planning, financial analysis, control and decision-making, especially in issues related to cost control, diversification of cultures and comparison of results. Faced with the development of agriculture, producers are supposed to seek modernization by acquiring knowledge not only of agricultural techniques, but also of farm management (Farina et al., 2015). Based on this advance, farm managers who do not use the information produced by accountants in decision-making are not very likely to remain in business.

For a financial analysis of the investment project to be carried out on a farm, the indicators to be selected must provide adequate and useful information for the purpose of decision-making. A financial feasibility analysis shows whether a particular project or activity will bring a return on investment and profit, and it ensures business perpetuation planning (Gollo et al., 2019).

Therefore, based on the data collected, a financial analysis was made to evaluate the feasibility of implementing robots on a farm with a total land area of 57 hectares, of which 10 hectares are used in dairy activities (facilities and pasture area) and 9 hectares for silage production.

On the farm, the following activities are carried out: milk production; swine meat production, and corn silage production. Silage is used as feed for the dairy herd. The workforce in charge of the activities is made up of family members and employees. The family has lived in rural areas for approximately 60 years.

In view of this scenario, making an analysis of project investments is necessary because it can provide the manager with benefits in terms of decision-making. According to the information collected, a complete milking robot, that is, one providing milk quality control, automatic feeder, management software, udder cleaning (pre and post teat dipping), currently costs R$ 1,000, 000.00 (one million reais). An investment of R$ 50,000.00 (fifty thousand reais) is also needed to adapt the current infrastructure, e.g., purchase generators and milk storage tanks. To design the present study, 70 lactating cows were sampled; they make up the farm’s herd, and produce an average of 29 liters of milk per day. The milk is sold at R$ 3.40 per liter.

Thus, first, data on two milking models were collected: conventional milking and robotic milking. A comparative table of both systems was designed to show the differences in production volume, costs, expenses and revenues when the conventional milking method is replaced with the robotic system. For this analysis, an incremental cash flow was organized, defined by Gitman and Zutter (2017) as the additional cash flows - outflows or inflows - expected to result from a proposed capital expenditure.

The analysis of the differences in costs, expenses and revenues of the two milking systems resulted in an incremental cash flow (Table 1), which shows that an initial amount of R$ 850,000.00 of the total capital needs to be invested to implement robotic milking.

Table 1. Incremental Cash Flow Overview.

Incremental Cash Flow R$							
Year	Opening Balance	Inflows	Outflows	Cash Flow	Discounted Cash Flow	Discounted Payback
0	-	-		(850,000.00)	(850,000.00)	(850,000.00)
1	(850,000.00)	161,406.00	(35,943.80)	197,349.80	179,408.91	(670,591.09)
2	(652,650.20)	169,476.30	(39,538.18)	209,014.48	172,739.24	(497,851.85)
3	(443,635.72)	177,950.12	(43,492.00)	221,442.11	166,372.74	331,479.11)
4	(222,193.61)	186,847.62	(47,841.20)	234,688.82	160,295.62	(171,183.49)
5	12,495.21	196,190.00	(52,625.32)	248,815.32	154,494.74	(16,688.76)
6	261,310.53	205,999.50	(57,887.85)	263,887.35	148,957.53	132,268.77
7	525,197.88	216,299.48	(63,676.63)	279,976.11	143,672.01	275,940.79
8	805,173.99	227,114.45	(70,044.30)	297,158.75	138,626.75	414,567.54
9	1,102,332.74	238,470.17	(77,048.73)	315,518.90	133,810.81	548,378.35
10	1,417,851.64	250,393.68	(84,753.60)	335,147.28	129,213.79	677,592.14
11	1,752,998.92	262,913.37	(93,228.96)	356,142.33	124,825.71	802,417.85
12	2,109,141.25	276,059.03	(102,551.86)	378,610.89	120,637.10	923,054.95
13	2,487,752.14	289,861.99	(112,807.04)	402,669.03	116,638.87	1,039,693.82
14	2,890,421.17	304,355.09	(124,087.75)	428,442.83	112,822.39	1,152,516.21
15	3,318,864.00	319,572.84	(136,496.52)	456,069.36	109,179.38	1,261,695.59
16	3,774,933.36	335,551.48	(150,146.17)	485,697.65	105,701.96	1,367,397.55
17	4,260,631.02	352,329.06	(165,160.79)	517,489.85	102,382.61	1,469,780.16
18	4,778,120.86	369,945.51	(181,676.87)	551,622.38	99,214.13	1,568,994.29
19	5,329,743.24	388,442.78	(199,844.56)	588,287.34	96,189.68	1,665,183.97
20	5,918,030.58	407,864.92	(219,829.01)	627,693.93	93,302.70	1,758,486.68

