

## **IMPROVING AGRICULTURE AND SUPPLY CHAIN BY USING BLOCK CHAIN TECHNOLOGY**

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### **ABSTRACT**

This paper documents experiences and findings about Block chain for Agriculture and supply chain. The paper aims to contribute to a better understanding of the Block chain technology and its implications for agrifood, especially how the agriculture and food supply chain can be improved in order to benefit people and the farmer. Block chain is a rising advanced innovation permitting pervasive monetary exchanges among conveyed untrusted parties, without the need of agents, for example, banks. This article analyses the effect of Block chain innovation in farming and nourishment production network, presents existing continuous undertakings and activities, and talks about mostly ramifications, difficulties and potential. Our discoveries demonstrate that Block chain is a promising innovation towards a straightforward inventory network of food & agriculture with numerous continuous activities in different sustenance items and supply chain related issues, however numerous limitations challenges still exist, which prevent its more extensive notoriety among ranchers and frameworks. These difficulties include specialized angles, training, approaches and administrative structures.

**Keywords:** Supply chain, Food, Agriculture, Block chain technology, Proof of concept  
**JEL Classification:** Q1, O3

### **I. INTRODUCTION**

#### **Block chain for Agriculture & Supply chain**

Block chain can possibly change totally is agribusiness. It may not appear as captivating as banking or human services, yet this outrageous industry supports our public. All the more significantly, it has a developing number of issues that frantically need unravelling. Agriculture contributes 16% to our economy. Shri Ram Raghvan (Vice President, IBM, India) believes that

the two major problems faced by the agriculture sector include low productivity and lack of visibility through the supply chain (Capital, 2018).

### **1.1 Prospect of using Block chain in Agriculture:**

**1.1.1 Crop and Food Production:** Catering the needs of the increasing population by growing more food with minimal resources while reducing environmental footprint, maximizing customer satisfaction, enabling transparency across the supply chain and guaranteeing fair income to farmers while handling the vagaries of the weather- the agriculture sector has many challenges to overcome while improving profitability under unfavourable environmental conditions. From farmer to manufacturer and grocer, Block chain coupled with IoT is remodelling the food production industry.

**1.1.2 Food Supply Chain:** Food Supply Chain tracking is critical to exploring the source from where the food has originated or grown. It is essential to ensure that the supplied eatables are safe to eat. But when it comes to the way the food supply chain is managed currently, it becomes challenging for the food producers and retailers to confirm the provenance of the products. With the emergence of the Block chain, it has become possible to bring trust and transparency in the food supply chain ecosystem, ensuring food safety for everyone.

**1.1.3 Controlling Weather Crisis:** Predicting and monitoring weather conditions are essential to the crop survival. The oxygen concentration level reaches zero, making it difficult for the plants to perform life-sustaining functions like water uptake, root growth and respiration. The lack of transparency in the current food chain ecosystems can result in unclear and high surge pricing. Consumers do not have an idea when did the crops suffer lousy weather conditions and what led to the increased costs. Due to the ability of Block chain to offer traceability and transparency, farmers and other stakeholders will be able to get a clear understanding of the price differences in the food distribution market.

**1.1.4 Managing Agricultural Finance:** Lack of transparency, credit histories and difficulties in contract enforcement are some of the myriad problems confronting between formal financial inclusion and smallholders. The inability to access financial services can have an adverse impact on the performance of agricultural value chains due to which producers cannot maximize their yields and buyers face struggles ensuring an efficient supply of commodities. The financial services do not only enable smallholders to invest in the agriculture, but also assist them in relieving liquidity constraints. It results in the difficulty for buyers to pay farmers on delivery, forcing poor smallholders to sell crops at the lower rates. Block chain brings fairness in the process of agricultural finance via transparency and shared control accessibility.

