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ABC Corte program: sustainable intensification of beef production

Abstract – This study evaluates the main results of the ABC Corte program, which aligns with the 2030 Agenda and COP30 goals for low-carbon agriculture. The program promotes the sustainable intensification of pasture-based beef production through technologies for pasture recovery and management, reducing pressure on new land and contributing to climate change adaptation and greenhouse gas mitigation. In 2024, the intervention yielded significant financial results: a gross margin of R$ 2,666.40 ha^{-1} per year, a benefit-cost ratio of 8.07, an internal rate of return of 203.11%, and a net present value of R$ 27,040,478.40 per production year. In the same year, mean productivity reached 978.22 kg live weight per hectare per year, representing an increase fivefold over the baseline, and 3.7 times above the intensification potential. The Ambitec-Agro system reveals significant positive impacts across animal welfare and health, soil quality, and water use efficiency indicators. The intervention results in an estimated land-saving effect of 4.04 ha for each hectare where it is successfully applied.

Index terms: beef cattle, climate change, pasture, SDG, sustainability.

Programa ABC Corte: intensificação sustentável da produção de carne bovina

Resumo – Este estudo avalia os principais resultados do Programa ABC Corte, o qual se alinha aos objetivos da Agenda 2030 e da COP 30 para uma agricultura de baixo carbono. O programa promove a intensificação sustentável da bovinocultura de corte a pasto com tecnologias de recuperação e manejo de pastagens, reduzindo assim a pressão sobre novas áreas e contribuindo para adaptação às mudanças climáticas e mitigação de gases de efeito estufa. Em 2024, a intervenção gerou resultados financeiros significativos: uma margem bruta de R$ 2.666,40 ha^{-1} por ano, uma relação benefício-custo de 8,07, uma taxa interna de retorno de 203,11% e um valor presente líquido de R$ 27.040.478,40 por ano de produção. No mesmo ano, a produtividade média atingiu 978,22 kg peso vivo por hectare por ano, tendo representado um aumento de cinco vezes em relação à linha de base e de 3,7 vezes acima do potencial de intensificação. O sistema Ambitec-Agro revela impactos positivos nos indicadores de bem-estar e saúde animal, qualidade do solo e eficiência do uso da água. A intervenção resulta em um efeito de "poupa terra" estimado em 4,04 ha para cada hectare onde é aplicada com sucesso.

Termos para indexação: bovinocultura de corte, mudanças climáticas, pastagem, ODS, sustentabilidade.

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Tocantins is a significant state for Brazilian beef cattle production, which is characterized by ranching (Araujo et al., 2023). In 2022, the sector generated a gross production value (GPV) of R$ 5.1 billion, positioning it as the state's second-largest economic activity and accounting for 30% of its total GPV (Brasil, 2022). The state's cattle herd reached 11.3 million animals in 2023, representing approximately 4.7% of the national herd (IBGE, 2023a, 2023b). Despite these figures being modest on a national scale, Tocantins faces considerable environmental challenges related to this activity.

Between 1985 and 2022, Tocantins cleared 4.5 million hectares for pasture conversion, being the fifth-largest contributor to deforestation for this purpose (Mapbiomas, 2023). This area is equivalent to 16.2% of the state's total territory. The mean productivity of traditional systems is expected to remain below the region's agronomic potential, as these systems are characterized by extensive areas of degraded pastures (Feitosa, 2019). In response to this context, Embrapa, in partnership with public and private institutions, launched the ABC Corte program. This sustainable intensification strategy focuses on pasture recovery, GHG emissions reduction, and the promotion of good production practices.

These environmental and productivity challenges underscore the need for a national strategy to promote a more sustainable model of beef cattle production. To address these issues, the Degraded Pasture Recovery Program was created as key component of Plan for Adaptation and Low-Carbon Emission in Agriculture (ABC Plan). As Arantes et al. (2018) highlighted, identifying potential areas for livestock intensification is crucial for the success of public policies such as the ABC Plan. Moreover, the restoration of pastures with low stocking rate in Brazil is essential for reducing greenhouse gas emissions.

