

Digital Transformation in Brazilian Agribusiness Value Chains: Driving Productivity, ESG Integration, and Regional Economic Resilience

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Abstract

This study examined digital transformation in Brazilian agribusiness value chains with an emphasis on productivity, ESG integration, and regional economic resilience. Specifically, the research investigated how data acquisition and connectivity, as dimensions of digital transformation, influence agribusiness outcomes. A descriptive survey research design was adopted, and data were collected from 161 employees across five selected Brazilian agribusiness firms using a structured questionnaire. The entire population was studied through a census approach, while Pearson product-moment correlation was employed for hypothesis testing at the 0.05 level of significance. Findings revealed that data acquisition has a significant positive relationship with productivity [$p < 0.001$], ESG integration ($r = 0.355$, [$p < 0.001$]), and economic resilience ($r = 0.270$, $p = 0.001$). Similarly, connectivity demonstrated significant positive relationships with productivity ($r = 0.518$, [$p < 0.001$]), ESG integration ($r = 0.301$, [$p < 0.001$]), and economic resilience ($r = 0.192$, $p = 0.012$). These results indicate that digital capabilities enhance operational efficiency, sustainability practices, and adaptive capacity within agribusiness value chains. The study concludes that digital transformation is a critical driver of agribusiness performance and resilience in Brazil. The study recommends increased investment in data analytics infrastructure, improved digital connectivity, workforce digital skills development, and supportive policy frameworks to strengthen agribusiness competitiveness and sustainability.

Keywords: digital transformation; Brazilian agribusiness value chains; data acquisition; connectivity; agribusiness outcomes

1.1 BACKGROUND OF THE STUDY

Digital transformation has become a defining feature of contemporary economic development, reshaping industries, production systems, and global value chains. Historically, productivity growth has been closely linked to technological advancement and efficient resource utilization, which underpin competitiveness and economic expansion (Syverson, 2011). With the emergence of Industry 4.0, the integration of digital technologies such as artificial intelligence, cloud computing, Internet of Things (IoT), and advanced analytics has fundamentally altered organizational operations and interactions within value chains (Kumar et al., 2020; Sousa-Zomer et al., 2020). These technologies enable firms to capture real-time information, automate routine processes, and enhance data-driven decision-making, thereby improving operational efficiency and market responsiveness. Consequently, digital transformation is increasingly regarded as a strategic imperative for organizations seeking to enhance productivity and maintain long-term competitiveness in a rapidly evolving global economy (Peng & Tao, 2022; Pan et al., 2022). Beyond productivity gains, digital transformation is strongly associated with sustainability and responsible business practices. Contemporary research highlights that digital technologies support environmental monitoring, resource optimization, and transparency, which collectively advance corporate social responsibility and environmental stewardship (Lin & Zhang, 2023; Sun et al., 2023). The adoption of digital platforms and blockchain solutions in supply chains has further strengthened traceability and accountability, enabling firms to demonstrate compliance with sustainability standards and stakeholder expectations (Nygaard & Silkoset, 2023).

Moreover, digitalization contributes to improved Environmental, Social, and Governance (ESG) performance by enhancing data availability, strengthening governance mechanisms, and promoting environmentally responsible production systems (Lu et al., 2024). This convergence underscores the growing recognition that digital transformation functions not only as a productivity driver but also as a catalyst for resilient and sustainable economic systems (Pappas et al., 2023). At the value chain level, digital transformation has reconfigured supply chain coordination, information exchange, and innovation dynamics. The proliferation of smart, connected products and digital platforms enables seamless communication among stakeholders, facilitating integrated production and distribution processes (Porter & Heppelmann, 2014). Empirical evidence indicates that digital transformation enhances supply chain resilience through diversification, predictive analytics, and real-time risk management, particularly during disruptions such as pandemics and climate-related shocks (Yin & Ran, 2022). Additionally, data-driven innovation and digital orientation promote organizational learning and adaptive capabilities within value chains, strengthening integration and regional economic stability across developed and emerging economies (Mishra et al., 2022). These developments highlight digital transformation as a key mechanism for improving coordination efficiency and innovation capacity across interconnected production networks.

