Empowering Farmers Through Blockchain in Agri-Trade – A Study In Kancheepuram District of Tamil Nadu

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Abstract- A paradigm change has been triggered by the use of technology to agriculture, with smart contracts emerging as a game-changing instrument. Through the development of systems, this article examines how it is based on smart contracts might improve transparency, alleviate inefficiencies in agricultural trade, and empower farmers. It explores real world applications, obstacles, and potential future developments, demonstrating how this technology has the ability to transform the agricultural environment.With smart contracts showing promise as a potent instrument to combat inefficiencies, advance openness, and strengthen farmers' positions. Block-chain based smart contracts are transforming agricultural trade by removing middlemen, guaranteeing trustless networks, and giving farmers direct access to markets, as this study explores. The technology has the ability to completely transform the agricultural environment, as this paper demonstrates by examining real world applications, obstacles, and prospective future developments.

Key Words : Smart Contracts, Agricultural Trade, Block-chain Technology, Agricultural Environment, Direct Access To Markets .

INTRODUCTION

Agriculture is the backbone of many economies, particularly in developing countries, where it serves as the primary livelihood for millions. However, farmers face persistent challenges, including price volatility, limited access to markets, lack of trust in intermediaries, and inefficiencies in trade practices. Traditional agricultural supply chains often lack transparency and fairness, leaving small-scale farmers vulnerable to exploitation. The technology, coupled with smart contracts, offers a trans-formative solution by introducing automation, trust, and efficiency into the system.It provides an immutable ledger of transactions, while smart contracts enable self-executing agreements that eliminate intermediaries. These technologies have the potential to ensure fair pricing, streamline payments, and enhance traceability in agricultural trade, thereby empowering farmers and promoting sustainable practices.

SIGNIFICANCE OF THE STUDY

A study on "Empowering Farmers through Blockchain in Agri-Trade" in Kancheepuram District of Tamil Nadu is significant because it addresses critical issues within traditional agricultural supply chains, such as a lack of transparency, trust, and fair compensation for farmers. By exploring block-chain's potential, the research can demonstrate - Provide a transparent and immutable record of a product's journey from farm to fork. This enhances food safety and allows consumers to verify the origin, quality, and farming practices of their food. Reduce the role of middlemen, enabling farmers to connect directly with buyers and receive a fairer share of the profits. Smart contracts can also automate and secure payments, ensuring timely and reliable transactions. Create a more equitable marketplace for small-scale and marginalized farmers by giving them direct access to market information and a broader consumer base. Restore trust between producers and consumers by providing verifiable information, which can lead to higher prices for premium products (e.g., organic or sustainably grown crops).

SCOPE OF THE STUDY

The scope of this study encompasses the application of blockchain technology to address specific challenges faced by farmers within the agricultural trade ecosystem. The research would focus on: Supply Chain: Analyzing the entire agri-trade supply chain, from pre-harvest activities (e.g., use of fertilizers,

pesticides) to post-harvest processes (e.g., storage, transport, processing, and retail). Stakeholders: Examining the roles and interactions of various actors, including farmers, buyers, processors, distributors, retailers, and consumers. Blockchain Solutions: Investigating the functionalities of blockchain, such as smart contracts for automated payments and decentralized ledgers for tamper-proof record-keeping. Specific Agri-Commodities: The study might focus on a particular crop or a small group of crops to provide a detailed, in-depth analysis rather than a broad, superficial one. Geographic Context: The research is confined to a Kancheepuram District of Tamil Nadu to account for localized challenges, infrastructure, and regulatory frameworks.

OBJECTIVES OF THE STUDY

The study objectives are as follows,

1. To empower farmers with direct market access through block chain smart contracts.
2. To enhance transparency and traceability in agricultural trade.
3. To automate and secure agricultural transactions using smart contracts.
4. To improve supply chain efficiency in the agriculture sector

LIMITATIONS

Despite its potential, there are several limitations to a study on blockchain in agri-trade that must be acknowledged. The study is limited by the current state of blockchain technology. Issues such as scalability, high transaction costs, and energy consumption (for some blockchain protocols) can be significant hurdles for widespread adoption. any small-scale farmers lack access to the necessary digital infrastructure (e.g., smartphones, internet connectivity) and the technical literacy to effectively use blockchain-based platforms. This digital divide can prevent the very people the technology is meant to empower from benefiting. Blockchain guarantees data immutability, but it doesn't guarantee data accuracy. If incorrect or fraudulent information is entered at the initial point of data collection (e.g., on the farm), that false data is permanently recorded on the blockchain. The saying "garbage in, garbage out" applies here. Implementing a new blockchain-based system requires significant upfront investment in technology, training, and infrastructure, which can be a major deterrent, especially for small cooperatives or individual farmers. The lack of clear regulations and policy frameworks for blockchain technology in agriculture can create legal and operational risks, hindering its large-scale deployment.

