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## Application of distributed ledger technology Blockchain in agriculture and allied sector: A review

**Lalita Garg and Kamal Kumar**

### Abstract

The blockchain is a ledger of accounts and transactions that are inserted and stored by all shareholders. It ensures a reliable source of openness about the status of farms, inventories, and agreements in the agriculture and allied sector. Blockchain technology can trace the origin of food and thus helps in creating authentic food supply chains and building trust between producers and consumers. Farmers can get instant data related to input material, soil, and weather conditions, all on one platform. Blockchain will help in building the link between farmers and consumers. It will empower small farmers to organize themselves and get closer to the market without the involvement of middlemen. This will reduce the problems of low income, as blockchain will give transparency in the supply chain, enabling farmers to get the real price for their product. At the same time, the integration of small and marginal farmers into the blockchain-based supply chain system poses many challenges. For this reason, in the application of blockchain technology to the agriculture and allied sector, it is necessary to carry out thorough research on the concerns. This article examines the application of blockchain technology in the Agriculture and Allied sector, as well as associated challenges.

**Keywords:** Blockchain, agriculture, allied sector, livestock, dairy, supply chains, insurance

### Introduction

The blockchain is a ledger of accounts and transactions that are recorded and stored by all participants. It ensures a trusted source of truth about the state of farms, inventories, and contracts in the agriculture and allied sector. Blockchain technology can track the origin of food and thus helps in creating reliable food supply chains and build trust between producers and consumers. Use of information and communication technology (ICT) increases the effectiveness and efficiency of data management in agriculture (Walter *et al.*, 2017) <sup>[43]</sup>. According to Brown (2015) <sup>[4]</sup> the remotely sensed data on soil conditions can support farmers' crop management. Mobile phones promote farmers' access to markets and provide financial support (Kaske *et al.*, 2018) <sup>[23]</sup>. Farmers can *get all* the agriculture input related data, moisture content and weather forecast on a single platform. It will empower small farmers to organize themselves and get closer to the market without the involvement of middlemen. This will reduce the problems of low income, as blockchain will give transparency in the supply chain, enabling farmers to get the genuine price for their produce (medium, 2018) <sup>[18]</sup>. This article examines the applications of blockchain technology in the Agriculture and Allied sectors. We will also discuss the challenges being faced by small farmers in creating the ecosystem for utilizing blockchain technology in the sector.

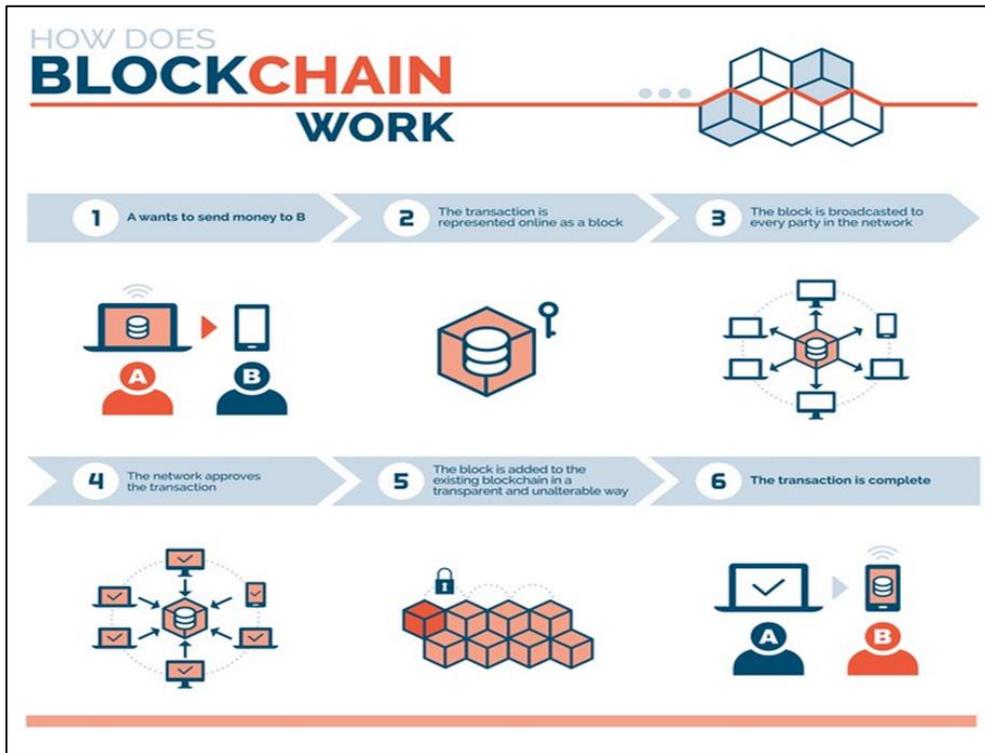
### What is Blockchain technology?

