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DETERMINANTS OF THE INTENSITY OF DIGITAL PRECISION TECHNOLOGY ADOPTION IN BRAZILIAN FEEDLOTS

Abstract.

Precision livestock farming has gained prominence as a tool to enhance managerial control and reduce risk in intensive production systems. In the case of Brazilian beef cattle feedlots, characterized by high price volatility, tight margins, and increasing pressure for environmental performance, the adoption of digital technologies represents a relevant strategy to improve decision-making processes. Unlike studies that focus solely on binary adoption (adopt/non-adopt), understanding adoption intensity is essential to capture the degree of digital transformation and its potential effects on competitiveness and sustainability. The objective of this study was to identify the determinants of the intensity of adoption of precision digital technologies among Brazilian beef cattle feedlot operators. Specifically, the analysis examined how structural factors, managerial characteristics, access to information, and commercialization strategies influence the number of digital technologies implemented at the farm level. The empirical analysis was conducted using a negative binomial regression model, appropriate for count-dependent variables and consistent with evidence of overdispersion in the data. The dependent variable corresponds to the number of precision digital technologies adopted by each feedlot. The dataset comprises information from Brazilian feedlots collected between 2020 and 2023, covering different regions of the country and representing a significant share of national production of finished cattle under intensive systems. The explanatory variables were organized into four main groups: (i) structural characteristics (feedlot static capacity and production scale); (ii) manager profile (educational level and experience); (iii) information sources and network connections (consulting services, producer associations, and information exchange with other producers); and (iv) market strategies, including the use of formal contracts in cattle commercialization. The model additionally controls for regional and time effects.The results indicate that larger-scale feedlots exhibit higher intensity of digital technology adoption, suggesting the presence of economies of scale in digitalization. The manager's educational level shows a positive and statistically significant association with adoption intensity, reinforcing the importance of human capital in the

digital transformation process. Access to qualified information sources and the use of formal commercialization contracts were also positively associated with a greater number of technologies adopted. These findings demonstrate that the digitalization of Brazilian feedlots depends not only on structural factors but also on managerial capabilities and integration into information networks, highlighting the relevance of policies and strategies aimed at strengthening human capital and promoting technological diffusion within the sector.

Keywords.
precision livestock farming; adoption intensity; count data regression; beef cattle feedlots.

Introduction

Precision Livestock Farming (PLF) has become an increasingly important component of livestock production systems, enabling improvements in productivity, animal welfare, resource-use efficiency, and environmental sustainability (Berckmans, 2017; Wathes, 2021; González-García et al., 2022). Through the integration of sensors, monitoring devices, automated equipment, and management software, digital technologies provide producers with real-time information that supports decision-making and enhances operational control (Bishop-Hurley et al., 2022; Caja et al., 2022).

The adoption of digital technologies has received growing attention in agricultural research. However, most studies focus on the adoption of individual technologies or binary adoption decisions, providing limited understanding of how producers progressively integrate multiple technologies into their production systems (Rutten et al., 2023). This limitation is particularly relevant in intensive livestock systems, where complementarities among technologies may generate benefits that exceed the effects of isolated adoption decisions (Groher et al., 2020; Palma-Molina et al., 2023).

Brazil is one of the world's leading beef producers and exporters, and feedlot systems have expanded substantially over recent decades as producers seek greater productivity and operational efficiency. Despite the increasing relevance of digital technologies in this context, empirical evidence regarding the factors that influence the intensity of technology adoption in Brazilian feedlots remains limited. Therefore, this study aims to identify the determinants of digital precision technology adoption intensity among Brazilian beef cattle feedlots.

Materials and Methods

Data were obtained through face-to-face interviews conducted between 2020 and 2024 with managers of 447 beef cattle feedlots located across the main cattle-producing regions of Brazil. The survey collected information on farm structure, managerial characteristics, behavioral attributes, perceived production challenges, and technology adoption.

Adoption intensity was measured as the cumulative number of nine precision livestock farming technologies adopted by each feedlot. The explanatory variables included structural characteristics of the production system, managerial and behavioral traits of decision-makers, access to information sources, and perceptions regarding operational and market-related constraints.

Following previous studies that investigated technology adoption intensity in agricultural systems (Kolady et al., 2021; Palma-Molina et al., 2023), a negative binomial regression model was estimated. This approach was considered appropriate because the dependent variable consists of count data and exhibited evidence of overdispersion (Cameron & Trivedi, 2013).

Results and Discussion

The results indicate that digitalization in Brazilian feedlots occurs through the gradual accumulation of complementary technologies rather than through isolated adoption decisions. Most producers adopted between two and five technologies, suggesting that digital transformation is underway but remains heterogeneous across operations.

Among the structural variables, feedlot production capacity was positively associated with adoption intensity. This finding supports previous evidence indicating that larger operations are more likely to adopt digital technologies due to economies of scale, greater access to financial resources, and increased managerial complexity (Gabriel & Gandorfer, 2023; Gargiulo et al., 2018; Mozambani et al., 2023).

Access to consultancy services emerged as one of the strongest determinants of adoption intensity. Producers receiving specialized technical support were significantly more likely to adopt a broader portfolio of technologies. This result is consistent with studies emphasizing the role of advisory services and knowledge-transfer mechanisms in reducing informational barriers and facilitating technological change (Carrer et al., 2022; Makinde et al., 2022).

Behavioral characteristics also played a significant role. More innovative producers exhibited higher adoption intensity, reinforcing findings from previous research that identifies innovativeness as a key driver of technology adoption in agriculture (Mendes et al., 2024; Konstantinos et al., 2025). These producers tend to be more willing to experiment with new technologies and more capable of recognizing their potential benefits.

Interestingly, producers who reported greater difficulties related to input acquisition and understanding market dynamics adopted a larger number of digital technologies. This finding suggests that technological investments may represent adaptive responses to uncertainty. By improving monitoring, information management, and decision support, digital technologies can help producers mitigate operational and market risks, particularly in feedlot systems characterized by high exposure to price volatility and production costs (Chavas & Nauges, 2020).

Conclusion

This study contributes to the literature by examining technology adoption intensity rather than binary adoption decisions, providing a broader perspective on the digital transformation of livestock production systems. The findings demonstrate that adoption intensity in Brazilian feedlots is influenced by a combination of structural characteristics, access to specialized knowledge, managerial experience, behavioral traits, and perceptions of operational challenges.

The results highlight the importance of strengthening technical assistance programs, fostering innovation-oriented environments, and improving producers' access to information networks. For policymakers and industry stakeholders, these findings provide evidence that accelerating digital transformation requires not only improving technology availability but also addressing informational and managerial barriers that constrain adoption. Such efforts may contribute to enhancing the competitiveness, resilience, and sustainability of intensive beef cattle production systems.

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