

# AgroChain: Decentralised Supply Chain Management System

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**Abstract:** *The “AgroChain: Decentralized Supply Chain Management System” research project explores the concept of decentralized supply chains for agriculture and their potential to revolutionize the food distribution system. Decentralized supply chains for agriculture are transforming the way food is produced, distributed, and consumed. By leveraging blockchain technology, smart contracts, peer-to-peer networks, and farmer cooperatives, this innovative system promotes transparency, reduces waste, empowers smallholder farmers, and ensures a resilient and sustainable global food supply. The proposed solutions to challenges include implementing blockchain technology for transparency, enabling direct-to-consumer models for fairer prices, utilizing data analytics and IoT devices for efficiency, promoting sustainability practices, supporting farmer cooperatives and capacity building, and exploring privacy-enhancing technologies.*

**Keywords:** Decentralized supply chain, agriculture, blockchain, transparency

## I. INTRODUCTION

The agriculture industry has several obstacles when it comes to effectively managing its supply networks. Conventional supply chain management solutions frequently have problems with fraud susceptibility, inefficiency, and a lack of transparency.(1) Blockchain technology has surfaced as a potential remedy for these issues. AgroChain is a decentralised supply chain management system made especially for farming that provides a creative solution to these problems. The idea of AgroChain, its underlying technology, possible advantages, difficulties, and opportunities for revolutionising the agricultural supply chain are all examined in this research study.(2)

A complicated web of relationships, the agricultural supply chain includes a wide range of participants, including farmers, wholesalers, retailers, and consumers. Conventional agricultural supply chain management systems frequently depend on manual procedures, paper-based paperwork, and centralised databases, which causes delays, inefficiencies, and higher expenses. Moreover, a lack of traceability and transparency can erode customer confidence and impede attempts to guarantee the safety and quality of food.(3,4)

## II. TYPES OF DECENTRALISED SUPPLYCHAIN MANAGEMENT SYSTEM

### **Decentralized Supply Chain Solutions include: (2,5)Blockchain-based traceability (39%)**

Throughout the supply chain, agricultural goods may be tracked transparently and irrevocably thanks to blockchain-based traceability technologies. The blockchain creates an auditable and tamper-proof record of every transaction pertaining to the production, processing, and distribution of agricultural commodities. Farmers, distributors, retailers, and customers are among the stakeholders whose confidence is increased by this, along with openness, accountability, and trust. Customers may obtain comprehensive information on the provenance, calibre, and sustainability of agricultural goods by scanning QR codes or RFID tags on items, giving them the power to make wise purchase decisions.

**Online agricultural marketplaces (28%)**

Peer-to-peer trade of agricultural products is made possible by online agricultural marketplaces, which put producers and buyers in direct contact instead of through conventional middlemen. Farmers may access larger markets, better pricing, and more transparent transactions through these marketplaces. Farmers may use digital platforms to market their goods, bargain with customers across borders and regions, and schedule delivery. Online agricultural markets enable farmers to increase sales and diversify their business prospects by facilitating improved market efficiency, price discovery, and information access.

**Mobile apps for farm management (18%)**

Using digital tools and resources, farmers may optimise and simplify their agricultural operations with the use of mobile applications for farm management. With the help of these applications, farmers can increase productivity and make data-driven decisions by using features like weather forecasting, pest control, inventory management, and crop planning. Farmers may check costs, monitor crop health, and optimise resource allocation by using real-time data and insights on their mobile devices. This allows for more effective and sustainable agricultural operations. Farmers may overcome logistical obstacles, adjust to changing conditions, and increase their overall profitability and resilience with the use of mobile applications for farm management. (6)

**IoT-based monitoring systems (10%)**

Sensors and other devices are used by IoT-based monitoring systems to gather and evaluate data on a range of agricultural production and supply chain management topics. By keeping an eye on variables like temperature, humidity, crop growth, and soil moisture, these systems give farmers important information about the health of their crops and the surrounding environment. Farmers can maximise yields and minimise resource loss by optimising pest management, fertilisation, and irrigation techniques with the help of IoT technology. Real-time tracking of goods, machinery, and transportation is also made possible by IoT-based monitoring systems, which enhances supply chain visibility and response to market demand.

