



APPLICATION OF BLOCK CHAIN TECHNOLOGY IN SERICULTURE

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Abstract

Sericulture, the cultivation of silkworms for the production of silk, is an ancient industry with a rich history contributing to both economic development and cultural heritage. However, like many traditional industries it faces several challenges in terms of supply chain inefficiencies, quality assurance, and transparency. In recent years, block chain technology has emerged as a potential solution to address many of these issues. This article explores how block chain technology can be integrated into sericulture to enhance transparency, traceability, efficiency, and overall value creation in the silk industry.

Introduction to Sericulture

Sericulture also known as silk farming is the process of breeding silkworms (*Bombyx mori*) and harvesting their silk fibers for textile production (Kiruthika *et al.*, 2024). Usually, the procedure entails growing mulberry trees to feed the silkworms, raising the silkworms, collecting their cocoons, and extracting the raw silk strands. India, China, Brazil, and several Southeast Asian countries are major players in the global sericulture market contributing significantly to the global silk supply (Kiruthika *et al.*, 2020). The silk industry, while having centuries-old traditions has faced challenges that have hindered its growth and sustainability. These challenges range from issues in the supply chain such as fraud and adulteration to environmental concerns and a lack of adequate quality control measures. Block chain technology a decentralized and immutable digital ledger system has the potential to revolutionize sericulture by addressing these issues.

Understanding Block chain Technology

Block chain technology is a distributed digital ledger that records transactions across a network of computers in such a way that the record cannot be altered retroactively without the alteration of all subsequent blocks (Vijaya *et al.*, 2024). The key features of block chain include:

1. **Decentralization:** Unlike traditional centralized systems where a single entity controls the data block chain operates on a peer-to-peer network. This improves security and guarantees there isn't a single point of failure.
2. **Transparency:** Block chain allows for the transparent sharing of data across the network. All participants in the system can access the same information which is stored securely and immutably.
3. **Immutability:** Once data is entered into a block chain it cannot be changed or deleted without consensus from the network participants ensuring the integrity and accuracy of records.
4. **Smart Contracts:** These are self-executing contracts where the terms of the agreement are written directly into the code. They enable automatic execution of agreements once predefined conditions are met.

These features make block chain particularly useful for applications in industries that rely on complex supply chains need transparency and demand trust among participants.

Key Challenges in the Sericulture Industry

The sericulture industry faces several challenges that impact its efficiency and sustainability:

1. **Lack of Transparency:** In the sericulture supply chain, from the production of mulberry trees to the final silk product there are multiple intermediaries. Each of these parties might manipulate or conceal information regarding the quality and source of the raw materials or finished products leading to reduced trust among stakeholders.
2. **Adulteration and Fraud:** The silk industry is vulnerable to adulteration, where synthetic fibers are mixed with natural silk to increase profits. Without effective monitoring it is difficult to detect such fraud which can lead to a loss of consumer trust.
3. **Supply Chain Inefficiencies:** The sericulture industry involves numerous stakeholders such as farmers rearing centers cocoon processors and silk manufacturers. Managing such a complex supply chain without a unified system leads to inefficiencies delays and increased costs.
4. **Environmental Impact:** Sericulture requires a significant amount of natural resources especially water and land for mulberry cultivation. Moreover the use of chemicals in the production process can have negative environmental effects.
5. **Fair Trade and Farmer Welfare:** Sericulture is often characterized by low-income farmers who struggle with market volatility and lack bargaining power. This results in an unfair distribution of profits with farmers receiving only a small fraction of the retail price of silk.

How Block Chain Can Address These Challenges

Block chain technology offers a wide range of applications that can directly address these challenges in sericulture:

1. Improving Transparency and Traceability

One of the most significant advantages of block chain is its ability to provide complete transparency and traceability across the supply chain (Sharma and Kalra, 2021). In the context of sericulture block chain can record every transaction from the silkworm farming process to the final silk product.

- **Tracking Silk Production:** Block chain can enable the tracking of silkworms from their hatching to the production of cocoons and the final extraction of silk. By recording each step of the production process block chain creates an immutable history of each batch of silk including data about the quality, origin, and conditions of the farm.
- **Supply Chain Transparency:** Block chain provides a tamper-proof record of all parties involved in the silk supply chain from farmers to processors and retailers. By using QR codes or RFID tags consumers can access detailed information about the product's origin and quality building trust and enhancing consumer confidence.

