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Improving the Efficiency of Supply Chain in Agricultural Produce Using Blockchain

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***Abstract*—** The asymmetry in the information pertaining to agricultural supply chain is extremely evident in developing countries like India. Also, the entity worst affected by this asymmetry are the farmers, who do not receive their fair share of in spite of being the most crucial contributors to this food cycle. Moreover, dealing with specific agricultural produce which h ave a short shelf life becomes a complex task with higher rate of wastage every year. With the help of a distributed ledger system in place, we help track the agricultural produce supply chain in every part of the country by replacing whatever supply chain tracking or centralized record keeping mechanism is already in place to provide complete transparency of the lifecycle of produce and enabling faster transactions between nodes and in turn helping the farmers reap the best benefits of their hard work. This would bring complete transparency in nodes where the efficiency is lost, parti cularly, brokers, distributors, regulators, retailers, government departments, etc., Easy and accurate access to this information will improve the overall efficiency of the supply chain and in turn benefit all the entities involved equally.

***Keywords*—** blockchain, distributed ledger, agriculture, farmers, hyper ledger, agri-blockchain, supply chain management, smart contract, circular economy.

I. INTRODUCTION

As per the "India Economic Survey 2018", agriculture contributes 17-18% to the country's GDP and employs over 50% of the total work force [1]. With a huge sector of our country relying on farming, the stakes are extremely high on ensuring that the sector remains a viable option for farmers and that technology and other forms of advancement are implemented as and when needed to support their growth. However, a 2014 study by the Centre for Study of Developing Societies (CSDS), New Delhi pointed towards an agrarian crisis, with increasing number of farmers giving up farming [2]. 62% of the interviewed farmers were not aware of the Minimum Support Price (MSP) set across by the government, and the ones that did know, were by majority dissatisfied by the standard MSP across crops [2]. Market prices for commodities are far from consistent across various outlets and this all increases the burden on the farmer. Up to 75% of the farmers in our country, who hold less than 1 hectare of land (identified as small and marginal farmers), have their income lesser than their expenditure, which increases their burden to sustain [3]. This has resulted in more number of farmer deaths over the past decade. In 2015 alone, 12602 people involved in farming sector committed suicides [4].

The need for transparency in the supply chain management to better manage the lifecycle of agricultural produce is what prompts us to a blockchain powered supply chain to track and trace the origin of produce as well as make the supply chain completely immutable and trusted. This would replace the current centralized record keeping system, thus eliminating the need for third parties to be involved.

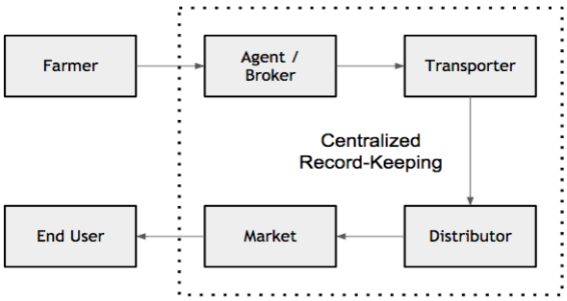

Figure 1. Current agricultural supply chain model

Our proposed mechanism showcases a decentralized blockchain powered supply chain to replace the current centralized record keeping system, which will store everything concerning the produce as they move through the value chain. This will also help facilitate smoother financial transactions which will increase the speed by which farmers receive the payment for their commodities, improving the efficiency of the entire supply chain.

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The paper is organized as follows, Section I contains the introduction of the proposed mechanism, Section II contain the related work in blockchain implemented solutions for agriculture across other countries, Section III contains the architecture and essential steps of the proposed mechanism, section IV explains the methodology of the mechanism with flow chart, Section V concludes the research work with future directions.Since this isn't a centralized database or a repository of transactions, anyone can participate in the network as a node and access the blockchain ledger. The transaction data sent across to the network is hashed by means of a SHA256 cryptographic hashing function and then upon successful validation from the nodes, is stored in a block with the timestamp and hash of the current block.