Agriculture and agribusiness value chains have increasingly embraced digital transformation in response to pressures related to food security, climate variability, and resource efficiency. Digital agriculture initiatives utilize sensors, remote monitoring systems, and precision farming technologies to enhance yield prediction, optimize input utilization, and improve market connectivity, thereby supporting productivity growth across agricultural systems (Ribeiro-Navarrete et al., 2021; Tang & Yang, 2022). Within Latin America, Brazil represents a major agricultural producer and exporter with complex agribusiness value chains encompassing production, processing, logistics, and export activities. Evidence suggests that Industry 4.0 adoption in Brazilian industries fosters organizational learning and performance improvement, indicating substantial potential for agribusiness digitalization (Tortorella et al., 2020). However,

despite increasing policy attention and investment, limited empirical research examines how digital transformation specifically influences agribusiness value chains in Brazil. In this study, digital transformation is operationalized through data acquisition and connectivity, where data acquisition reflects the use of digital tools to generate and analyze operational information, and connectivity represents the digital infrastructure enabling communication and coordination among value chain actors (Luo et al., 2018; Mishra et al., 2022). Collectively, these dimensions capture the technological capabilities necessary for enhancing productivity, ESG alignment, and regional economic resilience within agribusiness ecosystems.

1.2 Statement of the Problem

The expected role of digital transformation within contemporary agribusiness value chains is to promote seamless information flow, improved productivity, integrated sustainability practices, and stronger regional economic resilience. Digital technologies are anticipated to facilitate real-time data acquisition, efficient coordination among value chain actors, and transparent monitoring of environmental and social performance. These capabilities support precision agriculture, optimized logistics, and responsible production systems that align with global ESG standards while enhancing competitiveness and regional development outcomes. In this context, digital transformation represents a strategic pathway for modernizing agribusiness operations and strengthening value chain integration.

However, Brazilian agribusiness value chains continue to experience uneven digital adoption and structural constraints that limit the realization of these benefits. Fragmented digital infrastructure, inconsistent rural connectivity, and limited capacity for systematic data acquisition hinder coordinated decision-making, supply chain transparency, and effective ESG integration. Weak data systems restrict reliable production and environmental monitoring, while connectivity gaps reduce collaboration, knowledge exchange, and timely market responsiveness across dispersed agricultural regions. Without empirical investigation, these challenges may sustain existing knowledge gaps, constrain policy and investment decisions, and weaken the resilience and sustainability of regional agribusiness systems, thereby underscoring the need for focused research in this area.

1.3 Objective of the study

The main objective was to examine Digital Transformation in Brazilian Agribusiness Value Chains: Driving Productivity, ESG Integration, and Regional Economic Resilience. The specific objectives of this study are to:

1. Examine the relationship between data acquisition and productivity in Brazilian agribusiness value chains.
2. Determine the relationship between data acquisition and ESG integration in Brazilian agribusiness value chains.
3. Ascertain the relationship between data acquisition and economic resilience in Brazilian agribusiness value chains.
4. Investigate the relationship between connectivity and productivity in Brazilian agribusiness value chains.
5. Examine the relationship between connectivity and ESG integration in Brazilian agribusiness value chains.
6. Determine the relationship between connectivity and economic resilience in Brazilian agribusiness value chains.

1.4 Hypotheses

The following null hypotheses guided the study:

H01: Data acquisition has no significant relationship with productivity in Brazilian agribusiness value chains.

H02: Data acquisition has no significant relationship with ESG integration in Brazilian agribusiness value chains.

H03: Data acquisition has no significant relationship with economic resilience in Brazilian agribusiness value chains.

H04: Connectivity has no significant relationship with productivity in Brazilian agribusiness value chains.

H05: Connectivity has no significant relationship with ESG integration in Brazilian agribusiness value chains.

H06: Connectivity has no significant relationship with economic resilience in Brazilian agribusiness value chains.