## **II. REVIEW OF LITERATURE**

Block chain is a digital innovation for recording and checking exchanges. The distributed ledger record is a lasting, secure instrument that makes it less demanding to make cost-efficient business systems without requiring a brought together purpose of control. The use of this developing innovation is demonstrating extraordinary guarantee in the venture. With the expectations of Start-up India and Digital India, Block chain innovation can be a powerful method to accomplish the objectives of the activities and facilitate the business in India. Block chain innovation has been demonstrated and gives all the required security highlights to execute the arrangement rapidly (InsightsIAS, 2018). The last three years have seen an explosion of interest in Block chain Technology with a great many companies and research institutions focusing on potential applications of this technology across a spread of monetary, industrial and social sectors. Block chain is still in an early stage of development, with considerable potential for real life commercial applications (Lan Ge, 2018).

Key technical choices of Block chain include:

- Permission design, i.e., whether permission is needed to access the Block chain
- Choice of consensus algorithm, i.e., how a new block is added to the Block chain;
- Whether or not to use smart contract, i.e., whether to use the Block chain as a virtual machine where programs representing business processes are run;
- Whether or not to use cryptocurrency, i.e., whether the consensus algorithm and smart contract operations depend on an artificial currency or not. For BCT implementation, technical choices often result from the governance model chosen for the ecosystem of participants.

An expanding request in the public arena for more noteworthy data about sustenance mirrors the requirement for more straightforwardness and the absence of trust. In the meantime, increasingly more nourishment items and drinks are marked and joined by an assortment of confirmation plans, with an expanding danger of misrepresentation (selling inadequate item with superb marks or claims) and debasement. In the current situation, much of the compliance data and information is audited by trusted third parties and stored either on paper or in a centralised database and these approaches are known to suffer from many informational problems such as the high cost and inefficiency of paper-based processes and fraud, corruption and error both on paper and in IT systems. These information problems, indicating that current transparency and trust systems have not been able to solve or at times even have exacerbated the problems of low transparency and trust in agrifood chains, pose a severe threat to food safety, food quality, and sustainability. Block chain technology provides a way to confirm length of records and doubtless to facilitate

the sharing of information between disparate actors in an exceedingly food price chain This potential may lead to an exciting paradigm shift facilitating transparency and trust in food chains that ensures food integrity (Lan Ge, 2017).

### 2.1 Block chain background

In the simplest terms, a Block chain consists of a linked chain that stores auditable data in units called blocks. Many commentaries online start by explaining that a Block chain is similar to a Google document spreadsheet where multiple authors can contribute because of the mechanism of locking. Block chain is a bit more complex than that example and has unique characteristics that make it an attractive technology for tagging, storing and tracking anything of value. Bitcoin was one of the first and most popular implementations of Block chain technology.

To begin, a Block chain consists of blocks, each block containing the data (anything of value), its own hash value (a unique cryptographic value containing characters and numbers generated through a complex computational algorithm) and a pointer to the hash of the previous block.

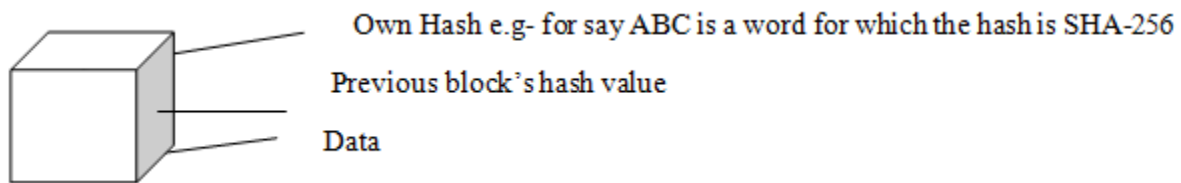


Figure 2(a): A Block

Similarly, there are many blocks, which has a chain mechanism with each other. Like in the following diagram:

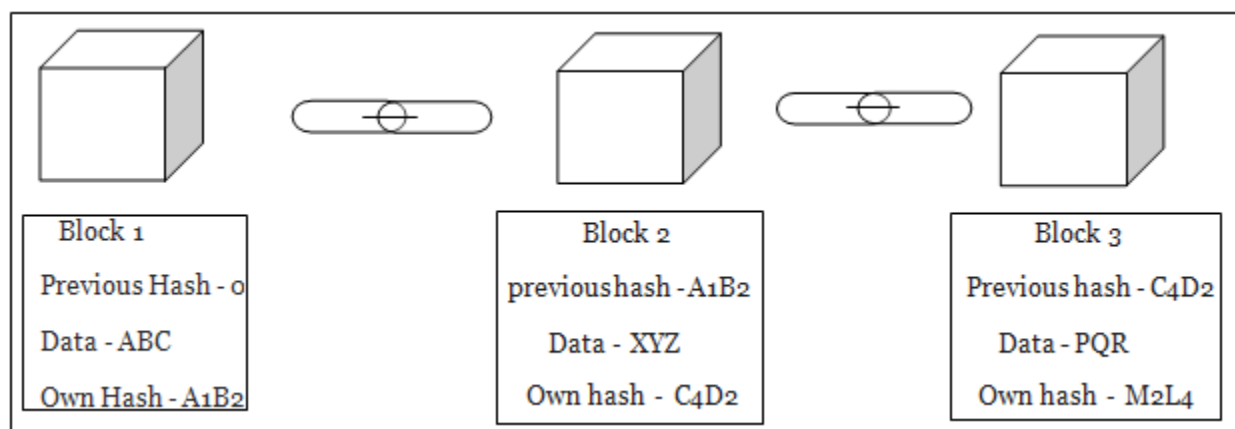


Figure 2(b): Block chain mechanism

## **2.2 Proof of Concept (PoC)**

This PoC pilot has exhibited that it is attainable to put fundamental data concerning testaments on a Block chain with a permissioned record and a brilliant contract. Contrasted with customary circumstances with unified databases, the PoC demonstrator indicates how a Block chain can be utilized to guarantee that diverse gatherings share a similar layer of data on the legitimacy and provenance of testaments that is carefully designed. This component can conceivably build the estimation of declarations (Andreas Kamilaris, 2018).

There are a few restrictions to the PoC demonstrator. To start with, the measure of information and data that is shared is restricted. For straightforwardness, our demonstrator concentrated on one shrewd contract with all members ready to peruse and compose. All members in a savvy contract (under this engineering) approach all information, and along these lines in a true sending, numerous keen contracts would should be sent for the distinctive legally binding connections so as to keep business secrecy. A significant perspective that would should be tended to is the association between shrewd contracts and the plausibility of information streams between brilliant contracts. The constraints of the PoC demonstrator, in any case, have little effect on its incentive in improving the comprehension of BCT, but instead recommend bearings for further research. To get better knowledge into the additional estimation of Block chain in all the more genuine cases, these issues ought to be tended to in further research and investigation.

## **2.3 Transparency and Trust in agrifood: food integrity**

The present-day supply chains are looked with numerous issues that have to do with the unwavering quality of data: buyer trust, store network straightforwardness, item quality, calculated issues, natural sway, individual buyer information, extortion, sanitation (Trienekens, 2012). Consumers are progressively worried about the security and supportability of nourishment and require more data on agrifood chains. The length and unpredictability of present day agrifood chains, nonetheless, have made a separation among purchasers and makers that makes it infeasible for shoppers to address their worries and questions straightforwardly to the producers. Expanding interest for nourishment data mirrors the requirement for straightforwardness and absence of trust. In the meantime, increasingly more nourishment items also, refreshments are marked and joined by an assortment of affirmation plans, with an expanding danger of extortion (selling inadequate item with top notch marks or claims) and debasement. In the current situation, much of the compliance data and information is audited by trusted third parties and stored either on paper or in a centralised database and these approaches are known to suffer from many informational problems. Notable problems are:

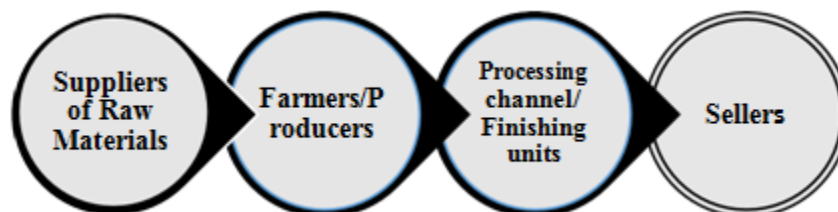
- The high cost and inefficiency of paper-based processes.
- Scam, corruption, blunder both on paper and in IT systems.
- Integrity of digital records (problems due to human error and data tampering).
- Double-spend of certificates.