The ABC Corte program is an initiative aligned with the principles of low-carbon agriculture, and a part of the Sectoral Plan for Climate Change Mitigation in Agriculture. The program was implemented through Technological Reference Units (URTs) established on selected farms. These units serve as a base for applying and closely monitoring a series of practices, including soil correction and fertilization, strategic feed supplementation, and rotational pasture management.

The ABC Corte program aims to develop and transfer sustainable technologies and practices to beef cattle producers. To achieve this, it fosters collaboration among stakeholders, technicians, and researchers to enhance the productivity and sustainability of livestock production. This integrated effort promotes an innovative and coordinated approach to beef intensification, contributing directly to the Sustainable Development Goals (SDG) (Grise et al., 2023).

The ABC Corte program was launched in 2017, establishing a network of 117 technical units across diverse property profiles in the Brazilian states of Tocantins, Pará, and Mato Grosso. Each of these URTs serves a dual purpose: they function as both a demonstration site and a shared learning platform. This structure fosters technical-scientific exchange among researchers, technicians, and producers.

The impact of ABC Corte program is assessed along three main axes: technical-productive indicators, such as weight gain, stocking rate, and productivity; financial indicators, determined using the Economic Surplus methodology; and environmental and social indicators, assessed using the Ambitec-Agro system. To evaluate the program's technological impact, indicators for each participant are continuously monitored during implementation. At the conclusion of the monitoring cycle, the final values are compared to the baseline to evaluate the changes achieved.

The core of the ABC Corte program assessment is the Ambitec-Agro system, a comprehensive methodology for evaluating the impacts of agriculture technological innovations (Rodrigues et al., 2015). This system enables an integrated approach to assessing the three axes within a rural context, presenting the outcomes of public investments in science and technology development, and raising awareness among researchers and managers about the importance of impact assessment. The system estimates scores that are evaluated comparatively, since they do not represent a fixed scale but rather the degree of impact (positive or negative) on a specific indicator.

Embrapa designed the ABC Corte program to promote sustainable intensification of pasture-based beef cattle production, focusing on degraded pastures recovery and efficient management. The program's objective is to increase animal productivity, thereby reducing the need to clear new land and contributing to mitigate GHG emissions, in line with the ABC+

Plan guidelines (Brasil, 2021). Between 2017 and 2024, technical, financial, socioeconomical, and environmental indicators were monitored in program participants across eight municipalities in Tocantins. The data collected was used to characterize the initial scenario (baseline), the intervention (technology), and the post-intervention period.

The 2017 baseline assessment established a detailed diagnostic based on observations of participants and their production. The participants, who represented properties with extensive or semi-intensive systems, were a sample of the typical technologies used in the studied municipalities. Data were obtained through structured interviews, technical visits, production records, and direct measurements conducted in partnership with extension institutions, cooperatives, private consultants, and producer associations. The first assessment collected technical and financial data. The technical indicators encompassed stocking rate, mean daily gain of herd, productivity, feed supplementation use, paddock subdivision, pasture management, and resource inputs. The financial indicators included production cost, gross margin, and benefit-cost ratio.

The results of the first assessment showed that pasture management systems were predominantly characterized by absence of systematic nitrogen fertilization, limited paddock subdivision, lack of soil correction, and restricted feed supplementation. The mean values for productivity in 2018 (115.2 kg live-weight ha^{-1} yr^{1}), stocking rate (1.6 animal units per hectare), and feed supplementation (below 0.1% of live-weight) were consistent with those typically observed in traditional pasture-based beef cattle systems in Brazil (Arantes et al., 2018).

The ABC Corte program technological intervention focused on improving pasture and animal management. It included the following practices: a mean application of 156.37 kg N ha^{-1} yr^{1} fertilization, soil correction and conservationist management, a mean division of grazing module into eight paddocks, a mean adjustment of stocking rate to 3.88 AU ha^{-1}, a mean feed supplementation of 0.19% of live-weight, and the installation of water troughs and strategic shadings. The intervention also provided training for managers and teams in intensive management. These interventions were adapted to each property's agroecological and socioeconomic conditions, ensuring that a unique intervention model was not imposed to assure technological adoption.