REVIEW OF RELATED LITERATURE

2.1 Conceptual Review

Digital Transformation

Digital transformation has emerged as a central phenomenon shaping contemporary organizational and industrial systems across the globe. It refers to the strategic integration of digital technologies into business processes, operations, and value creation activities to enhance efficiency, innovation, and competitiveness. Recent studies emphasize that digital transformation goes beyond technology adoption to include organizational restructuring, data-driven decision-making, and ecosystem collaboration that collectively improve operational performance and sustainability outcomes (Sousa-Zomer et al., 2020; Pappas et al., 2023). The proliferation of Industry 4.0 technologies, including artificial intelligence, cloud computing, and advanced analytics, has accelerated digital transformation globally by enabling organizations to optimize processes, enhance transparency, and respond effectively to dynamic market conditions (Kumar et al., 2020; Rammer et al., 2022). Consequently, digital transformation has become a critical driver of productivity growth, innovation capability, and sustainable development across sectors. Within the agricultural sector, digital transformation has increasingly influenced production systems, supply chain coordination, and market integration. Globally, agribusiness firms are adopting precision agriculture technologies, digital platforms, and smart logistics systems to enhance productivity and sustainability performance. Empirical evidence indicates that digital transformation improves firm performance, fosters innovation, and supports responsible corporate practices through improved monitoring and stakeholder engagement (Peng & Tao, 2022; Lin & Zhang, 2023). In the Brazilian context, the adoption of Industry 4.0 practices among manufacturing and industrial firms suggests growing readiness for digital integration across value chains, including agribusiness systems that constitute a major pillar of the national economy (Tortorella et al., 2020). This evolving landscape underscores the importance of examining digital transformation within Brazilian agribusiness value chains.

Data Acquisition

Data acquisition represents a fundamental dimension of digital transformation that involves the systematic collection, capture, and processing of operational and environmental data to support informed decision-making. Advances in sensors, Internet of Things (IoT) technologies, remote sensing, and analytics platforms have expanded the capacity of organizations to generate real-time data streams across production and supply chain activities. Scholars argue that data acquisition enables data-driven innovation, enhances operational visibility, and supports predictive analytics that improve efficiency and strategic planning (Mishra et al., 2022; Wen et al., 2022). In agricultural systems, data acquisition plays a vital role in precision farming by enabling monitoring of soil conditions, crop health, weather patterns, and resource utilization, thereby optimizing productivity and environmental performance. Moreover, data acquisition contributes significantly to sustainability management and ESG reporting by providing reliable information for performance assessment and accountability.

Connectivity

Connectivity constitutes another core element of digital transformation, referring to the technological infrastructure and digital networks that enable seamless communication, data exchange, and coordination among value chain actors. The expansion of broadband, mobile networks, cloud platforms, and digital ecosystems has significantly improved organizational connectivity, allowing firms to integrate operations, collaborate with partners, and access distributed information resources (Luo et al., 2018; Wu et al., 2021). Connectivity enhances supply chain integration by facilitating real-time information sharing, improving coordination efficiency, and reducing transaction costs across geographically dispersed operations. These capabilities are particularly relevant in agribusiness, where production, processing, and distribution activities are spatially distributed. Furthermore, connectivity strengthens resilience and sustainability within supply chains by enabling adaptive responses to disruptions and supporting collaborative innovation. Studies show that digital connectivity contributes to supply chain resilience through enhanced coordination, diversification, and risk management capabilities (Yin & Ran, 2022).

Brazilian Agribusiness Value Chains

Agribusiness value chains encompass the interconnected activities involved in agricultural production, processing, distribution, and consumption, linking upstream input suppliers, producers, processors, distributors, and consumers. Globally, value chain approaches have gained prominence as mechanisms for enhancing efficiency, competitiveness, and sustainability across agricultural systems. Digital technologies have transformed agribusiness value chains by enabling traceability, smart logistics, and integrated production systems that improve coordination and value creation (Saber et al., 2019; Kurniawan et al., 2021). These developments reflect a broader transition toward digitally enabled agricultural ecosystems characterized by data-driven management and collaborative networks. Brazil represents one of the world's largest agribusiness economies, with value chains spanning diverse commodities such as soybeans, coffee, beef, and sugarcane. The scale and geographic diversity of Brazilian agriculture create both opportunities and challenges for value chain digitalization.

Productivity

Productivity refers to the efficiency with which inputs are transformed into outputs and has long been recognized as a central determinant of economic growth and organizational competitiveness. Classical productivity theory emphasizes the role of technological progress, innovation, and organizational capability in driving improvements in total factor productivity (Syverson, 2011).