Blockchain is an especially promising and revolutionary technology because it helps reduce risk, stamps out fraud and brings transparency in a scaleable way for myriad uses (builtin). Blockchain consists of three components i.e. blocks, nodes and miners (builtin).

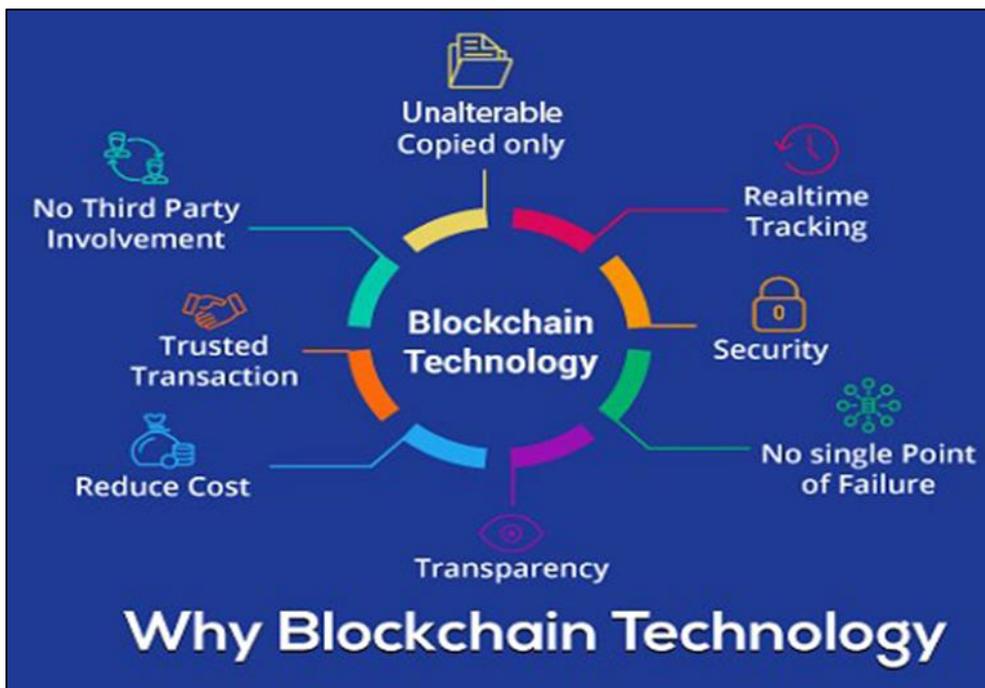
### Potential Blockchain technology benefits for agriculture and allied sector

Blockchain technology allows peer-to-peer transactions in a very transparent manner and without the requirement for an intermediary sort of a bank (such as for cryptocurrencies) or a middleman within the agriculture sector (Xiong *et al.*, 2020) <sup>[44]</sup>. Blockchain technology offers a secure approach to trace the transactions between anonymous shareholders. Sylvester (2019) <sup>[37]</sup> postulated that the concerns can be reported in real-time by consolidating smart contracts. The technology thus provides solutions to problems with food quality and safety, which are highly concerned by consumers and also the Government etc.

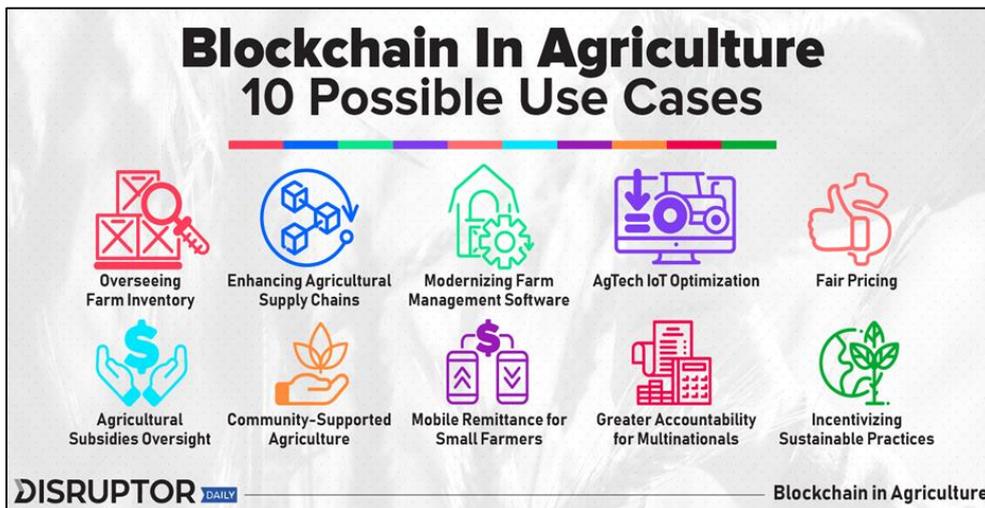
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**Application of Blockchain technology in agriculture and allied sector**