Source: Research data.

This value corresponds to the difference between the amount of BRL 1,730,000.00 for the implementation of the robot and adaptation of the structure, subtracting the amount of BRL 880,000.00 of previously invested capital for conventional milking, which is currently used on the farm. For the robotic system, a period of 5.11 years would be necessary to obtain the financial return for the capital invested, considering the discounted payback.

As shown in Table 1, after the implementation of the robotic system, revenues are expected to increase to R$ 161,406.00 in the first year and expenses are estimated to decrease by R$ 35,943.80 within the same period. These results corroborate the findings of Pacassa et al. (2022); the authors indicate that the implementation of milking robots allows increasing the volume of daily milk production because the animals can have easier access to the equipment, regardless of time of day. Also, the main advantage of implementing the system is the reduction of expenses, especially expenses with labor and animal feed, as animals receive a defined number of supplements per milking. On the other hand, the robotic system generates higher costs of milking inputs and material and maintenance costs, when compared to the traditional system. However, regardless of such situations, it would generate a result of R$ R$ 197,349.80 for the first year of investment.

From the second year onwards (Table 1), increases of 5% and 10% were estimated in inflows in outflows, respectively, as expenses normally increase more than gains. As a result, there was a cash flow (inflows – outflows) of R$172,739.24 and a positive NPV of R$209,014.48 in the year. This means that the investment is still viable in year 2, and it is evidence that R$ 443,635.72 out of the amounts invested will still need to be recovered. This process of analysis is carried out successively over the years of the estimated useful life for the robot (20 years), always considering the previous balance found as the initial balance, thus proving positive results linked to the project.

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However, in addition to incremental flow analysis, an analysis has to be made of the main indicators that can support the process. Among the existing ones, economic and financial viability indicators stand out: Internal Rate of Return (IRR), Minimum Acceptable Rate or Return (MARR), Net Present Value (NPV), Payback, Equivalent Uniform Annual Cost (EUAC), the Profitability Index (PI) and the Additional Return on Investment (ROIA) (Gitman & Zutter, 2017). Table 2 shows the results found for each indicator.

Table 2. Indicators.

Indicators	Results
Minimum Acceptable Rate of Return (MARR)	10% per year
Direct payback	4.9 years
Discounted payback	5.11 years
Net present value (NPV)	R$ 1.758.486,68
Internal Rate of Return (IRR)	28.79%
Equivalent Uniform Annual Cost	R$ 206.551,19
Profitability Index	R$ 3.07
Additional Return on Investment (ROIA)	5.77% per year

Source: Research data.

When one makes an investment, profit is expected. In this way, the MARR for the project was set at 10%, which characterizes the minimum rate that is expected to be received per year by making this investment. This MARR value was also stipulated by the study of Pacassa et al. (2022). The MARR reflects the return expected by the investor on the capital invested, with a percentage rate in a given period (Greca et al., 2014). Table 2 shows that the simple payback will be 4.9 years, while the discounted payback will be 5.11 years and the positive NPV will be R$ 1,758,486.68 at the end of 20 years. These figures demonstrate the feasibility of implementing the robotic system.