**Supply chain analytics platforms (5%)**

Agricultural supply chain activities are analysed and optimised by supply chain analytics systems using machine learning algorithms and advanced data analytics. These platforms combine and evaluate data from several sources, such as weather predictions, manufacturing systems, market trends, and transportation networks. Analytics systems facilitate the identification of patterns, trends, and inefficiencies within the supply chain, therefore empowering stakeholders to make informed decisions and enhance overall performance. Supply chain analytics tools enable farmers, distributors, and retailers become more competitive and sustainable in the market by offering insights into inventory management, demand forecasting, risk reduction, and cost optimisation.

Types of decentralized agriculture supply chain solution

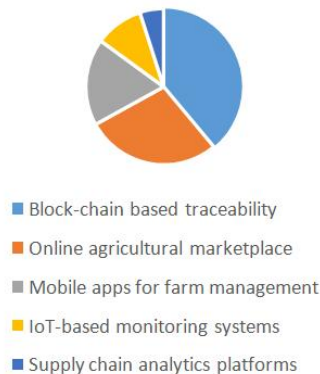


Figure 2.1

**III. BLOCKCHAIN IN AGRICULTURE**

Blockchain is a distributed ledger technology that makes it possible to record, verify, and authenticatetransactions across a computer network. Every transaction is safely documented in a block that is connected to the block before it to create a chain of blocks. The network's numerous nodes store these encrypted blocks, guaranteeing their transparency and immutability. Blockchain technology in agriculture may be used for production, processing, distribution, and retail, among other parts of the supply chain. (5)Blockchain makes it possible for stakeholders to follow the path of agricultural goods from farm to fork, confirm their legitimacy, and make sure they adhere to legal requirements. Blockchain improves accountability and transparency, lowers the possibility of fraud and counterfeiting, and increases customer trust in the safety and calibre of food goods by offering a tamper-proof record of transactions.

**IV. SURVEY ON ENGAGEMENT**

The kind of agricultural goods, the complexity of the supply chain, and the degree of decentralised technology adoption are some of the variables that can affect how frequently agricultural supply networks participate in decentralised agriculture.