Following the intervention, an increase in key indicators was observed. In 2024, mean productivity reached 978.22 kg live-weight ha^{-1} yr^{-1}, representing a fivefold increase over the baseline and 3.7 times above the intensification potential reported for Brazilian systems (Arantes et al., 2018). The stocking rate rose to 3.88 AU ha^{-1}, surpassing benchmarks (Silva et al., 2017; Pedrosa et al., 2021), and the mean daily gain reached 0.84 kg per animal. Financially, in that year, production costs were reduced by 62% due to lower input prices and improved resource use efficiency. The recorded gross margin was R$ 2,666.40 ha^{-1} yr^{-1}, with a benefit-cost ratio of 8.07, an internal rate of return of 203.11%, and a net present-value of R$ 27,040,478.40 per production year.

In terms of environmental impact, a land-saving effect of 4.04 ha was estimated for each hectare where intervention was successful. The Ambitec-Agro system indicated positive impacts, with particularly high scores in animal welfare and health (9.7), soil quality (6.88), and water use efficiency (8.4). On the social front, improvements were observed in workforce qualification, strengthening of institutional networks, and property valuation, with a mean score of 8.03. These social results were supported by socioeconomic indicators that showed income growth and by technical-productive indicators that confirmed higher productivity and stable production levels despite market fluctuations.

The ABC Corte program's distinctive features include the high production intensification, which surpasses national and international benchmarks (Silva et al., 2017; Arantes et al., 2018; Pedrosa et al., 2021). Other key features are the integration of technical and socioeconomic indicators, the continuous seven-year monitoring, the customization of interventions based on local conditions, and the achievement of significant financial results. These results demonstrate the feasibility and attractiveness of this integrated approach within the contexts and conditions observed in the present study.

The ABC Corte program has demonstrated its capacity to promote significant and sustainable gains in beef cattle production by balancing production efficiency, environmental conservation, and socioeconomic development. However, while the

results are promising, they are limited to the studied sample and should not be extrapolated to other regions without previous analysis. This study's limitations include a geographic scope restricted to properties located in eight municipalities in Tocantins with specific edaphoclimatic conditions, production structures, and socioeconomic contexts. Additionally, the data series spans only seven years, which limits the evaluation of long-term effects, such as the maintenance of productivity levels and the resilience of the systems to extreme climatic variability. Moreover, future studies should address the absence of detailed assessments of local biodiversity, carbon balance, and indirect impacts on related production chains. Despite these limitations, the findings provide a valuable reference for public policies and private strategies aimed at sustainable intensification of livestock production.

Future directions for the ABC Corte program include the expansion to neighboring states, the inclusion of other production systems, the integration of modules for real-time sustainability indicators, and the capacity building for technicians and producers, to effectively support public policies and private investments.

In this context, there are significant opportunities for collaboration and support to advance the program's goals. Research institutions and universities can contribute with complementary studies on biodiversity, carbon dynamics, and agro-environmental modeling. Rural extension agencies and producer collective organizations can expand the technical assistance network and promote the dissemination of best practices. Private sectors related to resource inputs, genetics, and monitoring services can assist in adaptation and diffusion of technology. Finally, international organizations and funding agencies can provide resources and expertise to scale adoption and consolidate ABC Corte program as a tool for the sustainable intensification of beef cattle production in Brazil and beyond.

The following conclusions were obtained in the present study: i, the ABC Corte program intervention yields significant financial results: in 2024 was observed a gross margin of R$ 2,666.40 ha^{-1} yr^{1}, a benefit-cost ratio of 8.07, an internal rate of return of 203.11%, and a net present value of R$ 27,040,478.40 per production year; ii, in 2024, mean productivity reaches 978.22 kg live-weight ha^{-1} yr^{1}, representing a fivefold increase over the baseline, and 3.7 times above the intensification potential; iii, the Ambitec-Agro system reveals significant positive impacts across animal welfare and health, soil quality, and water use efficiency indicators; and iv, the ABC Corte program intervention results in an estimated land-saving effect of 4.04 ha for each hectare where it is successfully applied.

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Data availability statement

Research data are available upon reasonable request to the corresponding author.

Declaration of use of AI technologies

No generative artificial intelligence (AI) was used in this study.

Conflict of interest statement

The authors declare no conflicts of interest.

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