Trakia Journal of Sciences, Vol. 21, Suppl. 1, pp 180-185, 2023

Available online at:
http://www.uni-sz.bg
ISSN 1313-3551 (online) **doi:10.15547/tjs.2023.s.01.031**

INTEGRATING BLOKCHAIN TECHNOLOGIES IN ORGANIC AGRICULTURE AND ORGANIC ANIMAL HSUBANDRY

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ABSTRACT
Blockchain technologies can be applied in organic agriculture and livestock farming to improve different aspects of farm performance. There are also potential economic benefits of using blockchain technology in organic farming. They could improve efficiency by automating and streamlining various aspects of the organic livestock supply chain, resulting in cost savings and higher profits for farmers. The technology can also improve traceability and transparency by providing an immutable and transparent record of every transaction in the supply chain, which can lead to increased consumer trust and demand for organic products. Additionally, blockchain technology can help reduce fraud in the organic market, provide access to new markets, and deepen collaboration between farmers, processors, and supply chain stakeholders. Blockchain technologies can reduce the costs and time associated with traditional payment systems. The study highlights some of the potential uses of blockchain technologies based on a comprehensive review of existing literature, but also based on existing platforms and models of integrating blockchain technologies within the operational activities of different stakeholders within the organic farming sector.

Key words*:* transparency, consumer trust, value chain, carbon footprint

INTRODUCTION

The entry of new technologies into various sectors of economic life has not been reserved for high-tech productions and related activities for a long time. The demonstrated wide potential is a prerequisite for their successful application even in traditional sectors such as agriculture and animal husbandry. Seemingly incompatible, blockchain technologies can actually be used in different levels of the production process, but also especially in the positioning of the final product, contacts with end users and other business partners along the value-added chain. It is the ability to track the individual stages that a product goes through before it reaches the final customer that is at the heart of the advantages that blockchain technologies can offer in the agricultural sector. Traditionally, consumers of organic products are willing to know the origin of the products, including the way they were grown, the methods of delivery and the sustainable practices applied at the separate production stages. The overall process drives their selection, and a manufacturer that can guarantee such kind of traceability will be able to achieve a competitive advantage by applying blockchain technologies in a new and innovative way.

The main goal of the study is to trace the advantages that can be the basis of implementation of blockchain technologies, firstly in organic, and then further in conventional animal husbandry and plant breeding. The presented potential applications of blockchain technology in organic farming and animal husbandry are reduced to five, but different approaches to the topic may lead to additional conclusions referring to more benefits that should be analysed separately.

Those non-extensive advantages that are subject of the current study are:

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- Certification and traceability
- Supply chain management
- Consumer confidence
- Payment systems
- Carbon footprint tracking

Overall, the combination of blockchain technology and organic farming principles has the potential to create new opportunities for sustainable and ethical farming, while promoting greater transparency, traceability and consumer trust in the livestock industry.

METHODS

The study uses various analyses of official and secondary databases, reports, surveys, web-based searches. In the first part of the study, which goal is to set a framework for the blockchain technologies potential to be integrated into farms, the main method is a literature review, aiming to identify leading trends in the field. An analysis of some aggregated official data available for public use and consultation was also carried out.

The second part of the study is about presenting some existing practices integrating one or several of the potential uses of blockchain technologies. To this end, the literature review will be complemented by case studies of already integrated use of blockchain technologies in the field of organic agriculture and organic animal husbandry.

RESULTS

In the first place, organic farming relies on certification to ensure that products meet certain standards. Blockchain can help improve the traceability and transparency of organic products, making it easier to verify the authenticity and quality of organic products (1-5). For example, blockchain-based systems can be used to track the production process of organic meat, dairy and other products from the farm to the end consumer.