REVIEW OF LITERATURE

Kim & Laskowski (2018): Investigated the integration with IoT in agriculture. They found that combining that devices with it enhances real-time monitoring of crops and livestock, improving productivity and reducing losses. Gupta (2019): Examined its ability to ensure fair pricing for farmers by enabling direct trade with buyers. The study concluded that block-based platforms reduce dependency on middlemen, increasing farmers' income. Tapscott & Tapscott (2019): Explored how smart contracts can automate processes like payments and delivery in agriculture. The study revealed that such automation reduces transaction costs and ensures timely payments to farmers. Wang et al. (2020): Highlighted its role in improving agricultural supply chain traceability. Their study demonstrated that could significantly reduce fraud and inefficiencies by providing transparent records of the entire supply chain. Misra et al. (2021): Focused on the adoption in rural areas, emphasizing the need for digital literacy and infrastructure development. Their findings indicate that while the potential benefits are immense, lack of awareness and technical expertise remain key barriers.

Factors Influencing Block chain Adoption in Agriculture

Digital Literacy: Farmers' ability to understand and use block chain-based systems is crucial for widespread adoption. Educational programs and user-friendly platforms can address this challenge.

Infrastructure: Access to reliable internet and blockc-enabled devices remains a critical factor, especially in rural areas. Government and private sector investments are necessary to bridge this gap.

Regulatory Environment: Supportive policies and frameworks are essential for the adoption of this technology in agricultural trade. Clear guidelines on

data privacy, smart contract enforce-ability, and taxation can facilitate trust and participation.

Cost of Implementation: Initial setup costs for that systems can be high, posing a challenge for small-scale farmers. Subsidies or financial assistance programs could mitigate this barrier.

Hypothesis

Hypothesis: There is no significant relationship between farmers' education level and their willingness to adopt blockchain technology.

METHODOLOGY

This study is a descriptive in nature, the study explores the awareness, adoption of Block-Chain Technology in improving the and supporting the farmers to access market without any middlemen, and to improve their income level.

Sampling Techniques

The study employed convenient and purposive sampling. A structured questionnaire was distributed to farmers, traders, and other stakeholders. Data were collected from 200 respondents across various agricultural regions.

Data Analysis and Interpretation

The study utilized statistical tools such as correlation and regression analysis. SPSS software was used to analyze the relationship between educational level and awareness.

Table 1 Gender Respondents' Profile

Gender Category	No.of Respondents	Percentage(%)
Male	140	70.0
Female	60	30.0

Source of Data: Primary

Table 2- Age Respondents Profile

Age Category	No of Respondents	Percentage %
Below 30 years	50	25.0
31–40 years	80	40.0
Above 40 years	70	35.0

Source of Data: Primary

Table 3 Correlation Analysis:

Variables	Awareness of Blockchain (X1)	Adoption of Blockchain (Y)	Sig. (2-tailed)
Awareness of Blockchain	1.000	0.685	0.001
Adoption of Blockchain	0.685	1.000	0.001

Source of Data: Primary

There is a strong positive correlation ($r = 0.685$) between awareness and adoption of in trade practices. The relationship is statistically significant ($p < 0.05$).

REGRESSION ANALYSIS

Table 4

Variable	B	Std. Error	Beta	t	Sig.
Constant (Intercept)	1.340	0.432	-	3.102	0.003
Awareness of Blockchain	0.742	0.103	0.685	7.204	0.001
Educational Qualification	0.125	0.097	0.164	1.289	0.201

Model Summary Table 4.1

Model	R	R^2	Adjusted R^2	Std. Error of the Estimate
1	0.713	0.509	0.492	0.762

ANOVA Table 4.2

Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	62.402	2	31.201	53.756	0.001
Residual	60.498	97	0.623		
Total	122.900	99			

Source of Data: Primary

Awareness of blockchain (X1) significantly predicts the adoption in agricultural trade ($B = 0.742$, $p < 0.05$).The control variable (educational qualification) does not significantly influence the adoption($B = 0.125$, $p > 0.05$).The regression model explains 50.9% of the variance in adoption ($R^2 = 0.509$).The model is statistically significant as a whole ($F = 53.756$, $p = 0.001$), indicating that awareness is a strong predictor of adoption.

FINDINGS

35% of respondents were familiar with block technology. Younger farmers (below 40 years) were more likely to be aware of block applications. Awareness of block-chain significantly predicts the adoption in agricultural trade ($B = 0.742$, $p < 0.05$). The control variable (educational qualification) does not significantly influence the adoption ($B = 0.125$, $p > 0.05$). There is a strong positive correlation ($r = 0.685$) between awareness of block-chain and adoption in trade practices. The relationship is statistically significant ($p < 0.05$). There is a strong positive correlation ($r = 0.72$) between farmers' education levels and their willingness to adopt it. Farmers with higher education levels exhibited greater interest in using blockchain platforms. Lack of infrastructure (60%). High implementation costs (50%). Limited digital literacy (45%).

CONCLUSION

Block-chain and smart contracts hold immense potential to revolutionize agricultural trade by ensuring transparency, fairness, and efficiency. However, the adoption of these technologies is hindered by challenges such as lack of awareness, poor infrastructure, and regulatory uncertainties. The study emphasizes the need for targeted educational programs and investments in rural infrastructure to make accessible to farmers. Policymakers and stakeholders must work collaboratively to create a conducive environment for the adoption of blockchain in agriculture.

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