By analyzing the discounted payback, which calculates how many periods it will take to cover the capital invested, or even how long it will take to recover the investment - after discounting a rate that investors would have earned if they had invested in another project (Greca et al., 2014), it appears that the invested capital can be recovered in the fifth year, considering the discounted payback and the MARR of 10% per year. From a business point of view, the investment is viable. The data corroborate the study by Pacassa et al. (2022); the authors, used the Monte Carlo System (SMC) and the Economic Feasibility Analysis System of Investment Projects - $AVEPI® (Lima et al., 2017) to perform investment simulations in a robotic system on a farm considering different scenarios. In the worst scenario, they would have a payback within 10 years and in the best scenario, within 5 years. On the other hand, the study of Salfer et al. (2017) reported that a 13-year payback period would be needed for the robotic system to have a positive impact on the invested capital. In the current scenario (2022), the price paid to farmers is more competitive, as it offers better remuneration of the capital invested.

The IRR represents the rate of return that equals the sum of cash flows and the value of the investment (Farina et al., 2015; Greca et al., 2014). In the present study, for calculation of the IRR, the investment recoverability period was considered, as the rate found was 28.79% in 5.11 years (Table 2).

In turn, the NPV showed a positive result of R$ 1,758,486.68 at the end of 20 years. Based on this value, the entire cash flow was discounted and a rate equivalent to the MARR was set at 10%. In this way, the present value refers to the future profits updated to the current value, discounting the amount of R$ 850,000.00 from the initial investment. Thus, after 5.11 years, capital invested begin to return and accumulate, demonstrating the feasibility of the investment.

While NPV concentrates all cash flow values at date zero, in VAUE the representative cash flow of the investment project is transformed into a uniform series. The equivalent annual value (EUAC) is a variation of the NPV that indicates the value of the net benefit for a certain period, in this case, the investment is being evaluated within a period of 20 years, which results in an equivalent annual value of R$ 206,551.19.

The profitability index (PI) shows how much profit is expected for the invested capital, that is, how much additional return can be recovered. For this investment, the PI showed that there will be a return of R $3.07 for every R$ 1.00 invested. This index shows the alternative of the expected profitability for the project for the same period of the MARR, and it will be called ROIA, which in this case proved to be 5.77% per year.

Thus, in view of the current scenario, agriculture will inevitably depend on automation, especially when it comes to the search for improvement in quality and productivity (Pereira & Malagolli, 2017). In addition to the shortage of labor in the countryside, robotic milking may be a solution for milk producers, as it standardizes activities that were previously manual and, therefore, prone to errors (Botega et al., 2008).

Moreover, accounting is an important control instrument for the analysis of results and for the projections of investments in activities/projects developed in rural areas. It enables short and long-term planning, as well as a comparison of the economic results and the financial viability of the investments.

4. Final Considerations

The present study sought to analyze the financial viability of implementing robotic milking on a dairy farm in western Santa Catarina. To achieve the proposed objective, this study was conducted as a descriptive case study with a qualitative approach.

The relevance of the study is evidenced by the main research findings; from the business point of view, for the study farm, the investment is viable under a payback of 5.11 years, and IRR of 28.79%. In addition to the capital invested, robotization offers improvements to the milk production activities, as it is related to a constant cash flow; also, associated with ergonomics, it supports the execution of work activities and leads to an optimization of working conditions owing to the inclusion of technology.

Moreover, in view of the advantages of the robotic milking system, and other technologies on the market, Brazil can become more competitive in the international market, but as long as producers and other players in the production chain seek to improve the milking process in order to increase product quality and food safety. After all, consumers are increasingly demanding and expect the production of healthier foods (Bodenmüller Filho et al., 2010). Achieving a higher level of competitiveness depends on knowledge of the characteristics of the production system, management techniques, and other information that can support technical assistance, leading to improved milk production and higher quality (Bodenmüller Filho et al., 2010; Werncke et al., 2016).

Future studies should look more closely into financial feasibility analysis for implementation of milking robots on farms, seeking to analyze all the tools developed within the dairy industry, and different aspects of this business; for example, the influence of robots on animal feeding and animal behavior; the use of robots to clean the animals' accommodation; and the projection of scenarios to optimize the results. In addition, the present study should be further expanded by using new investment analysis methodologies, as well as risk analysis and inclusion of indicators not presented here.

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