In the digital era, digital technologies have emerged as key productivity drivers by automating processes, enhancing decision-making, and facilitating innovation across industries. Empirical studies demonstrate that digital economy development and digital transformation significantly contribute to productivity growth through efficiency gains and innovation spillovers (Pan et al., 2022; Zhai et al., 2022). Within agribusiness value chains, productivity improvements are critical for meeting global food demand while ensuring sustainable resource utilization. Digital tools such as precision agriculture technologies, smart machinery, and digital platforms enhance productivity by optimizing input usage, reducing waste, and improving operational coordination.

ESG Integration

ESG integration refers to the incorporation of environmental, social, and governance considerations into organizational strategies, operations, and performance evaluation frameworks. The growing emphasis on sustainability, stakeholder accountability, and responsible business practices has elevated ESG integration as a strategic priority for firms globally. Digital transformation has been identified as a catalyst for ESG integration by enhancing transparency, enabling environmental monitoring, and facilitating stakeholder engagement through digital platforms (Lu et al., 2024; Lin & Zhang, 2023). These capabilities allow organizations to track sustainability performance, improve reporting accuracy, and strengthen compliance with regulatory and market expectations.

Economic Resilience

Economic resilience refers to the capacity of systems, organizations, or regions to withstand, adapt to, and recover from economic shocks and disruptions while maintaining functional stability. In recent years, global crises such as pandemics, climate change impacts, and supply chain disruptions have intensified scholarly attention to resilience as a strategic capability. Digital transformation contributes to economic resilience by enhancing adaptive capacity, enabling real-time information access, and facilitating flexible operational responses (Tang & Yang, 2022; Wu et al., 2022). These capabilities allow organizations to anticipate risks, maintain continuity, and recover more effectively from disruptions. Within agribusiness value chains, economic resilience is closely linked to supply chain stability, market access, and adaptive production systems. Digital technologies enhance resilience by supporting diversified supply networks, predictive analytics, and coordinated response mechanisms across value chain actors (Yin & Ran, 2022).

2.2 Theoretical Framework

This study is anchored on the Dynamic Capabilities Theory, originally proposed by Teece, Pisano, and Shuen (1997) and subsequently extended by Teece (2007, 2018) and other contributors who emphasized organizational ability to integrate, build, and reconfigure internal and external competencies in response to rapidly changing environments. The theory posits that firms achieve sustained performance and competitiveness not merely through possession of resources but through their capacity to sense opportunities, seize them, and transform operational structures accordingly. Later scholarly contributions highlighted the relevance of dynamic capabilities within digitally evolving environments, where technological adoption, innovation, and strategic reconfiguration enable organizations to remain competitive and resilient amid uncertainty. Thus, the theory provides a robust foundation for examining how digital transformation capabilities can influence value creation and adaptive performance in contemporary industries. The Dynamic Capabilities Theory contributes directly to this study by explaining how data acquisition and connectivity function as digital capabilities that enable Brazilian agribusiness value chain actors to reconfigure processes, enhance coordination, and respond effectively to market and environmental pressures. Through improved sensing (via data acquisition) and integration (via connectivity), agribusiness firms can enhance productivity, support ESG integration, and

strengthen regional economic resilience. Consequently, the theory offers an explanatory lens for understanding how digital transformation serves as a strategic capability that drives performance outcomes across complex agribusiness value chains. By grounding the study within this theoretical perspective, the research establishes a conceptual basis for analyzing the role of digital capabilities in fostering sustainable and resilient agribusiness systems in Brazil.

Empirical Review

Sousa-Zomer, Neely, and Martinez (2020) examined the relationship between digital transforming capability and organizational performance using a microfoundational perspective. The study adopted a survey design and analyzed firm-level data to assess how digital capabilities influence operational outcomes. Findings revealed that digital transformation capability significantly enhances performance through improved process integration and innovation capacity. The study concluded that digital transformation functions as a strategic resource that enables firms to adapt to environmental changes. This study is relevant, as it supports the proposition that digital transformation capabilities such as data acquisition and connectivity can improve productivity within agribusiness value chains.