Organic farming relies on certification to ensure that products meet specific standards and regulations. This certificate confirms that the farming practices used are organic, such as avoiding synthetic pesticides and genetically modified organisms (GMOs) and promoting sustainable farming methods. Blockchain-based systems can help improve the traceability and transparency of organic products, making it easier to verify the authenticity and quality of organic products. For example, in tracing the production process of organic meat, dairy products and other products from the farm to the end consumer.

Blockchain technology can improve the certification and traceability process by creating an immutable and transparent record of the entire production chain, from farm to consumer. This can be organised in one separate process or in several successive phases.

To verify organic practices, farmers can provide information about their farming practices into the blockchain, including the types of fertilisers, pesticides and feeds used, as well as information about the animals, their living conditions and health protocols. This data is recorded securely in the blockchain, which guarantees its integrity.

For auditing and certification purposes, certification and regulatory authorities have access to the blockchain to verify information provided by farmers. They can conduct audits and inspections more efficiently by having real-time access to recorded data. This improves the accuracy and reliability of the certification process.

As organic products move through the supply chain, every transaction and movement can be recorded on the blockchain. This includes information on the origin of the products, transport details, storage conditions and any processing or packaging steps. Consumers can access this information by scanning a QR code or using an online platform, allowing them to verify the authenticity and quality of the organic products they buy.

Blockchain can also facilitate the use of smart contracts, which are self-executing contracts with pre-defined terms. Smart contracts can be used to automate the certification process and ensure that all parties involved comply with organic farming standards. For example, a smart contract could mandate the use of only certified organic ingredients in the production of organic food products. A smart contract can also automatically initiate a transfer of ownership or payment when organic products are delivered to a distributor or retailer. This automation reduces manual errors, streamlines operations and improves efficiency.

Blockchain can guarantee the humane and ethical treatment of livestock in organic

farming. By recording relevant information about animals, such as breed, health conditions, feeding practices and living conditions, on the blockchain, consumers can be sure that the organic meat, dairy products or eggs they consume come from animals that have been raised according to specific animal welfare standards.

Blockchain-based platforms can facilitate collaboration between various actors in the organic agriculture supply chain, such as farmers, distributors, processors and retailers. By sharing data on the blockchain, such as inventory levels, quality test results, and delivery schedules, supply chain participants can ensure effective coordination and transparency, reducing the chances of fraud or miscommunication.

Blockchain technology can allow users to provide feedback and ratings for organic products directly on the blockchain. This feedback can be recorded and made available to other users, helping to build trust and improve the overall transparency and accountability of the organic farming industry.

Secondly, organic farming and livestock often requires a complex supply chain, with many different actors involved in the production and distribution of products, including farmers, distributors, processors, retailers and consumers. Blockchain technology can play a significant role in improving the efficiency and transparency of these supply chains by providing real-time data on the movement of goods and facilitating the sharing of information between different actors (1, 3, 5, 8). By using blockchain, every step in the organic farming supply chain can be recorded in a transparent and immutable way. Every transaction, transfer of ownership and movement of goods can be documented on the blockchain, creating a reliable and auditable record of the supply chain. This transparency helps prevent fraud, counterfeit products and unauthorised changes, ensuring the integrity of organic products.

Real-time data sharing between various stakeholders in the supply chain is made as easy as possible. Each participant can access the shared blockchain ledger, allowing them to view and verify information about the origin, quality and processing of organic products. This real-time visibility enables better coordination, collaboration and decision-making between supply chain participants.

Blockchain technology can facilitate quality control and compliance checks throughout the supply chain. Data regarding organic certifications, quality test results and regulatory compliance can be recorded on the blockchain. This information can be accessed and verified by relevant parties, ensuring that organic products meet the required standards and regulations at every stage of the supply chain.

Data recorded on the blockchain can provide valuable information to optimise the organic farming supply chain. Analytics and results based on blockchain data can help identify critical milestones, inefficiencies and processes that can be improved. This can lead to better inventory management, optimised transport routes, reduced waste and overall cost savings.
Consumer confidence is critical to the organic farming industry. Consumers seek reassurance that the organic products they buy are authentic, meet quality standards and are produced using sustainable and ethical practices. Blockchain technology can play an important role in increasing consumer confidence and lead to increased demand for organic farming products (7-9). This represents the third advantage of using blockchain technologies in organic farming.