For example, in countries like India, where farmers may sell their silk to multiple intermediaries block chain can help track the journey of each batch of silk making it clear where the silk originates and how it has been processed.

2. Combating Adulteration and Fraud

Silk adulteration is a significant issue, particularly in the textile industry where synthetic fibers are often mixed with genuine silk. Block chain technology can address this problem by ensuring that the authenticity of silk is verifiable at every stage of the supply chain.

- **Proof of Authenticity:** Each batch of silk could be given a unique digital certificate stored on the block chain. This certificate would verify the authenticity and quality of the silk preventing fraud and increasing consumer trust.

- **Verification of Sourcing:** Block chain can provide details on the exact farm or region from which the silk was sourced helping to ensure that the silk has been produced in accordance with specified standards. Consumers or manufacturers can verify this information before purchasing silk products.

3. Enhancing Supply Chain Efficiency

The sericulture supply chain often involves several intermediaries, each adding delays and increasing costs (Sharma *et al.*, 2022). Block chain can streamline this process by providing a decentralized and automated system for managing transactions and data.

- **Smart Contracts:** Block chain-based smart contracts can automate many processes in the sericulture supply chain. For example, once a silkworm farmer delivers the cocoons to a processor the contract could automatically trigger payment reducing delays and ensuring fair compensation.
- **Reduced Paperwork and Human Error:** Block chain reduces the need for manual data entry and paperwork, thus decreasing human error and improving efficiency. Since data is stored in a decentralized manner all parties involved can access the same information in real-time, enabling faster decision-making.
- **Optimized Inventory Management:** Silk production involves managing inventories of mulberry trees, silkworms, and cocoons. Block chain technology can provide real-time data on inventory allowing producers to optimize their operations and reduce waste.

4. Promoting Environmental Sustainability

Block chain can contribute to environmental sustainability in sericulture by providing a transparent and verifiable system for sustainable practices. For example:

- **Sustainable Farming Practices:** By recording the methods used for silkworm

cultivation, including pesticide and water usage block chain can provide consumers with detailed information about the sustainability of the silk they are purchasing.

- **Tracking Carbon Footprint:** Block chain can be used to track and report the carbon footprint of the entire silk supply chain encouraging practices that minimize environmental harm.

5. Supporting Fair Trade and Farmer Welfare

Block chain technology can create a more equitable value chain in sericulture by ensuring that farmers receive a fair share of the profits. Through decentralized networks and smart contracts block chain can eliminate intermediaries and ensure that farmers are paid fairly for their products.

- **Direct Payments to Farmers:** Using block chain-based smart contracts, payments can be made directly to farmers as soon as the silk is delivered to processors or buyers. This reduces the risk of delayed payments and ensures that farmers are compensated fairly in a timely manner.
- **Micro-Payments and Financial Inclusion:** Block chain also opens the door for micro-payments and financial inclusion for small-scale sericulture farmers enabling them to participate in digital financial systems that were previously inaccessible to them.

Case Studies of Block chain in the Silk Industry

Several block chain initiatives have already been launched to bring transparency and efficiency to the silk supply chain.

- **IBM and the Silk Road Initiative:** IBM has partnered with several stakeholders in the silk industry to create a block chain-based platform that tracks the entire journey of silk, from farm to fashion. This initiative aims to ensure the authenticity of the silk and promote ethical practices in its production.

- **TENCEL and Block chain:** The textile company TENCEL is utilizing block chain to track the production of their sustainable silk fibers. This initiative aims to provide consumers with detailed insights into the eco-friendly practices employed throughout the production process.

Conclusion

The application of block chain technology in sericulture holds significant promise for enhancing transparency, traceability, efficiency, and sustainability. By addressing the challenges of fraud, supply chain inefficiencies, and poor farmer welfare, block chain can create a more transparent, ethical, and efficient silk industry. As the technology continues to evolve it is likely that more sericulture enterprises will adopt block chain-based solutions ultimately revolutionizing the way silk is produced, traded and consumed. The integration of block chain into sericulture is not only an opportunity to modernize an ancient industry but also a step toward a more sustainable and fair global silk market.

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