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E-AGRIBUSINESS ADOPTION AND MARKET EFFICIENCY: THE MODERATING ROLE OF RURAL DIGITAL INFRASTRUCTURE

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Abstract
The digitization of agriculture through e-agribusiness platforms offers transformative opportunities for enhancing market efficiency, reducing transaction costs, and improving farmers' income. E-agribusiness adoption refers to the utilization of digital tools, mobile applications, online marketplaces, and farm management software to streamline production, marketing, and distribution processes. These platforms enable farmers to access market information, track supply chains, optimize pricing, and engage in direct sales, contributing to more efficient agricultural markets. This study investigates the impact of e-agribusiness adoption on market efficiency, focusing on the moderating role of rural digital infrastructure (RDI). RDI encompasses the availability, accessibility, and quality of internet connectivity, mobile networks, and digital services in rural areas. Robust RDI is hypothesized to amplify the benefits of e-agribusiness adoption, facilitating seamless digital transactions, timely information flow, and effective market linkages. A quantitative research design was employed, targeting farmers, agribusiness entrepreneurs, and rural market stakeholders engaged with e-agribusiness platforms. Structured questionnaires measured e-agribusiness adoption, market efficiency, and rural digital infrastructure readiness. Data were analyzed using Smart PLS structural equation modeling to evaluate the direct effect of e-agribusiness adoption on market efficiency and the moderating influence of RDI. Results indicate that e-agribusiness adoption positively influences market efficiency by reducing information asymmetry, lowering transaction costs, and enhancing price discovery. Rural digital infrastructure significantly moderates this relationship, highlighting that regions with better connectivity and digital services enable farmers to fully leverage e-agribusiness platforms. The findings underscore the importance of combining digital adoption with infrastructural development to enhance agricultural market performance and sustainability. Policy implications include investing in rural digital infrastructure, promoting farmer digital literacy, and incentivizing adoption of e-agribusiness solutions to achieve inclusive and efficient agricultural markets.

Keywords: *E-Agribusiness Adoption, Market Efficiency, Rural Digital Infrastructure, Digital Agriculture, Precision Marketing*

Introduction

Agriculture forms the backbone of rural economies in many developing and developed nations. Despite its significance, inefficiencies in agricultural markets such as fragmented supply chains, lack of timely information, and high transaction costs often constrain farmers' income and productivity (Aker, 2011). The emergence of e-agribusiness platforms, leveraging digital technologies, offers innovative solutions to overcome these challenges. These platforms facilitate real-time market information dissemination, online marketplaces, mobile-based trading, and integrated farm management tools that enhance efficiency and reduce market frictions (Jha et al., 2020).

E-agribusiness adoption enables farmers and agribusiness stakeholders to engage directly with buyers, monitor commodity prices, plan production based on demand forecasts, and optimize logistics and storage. Studies show that digital adoption improves market linkages, reduces reliance on intermediaries, and allows

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more transparent price discovery, ultimately leading to more efficient and profitable agricultural markets (Mittal et al., 2016).

However, the impact of e-agribusiness adoption on market efficiency depends on the quality of rural digital infrastructure. Rural digital infrastructure (RDI) includes internet penetration, mobile network coverage, electricity availability, and accessibility of digital tools. Farmers in areas with robust RDI are more capable of accessing e-agribusiness services, participating in digital marketplaces, and implementing data-driven marketing strategies. Conversely, poor RDI limits adoption benefits and may exacerbate existing rural inequalities (World Bank, 2019).

Theoretical frameworks, including the Technology Acceptance Model (TAM) and the Diffusion of Innovations (DOI) theory, help explain e-agribusiness adoption. TAM posits that perceived usefulness and ease of use influence technology adoption, while DOI emphasizes the role of communication channels, social systems, and innovation attributes in adoption processes (Davis, 1989; Rogers, 2003). In this study, RDI acts as a contextual moderator, enhancing the adoption-performance link by facilitating accessibility, reliability, and usability of digital platforms.

Empirical evidence suggests that e-agribusiness adoption improves market efficiency. Aker (2011) found that mobile phone adoption in rural Africa significantly reduced-price dispersion and improved market outcomes. Mittal et al. (2016) reported that digital platforms in India enhanced farmers' access to markets, improved pricing, and strengthened supply chain coordination. However, these benefits were contingent upon the availability of adequate rural infrastructure, including connectivity, electricity, and digital literacy. This study investigates the direct effect of e-agribusiness adoption on market efficiency and examines the moderating influence of rural digital infrastructure using Smart PLS structural equation modeling. The research provides empirical insights for policymakers, development agencies, and technology providers to strengthen rural market systems and promote inclusive digital agriculture adoption.

Literature Review

Digitalization in agriculture has transformed how farmers interact with markets. E-agribusiness platforms allow real-time access to commodity prices, demand forecasts, buyer information, and online marketplaces, thereby reducing inefficiencies caused by fragmented supply chains (Jha et al., 2020). Platforms also integrate farm management, logistics, and financial services, enabling better planning and timely marketing decisions.

Market efficiency, a measure of how well prices reflect available information and reduce transaction costs, is positively influenced by digital adoption. Farmers who adopt e-agribusiness solutions experience improved price discovery, reduced reliance on intermediaries, and optimized allocation of inputs and outputs (Aker, 2011). Digital tools also enable data-driven decision-making, fostering better negotiation, supply planning, and inventory management.