These information problems have resulted in low transparency and trust in agrifood chains and pose severe threat to food safety, food quality, and sustainability. In particular, food integrity has become a major concern. Food integrity refers to the fairness and credibility of food in food pricechains each at the physical layer and the digital layer, where the digital layer should provide reliable and trustworthy information on the origin and provenance of food products in the physical layer. Block chain innovation gives a way to guarantee perpetual quality of records and possibly to encourage the sharing of information between dissimilar entertainers in a sustenance esteem chain (in spite of the fact that this is an open inquiry). This potential may prompt an energizing change in outlook encouraging straightforwardness and trust in complex supply chains (Bessems, 2017).

## **2.4 Value chain models**

An Agricultural Value Chain approach involves a change in focus from inputs to supply chains that create value as perceived by the customer and results in a backward and equitable flow of value. The participants in the value chain improve their competitiveness through product standardisation, differentiation and food safety required in a competitive environment and improve competitiveness through innovation driven through better access to technology, credit and market opportunities.

### **Illustration 1: Conventional Supply chain**

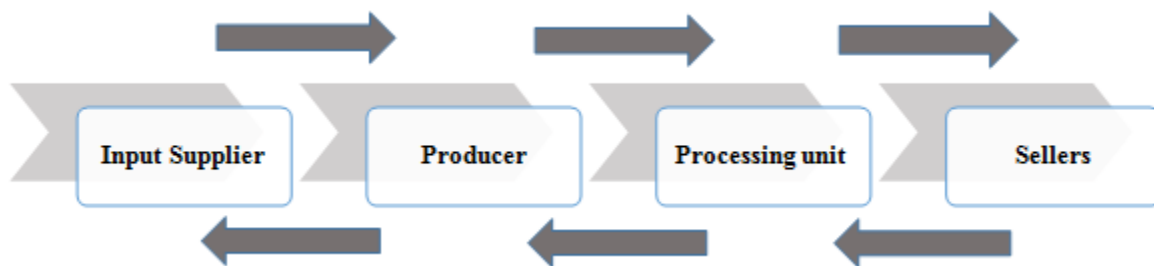


The concepts to value chain analysis has been explained below:

- Receiving the various stakeholders together and organising business linkages is the initial objective;
- Effective co-ordination of decisions and their exchanges is required for different participants in the value chain to work together;

- The governance of the value chain covers the rules regulating co-ordination within among the stakeholders;
- Increasing the value of the value chain is possible only by increasing the consumer demand;
- Beyond meeting the consumer demand the participants of the value chain need to be competitive;
- To maintain competitiveness the value chain needs continuously to innovate;
- For the value chain to be sustainable in the market and to establish effective linkages the chain needs to distribute benefits among the various participants.

**Illustration 2: Proposed model of Value chain with Links between Consumers and Producers**



The feature of an operational value chain shall include the following:

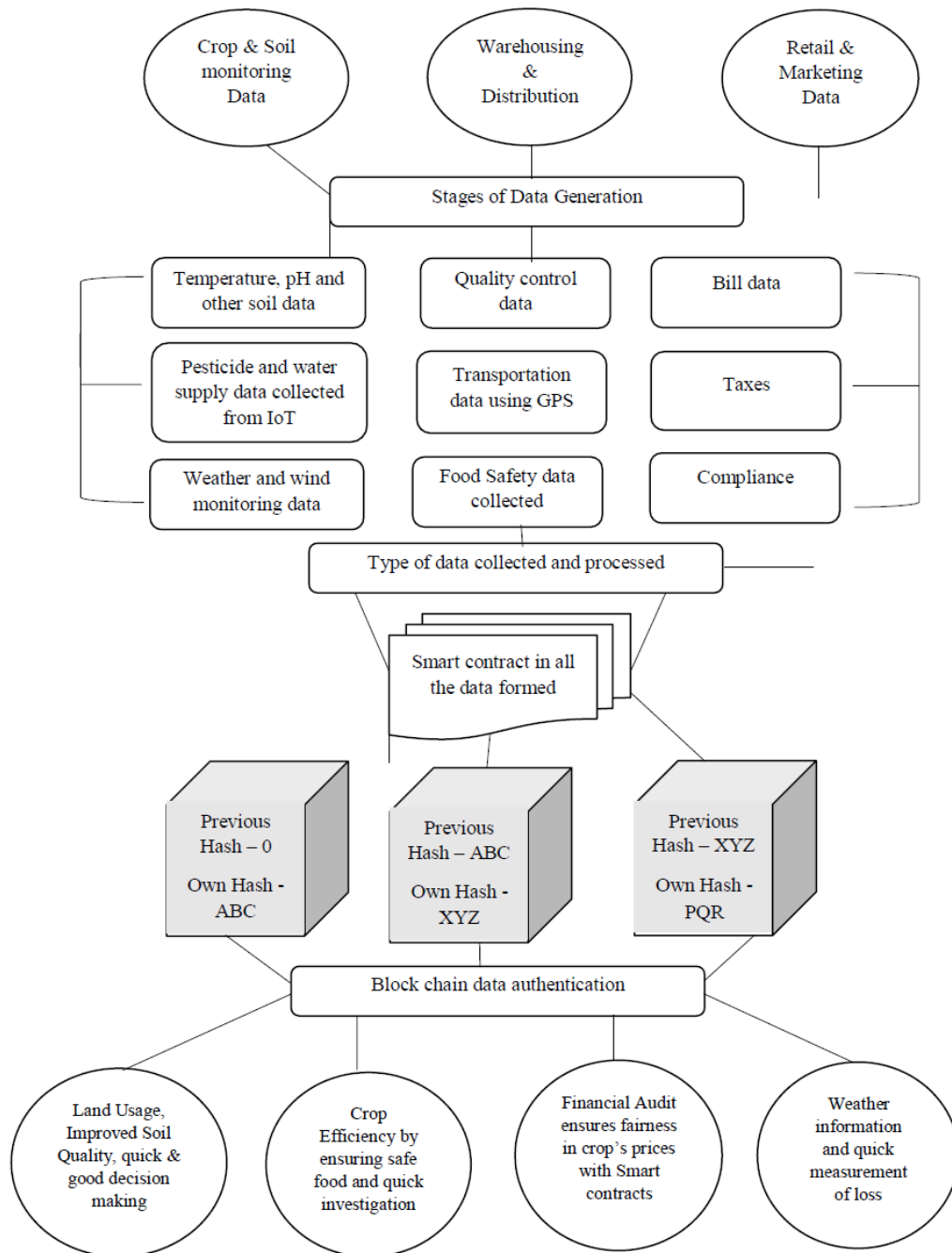
- Illustration 2 is showing forward and backward channel of flow of information;
- Distinguished products
- Constantly innovates, i.e., products, technologies;
- Creates higher value;
- Uses organizational mechanisms to achieve efficiency;
- Goes beyond spot market transactions and includes contracts, vertical integration, networks and supply chains.

### **III. PROPOSED MODELS**

Block chain technology offers tremendous opportunities to improve supply chain transparency, traceability and reduce transaction costs. Block chain makes use of cryptographic trust, is inherently traceable, time stamped, censorship resistant, distributed ledger and is near real time. Further enhancements in this innovation have empowered calculation based shrewd contracts which empower coordination of authoritative connections between confided in exchanging partners through self- verifying and self-executing agreements replacing intermediaries