II. RELATED WORK

In Arkansas, U.S.A., a farmer-owned agricultural cooperative called Grassroots, partnered with Provenance and Heifer International, has implemented blockchain within its supply chain to track and trace poultry throughout its lifecycle. The integrity of the supply chain is thus maintained since it is completely traceable throughout its lifetime. Agridigital, another blockchain startup, from Australia, has demonstrated an implementation for a blockchain powered supply chain to track and manage grains. This also includes facilitating financial transactions in order to fast-track the payment sanctioned to farmers.

Aside from these, respectable amount of studies has been done in replacing the traditional record keeping with a blockchain powered food supply chain in agriculture-oriented countries like China and Japan [5] [6] [7]. The case study on a blockchain powered agriculture supply chain published in 2019, suggests a scenario aptly applicable to India with a multi-agent system to solve the organizational structure problem within the supply chain [7]. This multi-agent system, amongst others, will enable further transparent tracking on third-party and government aided brokers, part of the supply chain. A multi-agent system would be a framework enabling multiple agents that cross-reference or communicate with each other in a variety of transactions. Such systems are known to solve various problems in supply chain management [8].

At the basic level, a blockchain is a distributed ledger capable of storing transactions which maintains validity through replication of data across the various nodes in the network [9]. It gained popularity in recent times, with the large scale open source implementation called Bitcoin, which enables users to transact using a cryptographically created currency [10]. These transactions are then validated by the nodes in the network (miners), who validate the authenticity of every transaction by means of proof-of-work [11].

III. ARCHITECTURE

The proposed mechanism for Indian agricultural supply chain management involves a decentralized blockchain with multiple nodes and a smart contract to approve and manage the transactions.

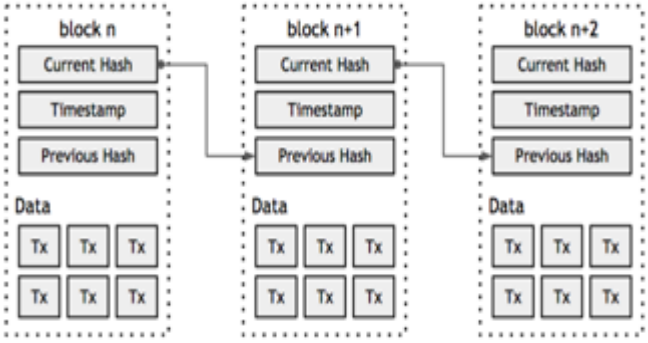

Figure 2. Connected blocks of data in a blockchain

Along with this, every block also contains a matching hash of the previous block, thus connecting them in a "chain of blocks". This ensures that the security of the data is maintained, since once a block has been added to the blockchain, it is not possible to move or remove it. The chain is immutable across all the nodes in the network.

A smart contract is a "computerized transaction protocol that executes the terms of a contract" automatically [14]. The clauses of the contracts are present in code in the function, hence eliminating the need for an approving third party. Smart contracts have a specific address on the blockchain, triggered by calling the address of the smart contract with the transaction data and the function is executed independently and automatically across the network [15].

IV. METHODOLOGY

The proposed implementation will be hosted on a smart contract based blockchain, similar to the Ethereum Project or the EOS Infrastructure [12] [13]. The blockchain network dedicated for the supply chain would replace the "trust" powered third party participants. The present supply chain, as shown above, begins with the farmer / producer. The chain then follows through the lifecycle of the agricultural produce, until the end user. Every entity in the chain is connected only to the immediate previous and next entity in the chain. This system relies on trust to validate the transactions occurring throughout the chain. With lack of transparency and security the nodes approve and accept the information passed on to them by the previous node. This being replaced with a blockchain powered implementation, would connect all the entities to a singular network through a multi-agent system, by means of smart contract enabled functions to approve the communication. Every entity, irrespective of whether it is the

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producer, agent, broker or distributor would have access to the blockchain as an agent, to update their transaction. The validity of the transaction would be verified on the network by the nodes and a new block with recently validated transactions will be added to the chain. Anyone can access the chain and trace validated transactions. This would enable transparency at the transaction level.

