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Identifying Practical Applications of Blockchain Technology in Agriculture

[1] Dr Anish K Ravi

[1] Professor & Head, Marketing and Communications, Chennai Business School, Chennai, Tamil Nadu, India.
Corresponding Author Email: [1] anish.ravi@cbs.org.in

Abstract*— Blockchain, also known as distributed ledger technology, is considered to have the potential to cause significant economic, political, and social transformations in India. Blockchain technology has been most helpful in understanding the source and journey of produce in agriculture. This is vital for farmers and consumers: it authorizes farmers to bargain for better prices throughout the supply chain while giving consumers confidence in knowing exactly where the produce comes from. This is crucial considering the growing lack of trust in sourcing produce sold in markets. While still challenged with fundamental limitations, Blockchain technology is a transformative Information and Communications Technology (ICT) that has changed our notion of trust. Improved efficiencies for sustainable agricultural development have been demonstrated when ICT-enabled farms have access to knowledge banks and other digital resources. The visible effects of this technology are already being noted there. This paper presents early evidence linking the use of blockchain in overcoming agricultural challenges facing India. The paper examines blockchain technology's impact and critical applications in agriculture and the food supply chain. It demonstrates how blockchain can help promote transparency, build trust and reputation, and enhance transaction efficiency. This paper looks at opportunities and key triggers for blockchain diffusion in agricultural practices in India. It also delves into challenges and obstacles developing economies will likely encounter in using blockchain.

Index Terms: Blockchain; Information Communication Technology; Internet of Things.

I. INTRODUCTION

Blockchain technology became widespread with the rise of bitcoin and other cryptocurrencies. The rise of cryptocurrencies like Bitcoin and Ethereum has taken the financial industry by storm. However, irrespective of what the future holds for bitcoin and its peers. The underlying technology blockchain will survive and is bound to make inroads in every sector. [1]

Even though the blockchain revolution started in the banking and finance industry, other industries like healthcare, energy, retail, governance, supply chain, and agriculture will be disrupted by blockchain applications. The technology authorizes highly secured digital transactions and recordkeeping. Even though blockchain saw its first use in cryptocurrencies, the concept can be used for all sorts of transactions, including agricultural ones. Blockchain can lower inefficiencies and fraud while enhancing food safety, farmer pay, and transaction times. The agricultural industry should be excited about the coming intake of blockchain technologies. However, technological shift often comes with unpredictable deficiencies and challenges.[2]

II. WHAT IS BLOCKCHAIN TECHNOLOGY?

The blockchain is a distributed ledger technology that allows all members to record transactions in a decentralized data log maintained on a network of computers rather than a physical ledger or a single database. Transactions must be approved through consensus, and everything is secured through cryptography. In simpler terms, think of blockchain as google sheets versus excel sheets sent through emails. In google sheets, all members have live access to the data being entered into the sheets and can independently record/track the updates of every entry being made. Add another layer on top of this, where access, once completed, is recorded permanently and cannot be edited or erased by any member. Blockchain is unique because data stored on its networks is transparent and incorruptible. Data is embedded on the web as a whole; by definition, it is public, and data, once stored, cannot be corrupted by altering any information on the blockchain. [3]

Blockchain creates a secure and transparent ledger system available to all parties within a supply chain, including producers, retailers, logistics providers, and regulators. This shared ledger gathers a complete record of each asset, all transactions in its history, and its existing ownership. Each modification to the ledger must be verified by all parties, which delivers the process's dependability and transparency. Changes can be made manually or automatically by adhering to a set procedure that was unanimously pre-approved during the technology design. Potential applications span various sectors and industries, from financial services to used car sales. Start-ups are already exploring potential applications for the agricultural sector. Blockchain provides a more secure communication system for faster and more transparent information sharing. Its main benefit may be moving transaction data away from the current antiquated pencil-and-paper systems.[4]

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III. BLOCKCHAIN TECHNOLOGY IN AGRICULTURE

One of the most logical applications of blockchain in agriculture is plagued with several challenges (I prefer to call them opportunities). With rising consumer consciousness toward food safety, blockchain applications can play a vital role in solving many agriculture-related problems. Blockchain vows to enhance traceability and clarity within agriculture value chains. The capability to quickly trace the source of food products would be a valuable tool during contamination incidents. With blockchains, regulators can promptly identify the source of the contaminant and determine the scope of affected products. A timely response by food companies can prevent illness, limit food waste, and contain financial fallout.[5]

A notification by the Food Marketing Institute and Grocery Manufacturers Association uncovered that an average food recall costs $10 million, exclusive of brand damage and lost conceivable sales. Other high-profile recalls have had costs as high as $1 billion, such as the peanut salmonella outbreak in 2009. While UPC codes provide tracking capabilities, much of this information is recorded in siloed databases and undigitized archives. A tracking system that is more convenient and easier to query can be created with blockchain technology, pushing down the time it takes organizations and authorities to determine food contamination origins.[7]

More than a third of all food farmed is wasted, and food waste costs the food industry nearly one trillion dollars yearly. Since blockchain transactions can be conducted faster and are less likely to be argued, spoilage along the supply chain can also be lowered. They can also help identify blockages that are contributing to spoilage. The added transparency that blockchain models afford can also play a decisive role in fighting food fraud.