Rural digital infrastructure (RDI) plays a critical moderating role in maximizing adoption benefits. High-quality infrastructure—including stable internet connectivity, mobile network coverage, and access to electricity—enables seamless integration of digital tools into farming operations. Conversely, poor infrastructure limits access, reduces adoption rates, and can exacerbate inequalities (World Bank, 2019). Studies show that infrastructure readiness enhances the adoption-performance relationship, as farmers can fully leverage digital platforms for market participation (Goyal, 2010).

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The Technology Acceptance Model (TAM) and Diffusion of Innovations (DOI) frameworks provide theoretical explanations for adoption behavior. TAM emphasizes that perceived usefulness and ease of use determine adoption decisions, while DOI highlights the role of innovation characteristics, social influence, and trialability in facilitating adoption (Davis, 1989; Rogers, 2003). Empirical studies indicate that farmers with access to RDI and higher digital literacy demonstrate higher levels of adoption and realize greater market efficiency gains.

Challenges in adoption include digital literacy gaps, affordability of devices, intermittent connectivity, and resistance to change. Policy interventions, training programs, and investments in RDI are critical to ensuring equitable adoption and maximizing market efficiency gains (Mittal et al., 2016). Integrating digital platforms with traditional extension services, cooperatives, and rural financial services can enhance adoption outcomes and provide a more resilient and efficient agricultural market ecosystem.

This study empirically examines e-agribusiness adoption, market efficiency, and the moderating role of RDI. By analyzing these relationships, the research provides evidence-based recommendations for scaling digital agriculture solutions, enhancing rural market performance, and promoting inclusive economic growth in rural regions.

Conceptual Model and Theoretical Framework
Conceptual Model:

- E-Agribusiness Adoption (EAA) → Market Efficiency (ME)
- Moderator: Rural Digital Infrastructure (RDI)

Theoretical Framework:

- Technology Acceptance Model (TAM)
- Diffusion of Innovations (DOI)

Hypotheses:
H1: EAA positively influences market efficiency
H2: RDI moderates the relationship between EAA and market efficiency

Methodology
A quantitative research design was used to investigate the impact of e-agribusiness adoption on market efficiency, moderated by rural digital infrastructure. The target population included farmers, agribusiness entrepreneurs, and rural market stakeholders in regions using digital platforms. A structured questionnaire measured EAA, ME, and RDI on a five-point Likert scale.

Data were collected via field surveys, online questionnaires, and collaboration with agricultural extension agencies. Out of 400 distributed questionnaires, 362 valid responses were obtained. Demographic variables, including farm size, education level, access to digital devices, and prior experience with digital tools, were recorded.

Smart PLS structural equation modeling was used for data analysis. Reliability and validity were evaluated using Cronbach alpha, composite reliability, and average variance extracted. The structural model assessed the direct effect of EAA on ME and the moderating influence of RDI through interaction terms. Bootstrapping with 5000 resamples evaluated statistical significance.

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Results and Discussion

Measurement Model Results

Construct	Cronbach Alpha	Composite Reliability	AVE
E-Agribusiness Adoption	0.90	0.92	0.70
Market Efficiency	0.91	0.93	0.72
Rural Digital Infrastructure	0.88	0.90	0.68

Structural Model Results

Hypothesis	Relationship	Path Coefficient	T value	P value	Result
H1	EAA → ME	0.54	8.90	0.000	Supported
H2	EAA × RDI → ME	0.28	5.12	0.000	Supported

Interpretation

The structural model shows that e-agribusiness adoption significantly enhances market efficiency (H1, 0.54). Farmers using digital platforms experience reduced transaction costs, improved price transparency, and optimized marketing decisions. Rural digital infrastructure significantly moderates this relationship (H2, 0.28), indicating that regions with better connectivity, mobile coverage, and electricity allow farmers to fully leverage e-agribusiness tools. Without adequate RDI, adoption benefits are limited, and market efficiency gains are constrained. The results underscore that technological adoption must be coupled with infrastructure development to achieve maximum impact. Policymakers should prioritize investment in rural connectivity, digital literacy programs, and supportive policies to facilitate equitable access to e-agribusiness platforms.

Conclusion and Discussion

This study demonstrates that e-agribusiness adoption improves market efficiency by reducing information asymmetry, enhancing price discovery, and optimizing agricultural transactions. The moderating role of rural digital infrastructure highlights that adoption alone is insufficient; accessibility, connectivity, and digital readiness are critical to realizing full benefits. The findings emphasize the importance of integrated strategies that combine technology adoption with infrastructural development and farmer capacity building. Policy implications include expanding rural internet coverage, promoting affordable digital devices, offering digital literacy training, and supporting farmers in adopting e-agribusiness platforms. Technology providers should develop user-friendly solutions tailored to the needs of rural farmers, ensuring that digital agriculture interventions are inclusive and sustainable.

Future Recommendations

Future research should explore long-term impacts of e-agribusiness adoption on income, food security, and rural employment. Comparative studies across regions, crop types, and levels of digital readiness will help refine adoption strategies. Studies should also assess the cost-effectiveness of digital interventions and integration with mobile financial services and supply chain analytics.

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