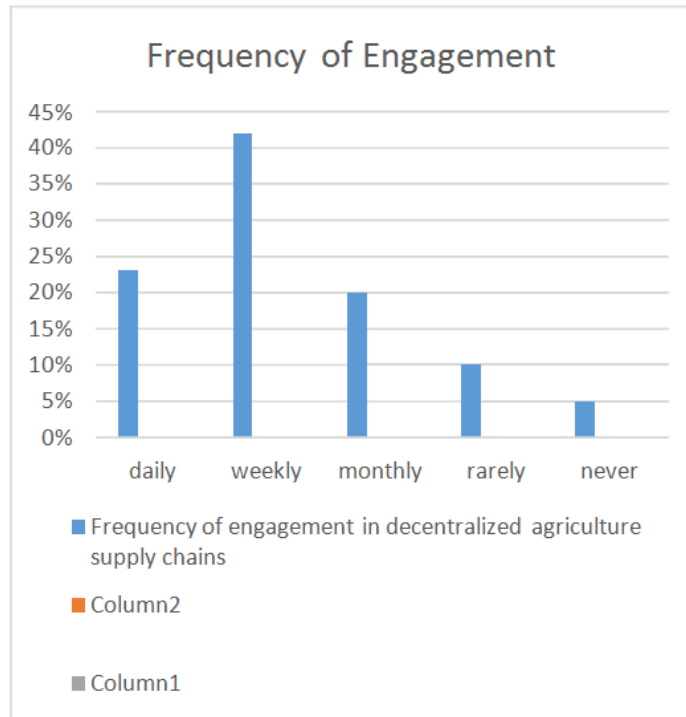


Figure 4.1

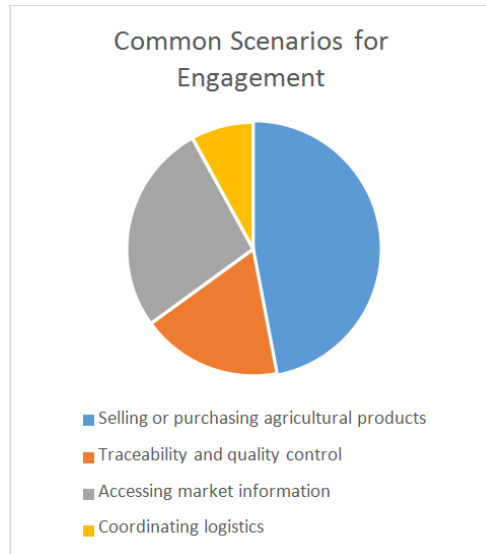


Figure 4.2

## V. ADVANTAGES

Blockchain-based decentralised supply chain management has a number of benefits that improve efficiency, security, and transparency. (4) The following list of benefits comes with using blockchain to build decentralised supply chain management:(5,7)

### **Openness:**

All supply chain partners may access a single, up-to- date version of the truth instantly thanks to blockchain technology, which creates an immutable and transparent ledger.

### **Trackability:**

End-to-end product traceability made possible by blockchain makes it possible to track items precisely and quickly from their point of origin to their destination.

### **Decreased Counterfeiting and Fraud:**

Because blockchain records are immutable, supply chain data integrity is maintained, hence reducing the risk of fraud and counterfeiting.

### **Intelligent Contracts:**

Blockchain's automated smart contracts make it possible for agreements to self-execute when certain criteria are satisfied, simplifying procedures and eliminating the need for middlemen.

### **Unchangeable Documents:**

Because data added to the blockchain cannot be removed or changed, it guarantees the accuracy and consistency of past supply chain data.

### **Effective Inventory Control:**

Accurate inventory management is made possible by real-time updates on the blockchain, which also optimise the whole supply chain by lowering overstock and stockouts.

### **Faster Settlements:**

Blockchain reduces settlement delays between various supply chain partners by enabling quicker and more transparent financial transactions.

### **Improved Cooperation:**

Blockchain offers a common, decentralised platform for cooperation that enables safe, standardised information sharing and interaction between many parties.

**Enhanced Management of Suppliers:**

Better supplier management is facilitated by transparent and verifiable supplier interactions on the blockchain, which guarantee adherence to predetermined terms and standards.

**Information Security:**

The decentralised design and encryption methods of blockchain improve data security by shielding private supply chain data from unwanted access.

**Cut Costs:**

Across the supply chain, cost reductions are achieved through streamlined procedures, less paperwork, and the removal of middlemen.

**Cross-border Exchanges:**

By offering a transparent and effective platform, blockchain streamlines cross-border transactions and lowers the complexity involved in doing business internationally.

**Live View:**

Real-time insight into the location and status of commodities is ensured by blockchain, facilitating prompt decision-making and issue response.

**Enhanced Occupancy:**

Because blockchain records are public and auditable, there is less chance of non-compliance with regulatory norms.

**Sustainability of the Environment:**

Sustainable and environmentally friendly practices may be enhanced by blockchain-supported decentralised supply chain management through process optimisation, waste reduction, and overall efficiency enhancement.

**VI. DISADVANTAGES**

Although blockchain-based decentralised supply chain management has many benefits, there are drawbacks and difficulties as well. It is important to acknowledge these possible disadvantages while contemplating the deployment of those technologies. The following are 15 drawbacks of using blockchain for decentralised supply chain management: (5,8)

**Exorbitant starting costs:**

The cost of using blockchain technology might be high as it involves infrastructure, development, and training costs.

**Problems with Scalability:**

Blockchain networks may experience scalability issues, particularly as the number of participants and transactions in the supply chain increases. This might result in longer processing times for transactions.

**Complexity of Integration:**

Integrating blockchain with existing legacy systems may be hard and time-consuming, requiring careful planning and cooperation.

**Absence of Standardisation**

The absence of industry-wide standards for protocols and frameworks might make it more difficult for various supply chain partners to collaborate and communicate with one another.

**Energy Use:**

Certain blockchain networks can use a lot of energy, which raises environmental concerns. This is especially the case for networks that use Proof-of-Work consensus mechanisms.

**Regulatory Uncertainty:**

The regulatory landscape around blockchain technology is still developing, and deployment may face difficulties due to ambiguities surrounding compliance and legal matters.

**Restricted Acceptance:**

A supply chain's members might not all be able or willing to use blockchain technology, which might result in incomplete and disjointed deployments.