As consumer demand for organic, GMO-and antibiotic-free food soars, the news is rife with cases of fraudulent labelling. The minor transactions—at the farm, warehouse, or factory—can be monitored efficiently and communicated across the whole supply chain when paired with Internet of Things (IOTs) technologies, such as sensors and RFID tags. Maersk, a shipping and logistics company, has intra-continent supply chains that implicate dozens of personnel and hundreds of exchanges. They assess that blockchain could save them billions by enhancing efficiencies that lessen fraud and human error.[10]

The benefits of candour extend to all legitimate market players. Blockchain technologies can prevent price extortion and delayed payments while eliminating middlemen and lowering transaction fees. This can lead to fairer pricing and even help small-holder farmers capture a more significant part of their crop value.[11]

For example, small-holder coffee farmers in Kenya normally brings a price around 15 times what farmers get paid—and then roasters pay even more. Blockchain can add pricing clarity between farmers and the marketplace. Grain millers are seldom answerable to farmers. They often report lower milling yields, so farmers fail to capture the actual value of their crop. In other cases, transportation companies report higher losses, and traders say lower grades and pricing than what was allocated at the exchange. Since each participant in the supply chain reports the exact figure to both the sender and the receiver of the delivery, the actual value of a farmer's harvest can be easily verified.[6]

Farmers worldwide, from West African cocoa planters to Indian sugarcane farmers, depend on buyers to honour contracts and pay promptly. Consumers often enter price agreements with farmers before the season begins, but default when reversing futures prices makes the contract unprofitable. Then the poor farmers are left to race for another buyer. Those fortunate enough to find another arrangement may be compelled to take a major price cut. The lag often means significant spoilage among products, eroding the value of the sale even more.[8]

One start-up, Full Profile, is tackling these issues by enabling real-time transactions for farmers through "smart contracts" that run on the blockchain. Because pre-approved reasoning can be built into a blockchain—as long as all players have opted in—payments can be made instantly pursuing the transfer of purchase ownership. The complete profile has calculated that supply chain risk, inefficiencies, and defaulting cost the Australian grains industry $1.5 billion, a substantial proportion of which can be recouped via blockchain solutions.[9]

Even when contracts are honoured, currency fluctuations can create unnecessary costs for all players in the supply chain. Russia has developed a cryptocurrency just for their beef market to shelter farmers and traders from this volatility. Blockchain technology is being utilized by banks to also mitigate threats through innovative insurance products which use satellite-collected weather data to ascertain farmer identities and claims.

IV. ROADBLOCKS TO BLOCKCHAIN ADOPTION

Blockchain technologies may seem like an elixir for the myriad problems afflicting the food and agricultural sectors. Yet critics argue that plenty of supply chain tracking solutions are already in place and that "blockchain is a solution looking for a problem." Many adoption hurdles dampen the touted benefits of blockchain solutions. All parties in a supply chain must embrace the technology, and all companies and organizations are not equally handy. Total concentration across all parties is essential for successful blockchain integration. Overall, blockchain adoption needs access to a reliable internet connection. Beyond smallholder farmers in developing countries, broadband is not a feasible option for numerous farmers living in rural areas. Approximately 10 percent of the United States population does not have a high-speed internet connection. That number jumps to 41 percent in rural areas of the US. The lack of

infrastructure required for digital transactions will need to be addressed before farmers can adopt blockchain.

Undue uncertainties can result from something as uncomplicated as an individual losing a private key. At worst, a compromised key jeopardizes the safety of the entire chain, mainly if that key falls into the hands of hackers. While blockchain is meant to stop fraud, digital transactions can be just as powerless as paper ones if they're made the prey of hackers and not adequately secured. The accepted "immutability" of blockchain information could make it easier for intruders to change the authorized ledger to one party's usefulness (such as covering a failed pesticide test or adding a bogus organic certification).

Security crises may be the most significant limitation for blockchain to overcome. Every transaction becomes data that is then stored. While blockchain is deemed safe and "unhackable," the same can't be said for the systems created around the technology. Security violations in Bitcoin exchanges and, more lately, in Ethereum exchanges have directed hundreds of millions of dollars in losses.

Any device utilized in the blockchain is also a possible source of susceptibility. Weak passwords and a poor network structure can reveal an entire business to hackers striving for a ransom or lost productivity. IoT botnets consisting of thousands of intelligent devices taken over due to faulty security have led to widespread internet outages. Adopting new technology requires trust, which may be hard to come by with farmers wary of new technology in the news and who don't have access to high-speed internet access.

V. CONCLUSION

Blockchain could alter agriculture, but that result is very much in the future. The technology will acquire an abundance of chances to thrive as food security becomes an ominous challenge in the face of climate change. Nevertheless, plenty of hitches could stop blockchain adoption in its trials. Regulation discrepancies may also contain widespread adoption, especially among international food and beverage companies. While smallholder farmers in developing countries might benefit the most from blockchain, they may face the most difficulty adopting it. Spotty network connectivity, outdated technology, and knowledge gaps could all impede the implementation of blockchain or at least require further innovation for success. There’s also plenty of scepticism about many of the claims and benefits. Blockchain proponents argue that it can quicken transaction times and trust between parties since all parties need to sign off on each immutable transaction. Finding the proper balance of flexibility within customized blockchain systems may thus allow all parties to appreciate the benefits of this potentially powerful technology.

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