The superior features that blockchain has can potentially disrupt existing solutions not only in industry and commerce but in almost every aspect of our daily lives. Agriculture and food supply chains are well interlinked since agricultural goods are almost often used as inputs in an exceedingly multi-stakeholder supply chain, where customers are the end-users. Blockchain supply chain management is prognosticated to expand at an annual growth rate of 87%, from \$45 million in 2018 to \$3314.6 million by 2023 (Chang *et al.*, 2019) [45].

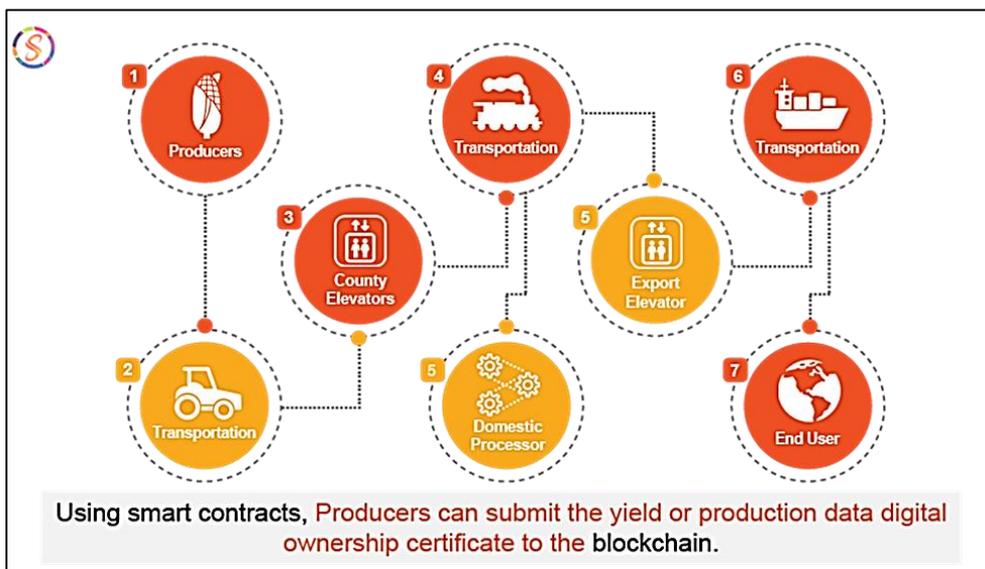
**Agricultural insurance**

Weather extremes threaten agricultural production, placing food security in danger (Lesk *et al.*, 2016) [26]. Indemnity-based insurances can accurately cover losses, however, they're vulnerable to problems arising from asymmetric

information problems (Just *et al.*, 1999) [20]. The productions that can't be measured, e.g., grazed meadows, can't be insured resulting into financial damage (Vroege *et al.*, 2019) [42]. Prompted by the drawbacks of indemnity-based insurances, the thought of index-based insurances was originated (Turvey, 2001) [39]. Blockchain can contribute to improving index insurance by ensuring timely payments and automatically integrating the weather information and other data sources (Gatteschi *et al.*, 2018) [12].

**Smart farming**

A key issue of building smart farming is developing a comprehensive security system that facilitates the utilization and management of the new oil i.e. data. Traditional ways manage data in a centralized manner and are susceptible to inaccuracy, data distortion, misuse and cyber-attack as well (Xiong *et al.*, 2020) [44].