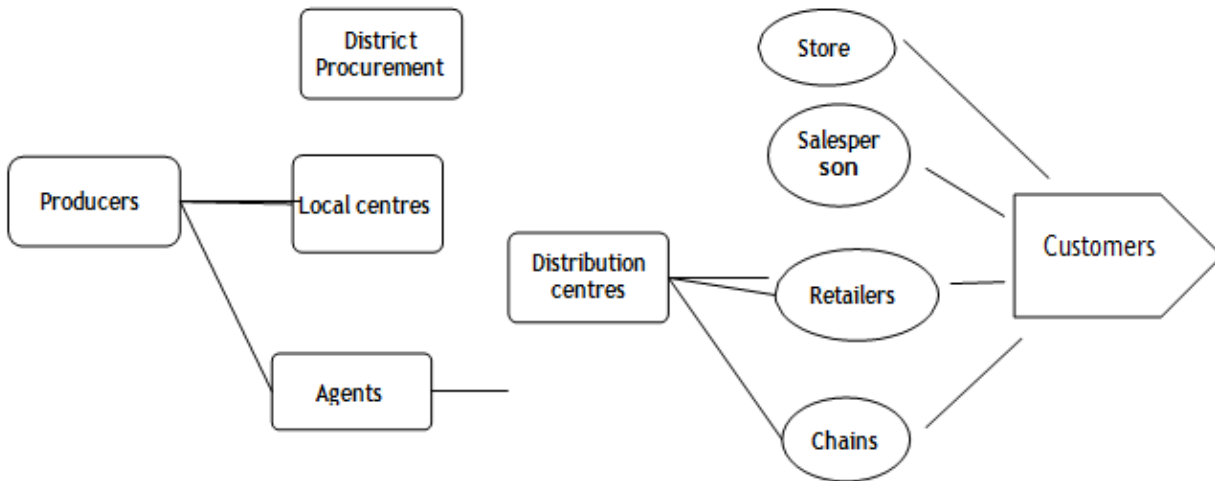
completely.

**Model 1: Showing ways to transform the crops and food items which are produced (Figure 1)**





Model 2: Improved Value chain (figure 2)



### 3. Model Interpretation

#### 3.1 Detail process of How Block chain can transform the way crops are produced:

Model 1 includes following step by step detail of the process:

**Step 1: Setting up IoT(Internet of things) devices:** IoT sensors and devices generate data which can help farmers make well informed decisions related to the growth of the crops. The information gathered from the IoT devices first need to be structures before getting saved on the data.

**Step 2: Cleaning and Enrichment of data:** Data enrichment is done to add more value to improve the quality of the captured information.

**Step 3: Making data ready for compliance:** Saving data on the Block chain does not mean that it should not be compliant. By using machine learning compliance should be ensured.

**Step 4: Making data more useful for following purposes:**

- Crop Quality Recommendations
- Crop Identification
- Crop Yield Prediction
- Crop Demand Prediction

**Step 5: Data gets saved on Block chain database:** The data gathered by machine learning gets stored on Block chain database and Smart contracts facilitates the exchange of data stored on the Block chain within the network.

### **3.2 Food Supply Chain**

Tracking Food supply chain is critical to exploring the source from where the food has originated. Compared to the old fashioned Letter of Credit Supply Chain Finance now encompasses trade finance instruments like factoring, reverse factoring, payable financing and dynamic discounting. A buyer led multi- investor securitisation process in an Enterprise Resource Planning ERP process and one involving Block chain process (Sam Haveson, 2017).

#### **3.2.1. Explanation of how the food supply chain the Block chain can reduce food frauds:**

It involves following steps for the explanation;

**Steps 1: IoT sensors generating data or Farmers storing data:** Smart farming allows sensors to generate crucial information related to the crops sown in the fields. When the farmer is not utilising technological methods, at that point they can basically store the fundamental data, for example, crop quality, kind of seed and climate conditions under which harvests sown.

**Step 2: Distributing grown up crops to companies for processing:** Once crops are grown up it can be transported to the refineries via IoT enabled vehicles. Storing data on the Block chain can also ensure if the compliance has been met at every step of supply chain.

**Step 3: Supply of Processed food to wholesalers and Retailers:** After the food items or crops are processed, wholesalers and retailers can bid for the products they want through the bidding platform. Block chain offers traceability in the supply chain, helping food companies conducting food recalls or investigations quickly.