Kumar, Singh, and Dwivedi (2020) investigated the application of Industry 4.0 technologies in SMEs for ethical and sustainable operations. Using a systematic analytical approach, the study identified technological adoption challenges and performance outcomes associated with digital transformation. Results indicated that Industry 4.0 technologies positively influence sustainability and operational efficiency despite infrastructural and skill barriers. The study emphasized the importance of digital integration for responsible production systems. This finding aligns with the current study by demonstrating how digital transformation can support ESG integration within agribusiness value chains.

Ribeiro-Navarrete, Botella-Carrubi, Palacios-Marqués, and Orero-Blat (2021) conducted an applied study on the effect of digitalization on business performance among knowledge-intensive business services firms. Employing quantitative methods, the study found that digitalization significantly improves organizational performance through innovation and enhanced customer engagement. The authors concluded that digital capability development strengthens competitive advantage and market responsiveness. These results provide empirical support for examining digital transformation as a determinant of productivity and economic resilience in agribusiness systems.

Pan, Xie, Wang, and Ma (2022) explored the role of the digital economy as an innovation driver for total factor productivity using econometric modelling techniques. The study established that digitalization contributes significantly to productivity growth by fostering technological innovation and resource optimization. Additionally, the digital economy was found to enhance knowledge spillovers and industrial upgrading. The study's outcome reinforces the argument that digital transformation dimensions may serve as productivity drivers in Brazilian agribusiness value chains.

Mishra, Singh, and Papadopoulos (2022) examined the linkage between digital orientation and data-driven innovation using the SAP-LAP framework. Through conceptual and empirical analysis, the study demonstrated that digital orientation enables effective data acquisition and analytics capabilities that promote innovation and decision-making quality. Findings emphasized the central role of data-driven innovation in organizational competitiveness. This study is particularly relevant to the present research, as it highlights data acquisition as a critical mechanism through which digital transformation influences value chain outcomes.

3.1 Methodology

The study adopted a descriptive survey design to examine digital transformation capabilities within selected agribusiness firms. This design was considered appropriate because it enables the systematic collection of quantitative data from respondents in their natural work environment without manipulation of variables. The study was conducted in Brazil, the largest country in South America, known for its vast geographical diversity, multicultural population, and strong economic reliance on agriculture and natural resources. Brazil's workforce is largely engaged in sectors such as agriculture, manufacturing, trade, and services, with the country globally recognized for large-scale production and export of commodities including soybeans, coffee, beef, and sugarcane. The selection of Brazil as the study area is justified by its strategic position as one of the world's leading agribusiness economies and a major adopter of agricultural technologies. Data for the study were obtained from primary sources; secondary sources were used to support the theoretical framework. Primary data were collected directly from respondents through a structured questionnaire designed to capture perceptions on data acquisition, connectivity, ESG integration, and regional economic resilience. Secondary data were sourced from scholarly articles, institutional reports, textbooks, and other relevant publications that provided conceptual and empirical support for the study variables. The population of the study comprised employees from five selected Brazilian agribusiness firms chosen based on criteria such as year of establishment, workforce size, and commercial location within key agribusiness regions. [The total population size was 161 employees, and due to the manageable size, the study adopted a complete enumeration (census) approach, allowing all members of the population to participate in the study. The validity of the research instrument was ensured through expert review and content validation procedures, whereby specialists in agribusiness management and research methodology assessed the questionnaire for clarity, relevance, and alignment with study objectives. The reliability of the instrument was established using a pilot test and internal consistency assessment to confirm internal consistency of the instrument (e.g., Cronbach's alpha coefficient should be reported). Data were collected through direct questionnaire administration to respondents within the selected firms, ensuring adequate response coverage and accuracy. The method of data analysis employed was Pearson product-moment correlation, which enabled the study to determine the direction and strength of relationships among the key variables and to test the formulated hypotheses at the 0.05 level of significance.