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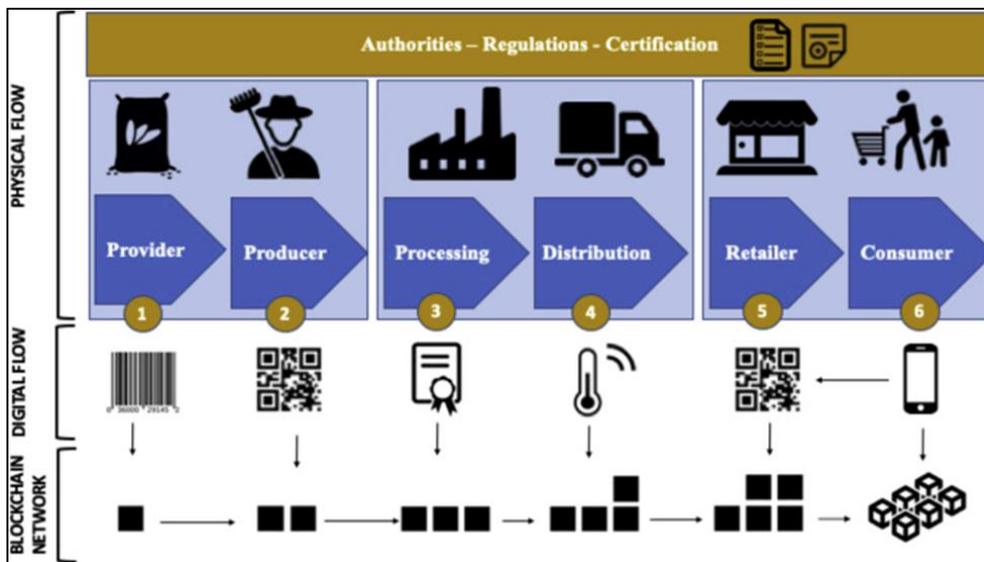
Blockchain technology ensures that the info and data are transparent to the participants and all recorded data are immutable (Catherine and Ezhilarasi, 2020) [1]. Blockchain technology generates security through decentralization instead of "security of vagueness" that traditional technologies depends upon (IBM Institute for Business Value, 2015) [19].

**Food supply chain**

Food being a huge, multi-trillion-dollar industry, and the worldwide food SC networks encompass the countless number of parties and players that are functionally and geographically diverse. There are some common problems in food supply chains like food traceability, food quality and safety and supply chain inefficiency, which add additional

risks to the society, economy, and therefore the health of humans. Organic produce, milk, coffee and tea, fruit juice, and olive oil are all on the list of commonly forged, diluted or adulterated foods (New Food Economy 2018) [32]. Mao *et al.* (2018) [28] and CoBANK (2018) [6] narrated that the blockchain has enhanced collaboration, confidence, and transparency in the food business. According to Walmart reports a further transparent and authentic record of actions on a blockchain can head to benefits including more trustworthy food, an enhanced movement to provide more original

products to consumers that boosts customers' trust (Chang *et al.*, 2019) [45]. Carrefour the Europe's largest retailer launched Europe's first food blockchain with one of its iconic animal product lines: free-range Carrefour Quality Line Auvergne chicken (Chang *et al.*, 2019) [45]. It includes the data like place and type of practice of chicken rearing, the name of the tenant, type of feed offered, veterinary healthcare treatments used, place of slaughtering, the place of meat processing and time of placement on the shelves of supermarkets (Chang *et al.*, 2019) [45].



Source: Google images

The use of blockchain technology helps in establishing a trust relationship of producer with consumers and build up the reputation of their products. As far as consumers are concerned the blockchain makes true and reliable information available about how food is produced and transacted. It helps in addressing the consumers' concerns about the safety, quality, and environmental friendliness of food (Ge *et al.*,

2017) [13]. According to Zhou *et al.* (2016) [46] blockchain makes reliable and accurate information available for regulatory agencies to carry out informed and efficient regulations. The work done by various researchers on application of blockchain technology for traceability is shown in the Table 1.

**Table 1:** Applications of blockchain technology for traceability across different agriculture sectors and products

Agriculture sector	Product	Research
	Crops	Umamaheshwari <i>et al.</i> , 2019 [40]
	Fresh fruit and vegetables	Feng (2013) [9]
	Bananas	Unurjargal and Comuzzi (2019) [41]
	Grains	Gunasekera and Valenzuela (2020) [15]
	Grapes	Ge <i>et al.</i> , 2017 [13]
	Maize	Wildt <i>et al.</i> , 2019 [7]
	Pasta	Hayati and Nugraha (2018) [16]
	Pepper	Chan <i>et al.</i> , 2019 [5]
	Rice	Kumar and Iyengar (2017) [24]
	Tea	Liao and Xu (2019) [27]
<b>Allied sector</b>	Honey	Dobbins <i>et al.</i> , 2018 [8]
	Salmon	Fishcoin (2018) [10]
	Fish	Lei <i>et al.</i> , 2020 [25]
	Chicken	Mohan (2018) [29]
	Halal meat	Rejeb (2018) [35]
	Pork	George <i>et al.</i> , 2019 [14]
	Turkey	Cargil (2018) [17]
	Meat	Feng (2013) [9], Unurjargal and Comuzzi (2019) [41]

