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Innovations in Management and Productivity of the Milk Production Chain in Manduri-SP

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ABSTRACT
This improvement program was implemented in the Manduri region, targeting the dairy cattle production chain. The project aimed to enhance the capabilities of local farmers and municipal agencies, enabling agricultural properties to improve quality and yield by utilizing freely provided program tools. The most significant outcomes were concentrated in Process Productivity Improvements (58.0%), Cost Reduction (24.41%), New Product Development (68.78%), Marketing and Sales (16.0%), and Management Controls (66.87%). At the program's conclusion, the effectiveness of tools such as the Innovation Radar, Mind Map, Improvement Plan, and Ishikawa Diagram was confirmed.

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I. INTRODUCTION

This project aims to provide rural entrepreneurs with specialized professional guidance and tailored support to strengthen their businesses, encourage networking, and foster innovation within the agricultural sector. The properties served by the improvement program are located in the city of Manduri-SP, with an average size of approximately 4 hectares. The primary agricultural activities carried out focus on beef and dairy cattle farming. These production chains are the most prominent in the region, as the dairy production is destined for dairies (SEBRAE, 2020).

The main institutions available in the municipality are Rural Unions, the National Service for Rural Apprenticeship (SENAR), and the Department of Agriculture, which, in alignment with the program, have been driving significant changes in agricultural areas. These changes include maintaining the quality of products to promote the prosperity of rural producers, which directly impacts the development of the city's commerce through its products (MANDURI, 2023).

Maintaining milk quality is essential for small producers, as it directly influences food safety and the commercialization of dairy products. The main guidelines to ensure the quality of milk from small producers, regulated by the Normative Instructions IN No. 76 (BRAZIL, 2018a) and IN No. 77 (BRAZIL, 2018b), both dated November 26, 2018, are: milking hygiene, training and capacity building, disease control, adequate storage, safe transport, quality tests, records and traceability, and technical monitoring. Therefore, it is essential to apply good practices and the provided management tools (LEIRA, 2018).

Thus, the project's objective was to develop, together with farmers and available municipal agencies, the capabilities for these agricultural properties to thrive in quality and yield as they implemented the tools provided free of charge for research purposes.

II. MATERIAL AND METHODS

The program was implemented in the municipality of Manduri-SP, serving 8 properties with a primary focus on dairy cattle farming. Over a 6-month period, from October 2023 to March 2024, 10 meetings (eight individual and two collective) were conducted.

Initially, the Innovation Radar was presented and applied to producers interested in participating in the program. This tool features 5 central dimensions and 21 themes of interest, aiding in the diagnosis and delineation of the enterprise. To complement the Radar Chart, a Mind Map was introduced, providing a schematic representation of potential actions and improvements for a generic rural property.

After identifying areas for improvement (challenges), an Improvement Plan was proposed for each rural property. Similar to an action plan, this tool outlines 'what' to do, along with 'who', 'when', 'how', 'why', and 'cost'. Improvement Plans are management tools that enable the enumeration of various actions in a project and

the monitoring of their progress, with the assignment of deadlines, responsibilities, and means to achieve the proposed goals.

Following the delivery of the Improvement Plan, the Ishikawa Diagram was introduced to producers. This is a graphical tool originating from Quality Management, created by Professor Kaoru Ishikawa, for quality management and control in various processes. In essence, it helps to reflect on the causes and effects of a particular problem and how to prevent it. This tool was used to record gains in milk quality and productivity.

Finally, the Innovation Radar was applied again to measure the T0 and Tf indicators, thereby determining the percentage improvement in the properties' performance across the main dimensions covered by the program.

The collected data were analyzed using descriptive statistics with Microsoft Excel® 2023 and means and standard deviations were reported.

III. RESULTS

The results for Process Productivity Improvement, Cost Reduction, New Products, Marketing and Sales, and Management Controls are presented in Table 1.

As per Table 1, the indicator of process productivity improvement showed an average increase of 58.0% in the properties served by the program. This was due to the producers' commitment to improving the quality of their products, with the main adaptations ranging from the channeling of milk collection, thus providing greater microbiological safety, to improvements in milking areas, disease control, and proper cow feeding.

Table 1: Average Percentage Increase (%) in Key Performance Indicators and Comparative Analysis of the Main Aspects Evaluated in the Rural ALI Program.

Total producers	Productivity Improvement %	Cost Reduction %	New Products %	Marketing and sales %	Management controls %
8	58,0±0,12	24,41±0,02	68,78±0,4	16,0±1,12	66,87±0,32

Means ± standard deviation.