4.1 DATA PRESENTATION AND ANALYSIS

$$r = \frac{\sum(X - \bar{X})(Y - \bar{Y})}{\sqrt{\sum(X - \bar{X})^2 \sum(Y - \bar{Y})^2}}$$

Interpretation of r:

$r = 0$ → No correlation

$0 < |r| < 0.30$ → Weak correlation

$0.3 \leq |r| < 0.5$ While $|r| < 0.5$ $0.3 \leq |r| < 0.5 \rightarrow$ Moderate correlation

$0.5 \leq |r| < 1$ While $|r| < 1$ $0.5 \leq |r| < 1 \rightarrow$ Strong correlation

Sign (+/-) indicates direction: positive or negative.

Significance:

With $\alpha = 0.05$ and $n = 161$, the critical r value $\approx \pm 0.154$ (from r -table for $df = n - 2 = 159$).

If $|r| > 0.154 \rightarrow$ significant correlation \rightarrow reject H_0

If $|r| \leq 0.154 \rightarrow$ not significant \rightarrow fail to reject H_0

Table: Pearson Correlation Analysis of Data Acquisition, Connectivity, and Agribusiness Outcomes

Hypothesis	Variables	r-value	p-value	Decision
H01	Data Acquisition & Productivity	0.482	0.000	Reject H_0
H02	Data Acquisition & ESG Integration	0.355	0.000	Reject H_0
H03	Data Acquisition & Economic Resilience	0.270	0.001	Reject H_0
H04	Connectivity & Productivity	0.518	0.000	Reject H_0
H05	Connectivity & ESG Integration	0.301	0.000	Reject H_0
H06	Connectivity & Economic Resilience	0.192	0.012	Reject H_0

Source: SPSS version 23, (2025)

There is a strong positive relationship between data acquisition and productivity, indicating that agribusinesses that effectively collect and utilize data are more productive.

Data acquisition has a moderate positive relationship with ESG integration, suggesting that firms using data can better implement sustainable and socially responsible practices.

The relationship between data acquisition and economic resilience is weak-to-moderate, showing that data-driven decisions slightly improve a firm's ability to withstand economic shocks. Connectivity shows a strong positive relationship with productivity, highlighting that connected systems (digital platforms, IoT, and internet access) enhance operational efficiency. The relationship with ESG integration is moderate, implying that connected agribusinesses are better positioned to adopt sustainable practices and comply with ESG standards.

Connectivity has a weak positive relationship with economic resilience, meaning connectivity contributes to resilience, but other factors may also be important.

Discussion of Findings

- 1. Data Acquisition and Productivity:** The analysis revealed a strong positive relationship between data acquisition and productivity ($r = 0.482$, $p < 0.01$), indicating that agribusinesses that effectively collect and leverage data achieve higher operational performance. This finding is consistent with Sousa-Zomer, Neely, and Martinez (2020), who argued that digital transformation capabilities, including data acquisition, enhance performance through improved process integration and innovation capacity. Similarly, Pan, Xie, Wang, and Ma (2022) demonstrated that digitalization drives total factor productivity by fostering technological innovation and resource optimization. The result underscores the critical role of data-driven decision-making in enhancing productivity within Brazilian agribusiness value chains.
- 2. Data Acquisition and ESG Integration:** Data acquisition exhibited a moderate positive relationship with ESG integration ($r = 0.355$, $p < 0.01$), suggesting that firms with strong data capabilities are better able to implement sustainable and socially responsible practices. This aligns with Kumar, Singh, and Dwivedi (2020), who found that the adoption of Industry 4.0 technologies promotes ethical and sustainable operations despite infrastructural and skill challenges. Lin and Zhang (2023) and Kong and Liu (2023) also highlighted that digital transformation positively influences corporate environmental and social responsibility through enhanced monitoring, governance, and stakeholder engagement. These studies support the present findings, emphasizing that data acquisition facilitates ESG compliance and integration in agribusiness systems.
- 3. Data Acquisition and Economic Resilience:** The correlation between data acquisition and economic resilience was weak-to-moderate ($r = 0.270$, $p < 0.01$), indicating that data-driven approaches moderately enhance a firm's ability to withstand economic shocks. This result is supported by Yin and Ran (2022), who observed that digital transformation improves supply chain resilience by enhancing coordination, flexibility, and risk management. Mishra, Singh, and Papadopoulos (2022) further argued that data-driven innovation, enabled by digital orientation, strengthens decision-making quality, which contributes to organizational adaptability. Collectively, these findings suggest that effective data acquisition serves as a key mechanism for building economic resilience in agribusiness value chains.
- 4. Connectivity and Productivity:** Connectivity showed a strong positive relationship with productivity ($r = 0.518$, $p < 0.01$), highlighting the impact of digital infrastructure, internet access, and networked systems on operational efficiency. This outcome aligns with Sousa-Zomer, Neely, and Martinez (2020), who reported that digital capabilities enhance firm performance through improved process integration and innovation. Ribeiro-Navarrete, Botella-Carrubi, Palacios-Marqués, and Orero-Blat (2021) also demonstrated that digitalization facilitates innovation and customer engagement, which directly improves organizational performance. The finding confirms that connectivity is a vital driver of productivity within Brazilian agribusiness value chains.
- 5. Connectivity and ESG Integration:** Connectivity was moderately positively related to ESG integration ($r = 0.301$, $p < 0.01$), implying that well-connected agribusinesses are better positioned to adopt sustainable practices and comply with ESG standards. Sun, Wang, Wang, and Sun (2023) found that digital transformation positively affects CSR performance by enhancing governance and organizational learning, which increases stakeholder trust. Similarly, Lin and Zhang (2023) highlighted the role of digital tools in monitoring and enforcing environmental responsibility. These studies corroborate the current finding,

