### Literature Review: Transforming Agricultural Supply Chains through AI, Blockchain, and Big Data Analytics

#### Abstract

This paper explores the transformative impact of artificial intelligence (AI), blockchain technology, and big data analytics on agricultural supply chains, focusing on financing. These technologies are driving significant advancements in decision-making, transparency, efficiency, risk management, financial inclusion, and sustainable growth opportunities. AI enhances predictive analysis and automates processes, fostering informed investment strategies. Blockchain introduces unprecedented transparency, particularly through smart contracts, facilitating direct funding of agricultural projects and transparent trading. Big data analytics empower stakeholders with insights to enhance financial inclusion and identify sustainable investment opportunities. This study underscores how these technologies collectively support aligning financial investments with sustainability goals, contributing to the development of a sustainable agricultural economy. The confluence of AI, blockchain, and big data streamlines operational processes and opens new avenues for growth and investment in agriculture, particularly in financing.

#### Introduction

The agricultural supply chain is a complex ecosystem involving multiple stakeholders, from farmers to retailers. However, this network is often hindered by inefficiencies such as disconnection between stakeholders and the lack of unified data integration. According to Zhao (2024), while vast amounts of data are generated across the supply chain, these are often underutilized, preventing stakeholders from extracting actionable insights to inform decision-making. This review explores how AI, blockchain technology, and big data analytics enhance agricultural financing and overall supply chain efficiency, highlighting current gaps in the literature and justifying the need for applications that address these issues.

#### The Role of AI in Agricultural Financing

AI technologies are revolutionizing agricultural financing by addressing key challenges in the sector. AI can analyze extensive datasets to develop predictive models, particularly beneficial in regions with limited access to credit history. Akinyemi et al. (2022) demonstrated that AI applications, such as machine learning, enhance credit scoring models by integrating data sources like social media activity and satellite imagery, offering a more comprehensive assessment of a farmer’s creditworthiness. This innovation promotes financial inclusion, especially for smallholder farmers, by providing a reliable basis for lending.

Moreover, AI optimizes resource allocation through real-time data analysis. By assessing weather patterns, soil health, and market demand, AI models can predict crop yields, allowing lenders to better assess risks associated with financing agricultural ventures (Mocanu et al., 2023). While these advancements are promising, long-term studies are needed to evaluate the sustainability of AI-driven agricultural financing across various regional contexts.

#### Blockchain Technology and Supply Chain Transparency

Blockchain technology has gained traction for its potential to enhance transparency, accountability, and traceability within the agricultural supply chain. Blockchain’s immutable ledger allows for secure tracking of agricultural products, creating trust between stakeholders. Ellahi et al. (2023) note that blockchain improves food safety and operational efficiencies, addressing critical issues such as fraud and inefficiencies in the supply chain. The use of smart contracts automates transactions, reducing the reliance on intermediaries and lowering transaction costs for agricultural stakeholders.

However, current blockchain frameworks often lack interoperability with other emerging technologies, such as AI and big data analytics. This limits the potential of blockchain to transform the agricultural financing landscape fully. Zhang et al. (2023) argue that integrating blockchain with AI could facilitate real-time data sharing and decision-making, enhancing traceability and financing mechanisms for farmers. The development of scalable, integrated solutions remains a critical area for future research.

#### Big Data Analytics for Informed Decision-Making

Big data analytics plays an essential role in transforming agricultural supply chains by allowing stakeholders to analyze vast amounts of data generated throughout the sector. The ability to process and analyze real-time data provides stakeholders with more informed decisions regarding production planning, resource allocation, and risk management. Zhang et al. (2023) highlight that big data can identify market trends, consumer preferences, and potential supply chain disruptions, allowing farmers and investors to adapt their strategies accordingly.

Furthermore, integrating big data analytics with AI enhances the predictive capabilities of the agricultural supply chain. Utilizing data from multiple sources, including weather forecasts, soil conditions, and market prices, allows stakeholders to develop comprehensive models that inform financing decisions and optimize resource use (Sultana et al., 2023). However, smallholder farmers often lack access to the infrastructure and tools necessary to take full advantage of these advancements, posing challenges to broader adoption.

#### Gaps in Agricultural Financing and the Justification for Application Development

Despite the advancements offered by AI, blockchain, and big data analytics, several gaps persist in agricultural financing that justify the development of specialized applications. Current literature identifies key issues:

**Interoperability**: A lack of interoperability between blockchain, AI, and big data analytics frameworks limits the full potential of these technologies. A more integrated approach would allow seamless data exchange, improving transparency, traceability, and financing decisions. Research should focus on developing interoperable frameworks that combine the strengths of these technologies (Zhao, 2024).

**Scalability**: While AI and blockchain solutions have demonstrated potential in certain regions, scalability remains a challenge, especially for smallholder farmers who lack access to technological infrastructure. Solutions that can be adapted across diverse agricultural contexts are needed to ensure widespread adoption (Akinyemi et al., 2022).

**Digital Literacy and Access**: One of the significant challenges in implementing these technologies is the lack of digital literacy among many agricultural stakeholders. Training programs and educational initiatives are necessary to empower farmers and other stakeholders to utilize these advanced tools effectively. Additionally, access to digital infrastructure remains limited in many rural areas (Abdullahi, 2024).

**Regulatory Frameworks**: Existing regulatory frameworks often fail to support the integration of digital financial solutions in agriculture, leading to gaps in financial services for rural and marginalized farmers. Developing frameworks that balance innovation with security and accountability is critical to overcoming this challenge (Mohammed Abdullahi, 2024).

**Structural Deficiencies**: As Abdullahi (2024) identifies, a structural problem exists within both public and private financial institutions in providing digital financial services to smallholder farmers. A lack of a universal API, poor digital infrastructure, and insufficient financial inclusion for marginalized farmers in rural areas exacerbate these problems. Addressing these gaps by developing an application that integrates AI, blockchain, and big data analytics can provide a solution by enabling digital financial services tailored to rural agricultural needs.

#### Justifying Application Development for Agricultural Financing

The literature points to a significant need for applications that address the gaps in agricultural financing by integrating AI, blockchain, and big data analytics. The development of such an application could help bridge the digital divide in rural agricultural regions, providing farmers with access to critical financial services. By offering predictive insights, transparency through blockchain, and improved decision-making capabilities via big data, these applications would enable more effective financing models that reduce risks and improve productivity.

For instance, an application that combines AI-driven risk assessments with blockchain-based smart contracts could streamline the lending process, making it more accessible for smallholder farmers. Additionally, by integrating big data analytics, such an application could provide farmers with real-time insights into market trends, weather patterns, and supply chain disruptions, enabling more informed decision-making and resource allocation.

#### Conclusion

The integration of AI, blockchain, and big data analytics represents a pivotal opportunity to enhance financing mechanisms and improve overall efficiency in agricultural supply chains. However, significant gaps remain, particularly in interoperability, scalability, digital literacy, and regulatory frameworks. Developing applications that address these challenges is crucial for realizing the full potential of these technologies. By leveraging the capabilities of AI, blockchain, and big data analytics, the agricultural sector can overcome inefficiencies, enhance financial inclusion, and drive sustainable growth. As these technologies continue to evolve, the development of integrated solutions will play a critical role in transforming agricultural financing and ensuring the long-term sustainability of global food supply chains.

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