**Data Privacy Concerns:**

Blockchain guarantees data integrity, but because every transaction history is public to all participants, it also poses privacy concerns.

Risks associated with smart contracts: Vulnerabilities or mistakes in the smart contract code might result in unanticipated events, disagreements between parties, or security breaches.

**Talent and Skill Needed:**

Blockchain-enabled decentralised supply chain implementation and upkeep require qualified experts, and a talent scarcity may be an obstacle.

**User Opposition:**

The acceptance and effectiveness of blockchain-based solutions may be hampered by opposition from stakeholders and users used to conventional methods. Restricted Governance and Regulation:

Because blockchain technology is decentralised, creating governance and regulatory frameworks may be difficult, which might lead to disagreements and conflicts.

**Danger of 51% Of Attacks:**

There is a chance of 51% attacks in blockchain networks that use Proof-of-Work consensus, in which a hostile party could seize control of the majority of the network's processing power.

**The inability to reverse a transaction:**

Information entered onto the blockchain cannot be removed. Errors and fraudulent transactions are difficult to fix.

**Restricted Development:**

Since the technology is still in its infancy, questions concerning its long-term viability, standardisation, and potential advancements may arise.

Notwithstanding these downsides, many of these issues are being addressed by continuing research and development, and in some situations, the advantages of decentralised supply chain management using blockchain technology may exceed the disadvantages. Before choosing to put such solutions into practice, organisations must carefully evaluate their unique demands and limits.

**VII. APPLICATIONS**

Decentralized supply chain management systems have diverse applications across various industries, offering benefits such as increased transparency, traceability, security, and efficiency. Here are some key applications of decentralized supply chain management systems: (4)

**Food Traceability and Safety:**

To improve safety and traceability, decentralised supply chain management systems are widely employed in the food business. Stakeholders can follow food goods from farm to table using blockchain technology, guaranteeing authenticity and transparency at every turn. This protects the general public's health and lowers the risk of foodborne infections by facilitating the quick diagnosis and mitigation of food safety hazards, such as contamination and spoiling.

**Pharmaceutical Supply Chain:**

In the pharmaceutical business, decentralised supply chain management systems are essential because they guarantee the validity and integrity of drugs at every stage of the supply chain. Stakeholders can confirm the origin of pharmaceutical items, stop fake medications from reaching the market, and adhere to legal requirements for drug traceability and serialisation by documenting each transaction on an unchangeable blockchain ledger.

**Logistics and Transportation:**

In logistics and transportation, decentralised supply chain management systems are used to optimise the flow of commodities and streamline supply chain processes. Stakeholders may automate procedures like freight management, route optimisation, and customs clearance by utilising decentralised platforms and smart contracts. This will cut down on the expenses, mistakes, and delays that come with using traditional paper-based methods.

**Manufacturing and Inventory Management:**

Manufacturing and inventory management use decentralised supply chain management systems to increase visibility, productivity, and collaboration throughout the supply chain. Stakeholders can manage inventory levels,

automate inventory replenishment, and monitor the production process in real-time by combining blockchain technology with IoT devices, sensors, and RFID tags. This will result in leaner and more responsive manufacturing processes.

**Sustainable and Ethical Sourcing:**

Decentralised supply chain management systems facilitate ethical and sustainable procurement by offering transparency into the origins and methods of goods and raw materials. Stakeholders may ensure adherence to ethical, social, and environmental norms, encourage fair labour practices, and tackle problems like child labour, deforestation, and violations of human rights in international supply chains by tracking the path of commodities back to their original source.(8)

**Retail and Consumer Goods:**

In the retail and consumer products sector, decentralised supply chain management solutions are used to boost product authenticity, fight fake goods, and increase customer loyalty and confidence. Through providing consumers with comprehensive details on items, such as their provenance, composition, and manufacturing processes, vendors may encourage well-informed consumer choices and cultivate closer bonds with customers.

Cross-Border Trade and International Commerce: Decentralised supply chain management systems offer a safe, transparent platform for handling paperwork and completing transactions, which helps to promote international trade and commerce. Stakeholders may accelerate the movement of commodities across borders, streamline customs procedures, decrease paperwork, and promote global commerce and economic integration by digitising trade papers such as invoices, bills of lading, and certificates of origin.