**Step 4: Consumers can back trace the supply chain:** from farm originating details to transportation details, batch numbers, food processing and factory data, expiration details, storage temperature and other details digitally linked to the food items within the Block chain, consumers can explore everything by back tracing the supply chain.

#### **Model 2: Improved value chain system**

A traditional vegetable supply chain in India covers a long supply chain of producers, consolidators, sub agents, agents, transporters, merchant, exporters, wholesalers, retailers etc. before the consumers. It is sought to transform the supply chain as shown in figure 2. The local

government level consolidation centres, district procurement centres and wholesale markets are the major players apart from retailers. The model is based on backward integration and is focussed towards building the entire value chain from farmer to end customers. By improving the infrastructure at the local body level and district procurement centres and the wholesale markets, quality and safety standards can be adhered to, shelf life can be increased, grading and packaging can be organised more effectively, post-harvest losses can be reduced and farmers can obtain better returns. Better demand information travels across the chain and harvest calendars, logistic plans etc. can emerge effectively creating value additions. Use of collective market / certification marks and Geographical Indicators can be important tools for improving standardisation, quality control and for better market value. As an effort in differentiation of products organically produced vegetables can be aggregated separately and branded and marketed through eco chains. Strengthening food safety through improving food testing facilities and improving traceability It is observed that fruits/ Vegetables or fish/meat from other states is laden with harmful chemicals artificial preservatives and pesticides.

### **3.3 Policy recommendations**

Given the quickly expanding dimension of digitalisation and interest for data and item trustworthiness, the agrifood area is in an exceptional position to investigate the capability of Block chain technology. Despite the fact that the use of Block chain in agrifood is right now still in its early stages, it very well may be normal that an ever increasing number of activities will be taken by different associations. Left ungraceful, this can result in the misuse of assets and botched chances for organizations and society in general.

### **3.4 From a policy perspective, the following recommendations can be made:**

- Support and stimulate development of Block chain applications as part of the digitalisation strategy to improve transparency, efficiency, competitiveness and sustainability of the agrifood sector;
- Facilitate and encourage the growth of the ecosystem of Block chain-minded parties in agrifood chains;
- Design and implement a clear regulatory framework for Block chain implementations in agrifood domain;

The competitiveness of farming and agrifood SMEs is a key policy issue in India. To harness the power of Block chain requires the adoption of Block chain technology by many SMEs (Small & Medium Enterprise) in farming and agribusiness. Most SMEs are however too small or lack the expertise to invest in Block chain by themselves. Furthermore, given the current development of

Block chain, the uncertainties are too high to develop a convincing business case for individual parties. It is therefore important to address the application issues in public research agendas. The main focus of research is not on the Block chain technology itself, but on the application of it to suitable use cases.

### **3.5 Conclusion**

This study proposes a Block chain based supply chain model prototype that enables improved supply chain model for agrifood. Block chain uses will keep on growing over agribusiness. Tools to interface ranchers to the agriculture supply chain by means of Block chain are as of now underway. Block chain could acquaint with different difficulties also, by making it beneficial for merchandisers or processors to contract legitimately with farmers so as to safeguard farm level discernibility. The push towards character safeguarding and division underway agriculture could additionally support interest in on-ranch stockpiling also, direct-to-rancher advertising channels. The approach of useful advancements in the digitised age, for example, Block chain and smart contracts, has offered ascend to new answers for antiquated issues in developing markets. Agriculture, the world's least digitized segment, is a prime contender for interruption. Block chain appears to be a promising tool for reforming Indian agriculture. Block chain is still a very recent technology, so there's a long way to go before its full set of application can be developed and put into practice. Block chain isn't a panacea or a sharp method to settle the majority of horticulture's production network difficulties. Adopters of Block chain innovation will confront more prominent inspection in a media-rich condition when more prominent straightforwardness is offered on issues going from supportability practices to welfare. Block chain will likewise serve to improve supply chain accountability and responsibility.

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