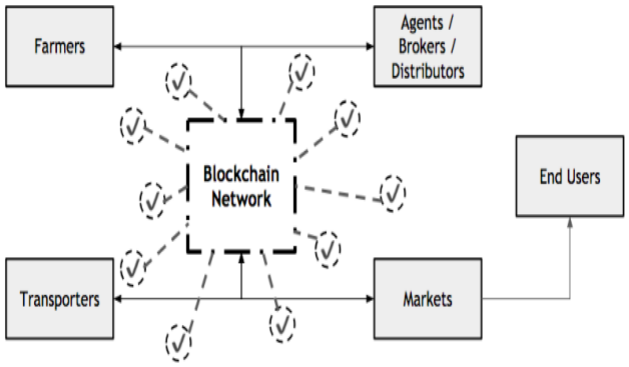

Figure 3. Architecture of the current blockchain food supply chain

However, to add a transaction to the ledger, the requesting agent / entity must sign the transaction with a private key, to indicate their signature or approval to the given transaction. This key is and sent along with the transaction as a request to the network. Upon successful validation by the network, the entry is added as a transaction in the next block. Since the data once added cannot be reverted, this creates a strong sense of responsibility for the entities involved.

Any node in the network not adhering to the rules of the network would end up forking the chain and creating a new fork with the incorrect data, hence exiting the chain untampered. To manipulate the data across the blockchain for any particular transaction or set of transactions, the intended party would have to manipulate all the nodes in the network, which would be practically impossible to achieve. The data present across the network will be completely decentralized and transparent and any entity can search and access the details of any transaction.

This proposed mechanism of the agricultural supply chain will eliminate all the disadvantages associated with the current supply chain in the Indian agricultural sector and give an upper hand to the producer / farmer. Since the farmer will have the transparency to validate the transactions and have knowledge of every unit of the produce, in terms of stage in the lifecycle as well as financials involved, this would give a missing advantage to the Indian producer.

V. CONCLUSION AND FUTURE SCOPE

Our proposed mechanism suggests implementing Blockchain to replace the current supply chain in the agriculture sector in India. However, the gain from implementing Blockchain enabled solutions for agriculture do not end here. With successful use cases across the globe, in the areas of crop and soil monitoring, warehousing and distribution, retail pricing, marketing and sales, food safety and quality control, land and other resource usage, as well as, further preventive measures towards natural calamities like floods, draught, etc., the benefits of blockchain in agriculture are innumerable. We have proposed a more transparent, visible and farmer-oriented solution to manage the agricultural supply chain in our country. If implemented within the current infrastructure, further enhancements to the same, as well as, more implementations of blockchain to decentralize and enhance the agriculture sector overall, would follow.

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Authors Profile

Mrs. Spurthi N. Anjan pursued Bachelor of Engineering from Visvesvaraya Technological University, India. She is currently pursuing Masters of Technology in Computer Science and Engineering from R.N.S.I.T, Bangalore, India. She has over 5 years of industry experience primarily as a DBA in IBM. She has published research papers in reputed journals and conferences. Her main research work focuses on Machine learning , Big Data Analytics and Blockchain.

Mr. Johnson P. Sequeira pursued Bachelor of Science from the Mangalore University, India in 2013. After that, he began his working career with IBM India Pvt. Ltd. as a web and applications developer. In 2017 he began his own startup in the fields of web development, applications development and branding, and since then has been actively involved in multiple projects globally. Having worked in the fields of distributed ledger / blockchain as an advisor and consultant for a healthcare organization, he is currently working on a self-managed project for blockchain solutions for the pet industry. He has published a research paper in the field of machine learning for an Indian publication. His main interests include Cryptography Algorithms, Hybrid Mobile Applications, Cloud Networking, dApps and Blockchain based education. He has over 7 years of industry experience.

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