The cost reduction indicator achieved an average reduction of 24.41%, mainly due to producers following the provided tools, such as the Improvement Plan and the Ishikawa Diagram. These tools included indicators for reducing costs, such as the use of compost barn to reduce feed costs, as well as identifying the correct amount of feed for each cow and reducing the number of cattle by prioritizing the most productive ones, thus increasing profits and reducing unnecessary expenses.

Thus, the success in cost reduction observed here corroborates broader trends in the literature, where the adoption of precise, data-driven tools has been shown to enhance economic efficiency in agriculture.

The indicator that showed the highest percentage improvement was new products, with an average of 68.78%, mainly due to the inclusion of other products such as dairy derivatives (cheese and curd) compared exclusively to the initial production, which was raw milk.

Thus, the success achieved with the introduction of new products in this study reflects a broader trend recognized in the literature, where diversification is seen as an effective path for growth and sustainability in the agricultural sector.

The marketing and sales indicator reached an average increase of 16.0%, mainly due to investments in promoting the new products added to the properties, which are likely to attract new customers.

The indicator that achieved the second highest percentage improvement was management controls with an average of 66.87%, this being the indicator that determines the progress of the entire production chain. The main changes resulted from the filling of simple spreadsheets recording cash inflows and outflows, feed consumption per liter of milk produced, identification of cows and the amount of milk produced, as well as the production of dairy derivatives.

IV. DISCUSSION AND CONCLUSION

This result can be compared to findings from studies by authors such as de Oliveira et al. (2020), who also reported significant improvements in agricultural production after the implementation of good management practices and technology. Similarly, the adjustments made to milk collection channels and milking areas in the present study echo the findings of Ornellas et al. (2017), who highlighted the importance of these practices to ensure microbiological safety and productive efficiency in the agricultural sector

This outcome parallels findings by Cittadin et al. (2021), who highlighted significant cost savings in dairy farming through the implementation of targeted management strategies, such as optimizing feed usage and herd size. Similarly, the use of compost barns to lower feed costs aligns with the research of Ferreira and Ribeiro (2022), who demonstrated that sustainable farming practices could lead to substantial financial benefits. Moreover, the focus on identifying the optimal feed amount for each cow and prioritizing the most productive

cattle resonates with the work of Abreu et al. (2023), who emphasized the importance of precision feeding and selective breeding in maximizing profitability.

This significant increase in product diversification is consistent with the findings of Camêlo (2021), who also observed an increase in the profitability of rural properties after the introduction of new dairy products to the portfolio. Similarly, Lima (2023) demonstrated that the addition of higher value-added products, such as artisanal cheeses, can not only increase revenue but also strengthen market competitiveness. Furthermore, the product diversification strategy is aligned with the analysis of Camargo and Soares (2021), who highlighted the importance of innovation in agribusiness to meet market demands and reduce the economic vulnerability of producers.

This growth is in line with the results observed by Leite and Sgarbossa (2021), who also identified that effective promotion of new products can lead to significant increases in sales, especially in local markets. Similarly, Costa et al. (2018) highlights that investing in targeted marketing strategies, such as advertising campaigns and tastings, is crucial for increasing the visibility of differentiated agricultural products, resulting in greater customer loyalty.

Ferronato and Silva (2021) argue that the use of management tools, even simple ones, is fundamental for the sustainable development of agricultural production, reinforcing the idea that strict control of operations is indispensable for long-term success. Therefore, the remarkable progress in the management control indicator in this study is aligned with the existing literature, which underlines the importance of effective management for improving the production chain.

The study had a decisive impact on the development of rural properties in Manduri-SP, proving to be a vital tool for advancing management and productivity on the region's dairy farms. The adoption of innovation tools, while optimizing processes and introducing new products, provides greater diversification and competitiveness in the market. However, it is crucial to recognize that the sustainability of these results depends not only on the initial implementation of these practices but also on the producers' continuous capacity to adapt and maintain them in the face of future challenges, such as economic and climate changes.

Additionally, the reduction of costs, although significant, should be viewed from a critical perspective that considers the potential limitations of this model in the long term. The rigorous control of operations, which has proven effective in improving efficiency, needs to be balanced with an approach that allows for flexibility and continuous innovation. Only in this way can the sustainability of the production chain be truly guaranteed, ensuring that the positive results achieved so far are maintained and expanded in the future, benefiting both farmers and the local economy.

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