**VIII. FUTURE SCOPE**

Decentralised supply chain management systems have a bright future ahead of them because to developing business models, continuous technical improvements, and shifting customer expectations. The future potential of decentralised supply chain management systems includes the following significant elements:

Blockchain Technology Advancements: With new features including enhanced scalability, interoperability, and privacy capabilities, blockchain technology—the basis of decentralised supply chain management systems—keeps developing. Future developments in blockchain technology will improve decentralised supply chain management systems' functionality and performance, allowing for increased data interoperability, transaction throughput, and privacy and security measures.(4)

Integration with upcoming Technologies: Big data analytics, artificial intelligence (AI), machine learning (ML), the Internet of Things (IoT), and other upcoming technologies will all see an increase in integration across decentralised supply chain management systems. Stakeholders may obtain real-time data on product movements, environmental conditions, and supply chain performance by integrating blockchain technology with IoT sensors, RFID tags, and smart devices. This allows for proactive decision-making and predictive analytics.

The future of decentralised supply chain management is represented by digital twins and digital supply networks, which allow virtual representations of real assets, workflows, and connections throughout the supply chain. Stakeholders may simulate and optimise supply chain processes, detect bottlenecks, and minimise risks in a virtual environment prior to executing changes in the actual world by constructing digital twins of goods, facilities, and logistical networks.

Decentralised supply chain management systems are expected to be essential in advancing both sustainable supply chain practices and the concepts of the circular economy. Stakeholders can track the lifespan of products, maximise resource utilisation, and cut waste through recycling, remanufacturing, and reverse logistics activities by providing transparent and traceable supply chains. The shift from linear, extractive supply chains to closed-loop, regenerative systems that reduce environmental impact and optimise resource efficiency will be made easier with the help of decentralised supply chain management systems.(8)

Supply Chain Resilience and Risk Management: Decentralised supply chain management systems will prioritise strengthening supply chain resilience and risk management skills in an increasingly unpredictable and interconnected environment. Stakeholders may recognise and reduce risks associated with supply chain disruptions, cybersecurity threats, natural catastrophes, and geopolitical instability by utilising distributed ledger

technology and predictive analytics. In order to maintain business continuity and minimise supply chain interruptions, decentralised supply chain management systems will make proactive risk assessment, scenario planning, and contingency planning possible.(4)

Ecosystem cooperation and Industry Standards: In order to enable interoperability, data exchange, and best practices throughout supply chains, decentralised supply chain management systems will encourage ecosystem cooperation and industry standards. In order to facilitate smooth integration and cooperation among stakeholders, industry consortia, standards organisations, and regulatory agencies will be crucial in establishing common standards, protocols, and governance frameworks for decentralised supply chain management systems.(8) In summary, ongoing innovation, integration with cutting-edge technology, a focus on sustainability and resilience, and stakeholder cooperation will define the future of decentralised supply chain management systems. Organisations may take advantage of fresh opportunities in the global supply chain ecosystem for efficiency, transparency, and value creation by adopting decentralised supply chain management systems

### IX. CONCLUSION

In conclusion, the report highlights the transformative potential of decentralized supply chains for agriculture. By leveraging technologies like blockchain, smart contracts, and peer-to-peer networks, these systems offer numerous advantages such as transparency, traceability, reduced intermediaries, enhanced consumer engagement, and improved efficiency. They also address critical challenges in traditional supply chains, including environmental impact, lack of access for smallholders, inefficiency, and lack of transparency. The proposed solutions discussed in the report, such as sustainability practices, farmer cooperatives, direct-to-consumer models, and the use of privacy-enhancing technologies, contribute to the successful implementation and adoption of decentralized supply chains. These solutions promote sustainable agricultural practices, empower smallholder farmers, reduce waste, enhance food safety, and ensure fairer prices for producers. While there are challenges to overcome, such as technology adoption, data security, scalability, and resistance from traditional players, the report emphasizes that with growing adoption and government support, decentralized supply chains have the potential to revolutionize the agriculture sector. They can create a more reliable, equitable, and sustainable food distribution system, ultimately benefiting farmers, consumers, and the environment

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