suggesting that connectivity supports ESG integration by enabling real-time data sharing, monitoring, and stakeholder communication.

6. **Connectivity and Economic Resilience:** Connectivity showed a weak positive relationship with economic resilience ($r = 0.192$, $p < 0.05$), indicating that digital networks contribute to resilience, though other factors may also be influential. Yin and Ran (2022) noted that digital capabilities improve adaptive capacity during disruptions, supporting the idea that connectivity enhances supply chain flexibility. Pan et al. (2022) also emphasized the role of technological integration in resource optimization and industrial upgrading, which can buffer against shocks. Hence, while connectivity alone does not fully determine resilience, it forms a foundational element of a digitally adaptive agribusiness system

Conclusion

This study examined the relationships between data acquisition, connectivity, and key performance outcomes productivity, ESG integration, and economic resilience within Brazilian agribusiness value chains. The findings indicate that data acquisition significantly enhances productivity, ESG integration, and economic resilience, with the strongest effect observed on productivity. Similarly, connectivity positively influences productivity and ESG integration, while its effect on economic resilience is weaker but still significant. These results confirm that digital transformation capabilities, particularly data acquisition and connectivity, serve as strategic resources that enable agribusiness firms to improve operational efficiency, adopt sustainable practices, and build resilience against economic and environmental shocks. Overall, the study highlights the critical role of digital technologies in driving performance and sustainability within agribusiness systems, supporting prior evidence from Sousa-Zomer, Neely, and Martinez (2020), Kumar, Singh, and Dwivedi (2020), and Yin and Ran (2022).

Recommendations

Based on the findings of this study, the following recommendations are proposed for agribusiness firms and policymakers:

1. Agribusiness firms should prioritize the development and implementation of robust data collection and analytics systems. Effective data acquisition enables evidence-based decision-making, enhances productivity, and supports ESG integration.
2. Firms should strengthen digital connectivity through reliable internet access, IoT adoption, and networked platforms to improve operational efficiency, facilitate real-time information sharing, and support sustainability initiatives.
3. Organizations should incorporate digital transformation initiatives into their strategic planning to build economic resilience, including digital tools for risk management, process optimization, and supply chain flexibility.
4. Employees should be trained on leveraging data analytics and digital tools effectively. Building digital competencies will maximize the value of data acquisition and connectivity in driving productivity and ESG outcomes.
5. Policymakers should encourage the adoption of digital technologies in agribusiness through incentives, grants, and infrastructure development. Policies that promote digital inclusion can enhance sustainability, productivity, and resilience across the sector.
6. Organizations should implement digital tools that enhance supply chain flexibility, coordination, and risk management. Although the effect of connectivity on economic

resilience is weak, it remains significant, indicating that connected systems contribute to organizational adaptability during disruptions.

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