**Blockchain technology in dairy sector**

India has enormous potential within the dairy industry, as we are the world's largest producer of milk and dairy sector is the rapidly growing sector. Dairy sector in India faced several problems like chilling centres, lack of value addition facilities,

quality of the products and lack of technical support. A study conducted by India's Food Safety and Standard Authority (FSSAI) shows that 68.4 percent of the country 's milk isn't in line with the legal norm (Shingh *et al.*, 2020) [36]. Today, consumers are way more aware and prepared to pay more if it

is of best quality and with zero adulteration. Blockchain technology has great potential for transforming the dairy sector, because it can address various challenges within the dairy supply chain that prevent transparency and traceability of the dairy products.

### Livestock sector

After the 2013 Horse meat scandal (Kamath, 2018; Montecchi *et al.*, 2019) <sup>[21, 31]</sup> Europe ordered meat supplier & other livestock commodity supplier to bring transparencies into the value chain, COVID 19 crisis will now be the tipping point, those that can't fulfill consumer's aspiration will lose the market share. Blockchain is that the only way forward. One application named 'Agro Trust' brings transparency in pricing by replacing middlemen from the value chain. The Information Network for Animal Productivity and Health (INAPH) program of NDDDB, used RFID technology to tackle stray animal menace & insurance fraud (invest India)

### Fisheries sector

Blockchain technology can use to tackle illicit, unreported & unchecked fishing, which abuses the marine ecosystem. World Wildlife Fund (WWF) working on a blockchain pilot project in New Zealand to trace all fish from vessels to supermarkets in order to tackle the illegal fishing & selling, easily (vetamit,2020) <sup>[3]</sup>.

### E-commerce of agricultural products

Tiago *et al.* (2017) <sup>[38]</sup> demonstrated that consumer with high overall trust is more willing to buy online, however, the fundamental information of agriculture products isn't easy to be confirmed and trusted by consumers. Reddy and Divekar (2014) <sup>[34]</sup> found that cash on delivery and logistics service are the foremost crucial challenges faced by e-commerce companies in developing countries. Blockchain technology may provide proper solutions for several aspects of those problems by ensuring information security, supply chain management, digital payment methods, and enhanced consumer confidence and by reducing the input cost of farmers.

### Challenges

Concerns associated data management within the blockchain, are important and need to be carefully worked upon (Pearson *et al.*, 2019) <sup>[33]</sup>. From a technical perspective, the accuracy of information data that are inserted by the sensors or by persons cannot be guaranteed, for instance, if a sensor malfunctions, then the data across the blockchain is not accurate (Galvez *et al.*, 2018) <sup>[11]</sup>. Blockchain will certainly increase the transparency of the food supply chain furthering the consumer trust, but its usage comes with an enormous energy and financial cost (Mondal *et al.*, 2019) <sup>[30]</sup>.

Behnke and Jansen (2019) <sup>[2]</sup> identifies 18 boundary conditions for food traceability, 5 of which directly apply to blockchain technology. Major of those are associated with regulatory requirements, the inner supply chain and production processes, which require significant organizational changes so as to support the complete benefits of traceability. Kamilaris *et al.* (2019) <sup>[22]</sup> analyzed the blockchain's impact on the agriculture supply chain, and the major challenges highlighted by them were, the accessibility to blockchain technology, governance and sustainability, policy and regulation, technical hurdles, and configuration arrangements that must be taken care of to achieve successful adoption of

such innovative technologies.

### Conclusion

Blockchain technology is a decentralized transaction environment where all transactions are recorded in a public record that is visible to all. The purpose of blockchain is to render anonymity, security, privacy, and transparency to all its users. However, these properties put several technical challenges and constraints that need to be addressed. In India farmers have small herd sizes and landholdings as well. The integration of these farmers into the blockchain-based supply chain systems poses many challenges. For this reason, to apply blockchain technology to the agriculture and allied sector, it is necessary to carry out a thorough research on these issues. The scientific research should be oriented towards a more practical approach for creating pilot applications and platforms as well as by combining them with big data, AI and machine learning techniques, in order to form a better, safer, and well protected agriculture and allied sector.

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