The use of blockchain provides a transparent and immutable record of information, making it difficult to change or manipulate data. By using the blockchain, information related to organic certifications, production methods and quality standards can be securely recorded and verified. Thus, consumers have access to detailed information about the entire life cycle of organic products. They can check the origin of the products, the agricultural practices used, and any certificates obtained. This access to information promotes transparency and empowers consumers to make informed decisions based on their values and preferences.
Blockchain can be used to ensure accurate labelling of organic products. By recording relevant data on the blockchain, consumers can be sure that the products they buy meet the organic standards they are looking for. Blockchain immutability ensures that once data is recorded on the blockchain, it cannot be changed or manipulated. This feature increases

consumer confidence by providing a verifiable and tamper-proof record of organic farming processes, certifications and quality standards followed.

Next, blockchain-based payment systems can help reduce the costs and time associated with traditional payment systems such as bank transfers and credit card payments. This can help make it easier for farmers to sell their organic products directly to consumers without having to rely on middlemen (4, 10, 11).

Blockchain enables direct peer-to-peer transactions without the need for intermediaries. Farmers can directly sell their organic products to consumers. This can lead to increased profitability for farmers and potentially lower prices for consumers. Blockchain-based payment systems can help reduce the transaction costs associated with traditional payment methods. By eliminating middlemen and their fees, farmers can receive payments more directly and efficiently. Additionally, blockchain-based transactions may be less susceptible to currency exchange fees, especially for international transactions.

Blockchain-based payment systems can facilitate faster settlements between buyers and sellers. Transactions recorded on the blockchain can be settled in near real time, eliminating the need for lengthy settlement processes associated with traditional banking systems. This can improve cash flow for farmers by allowing them to more quickly reinvest in their current operations. For producers who trade with customers outside their country, blockchain payment systems can simplify cross-border transactions. Blockchain 's borderless nature enables seamless transactions, overcoming barriers such as currency conversion and complex banking processes. This can open new opportunities for organic farmers to reach global markets and expand their customer base.

The decentralised nature of the blockchain ensures that transactions are verified and recorded in a tamper-proof manner, increasing security and reducing the risk of fraud. This can build trust between organic farming buyers and sellers as they can be assured that payment transactions are reliable and secure.

Finally, organic farming is often associated with sustainable practices that aim to reduce greenhouse gas emissions and conserve natural resources. Blockchain technology can play a role in tracking and quantifying the carbon footprint of organic farming practices, making it easier to communicate the environmental benefits of using organic products (5).

Blockchain can be used to collect and store data related to various aspects of organic farming that contribute to reducing the carbon footprint of the supply chain. This may include information on energy consumption, fertiliser and pesticide use, waste management and transport. By collecting this data on the blockchain, it becomes easier to monitor and analyse the environmental impact of organic farming practices. Blockchain can facilitate the integration of carbon footprint data into the organic agriculture supply chain. By recording relevant data at various stages, from production to distribution, the carbon footprint of the entire supply chain can be calculated. This allows stakeholders to understand the cumulative environmental impact of organic farming practices and identify areas for improvement.

Blockchain immutability ensures that once data is recorded on the blockchain, it cannot be changed or manipulated. This feature is particularly useful in carbon footprint tracking as it provides a reliable and transparent record of the environmental impact of organic farming practices. This information can be accessed by stakeholders such as farmers, consumers and certification bodies, promoting transparency and accountability.

Blockchain-based smart contracts can be used to automate the tracking and trading of carbon credits in organic agriculture. By setting predefined rules and criteria within smart contracts, farmers can be rewarded with carbon credits based on their sustainable farming practices. These credits can then be traded on blockchain-based markets, creating economic incentives for farmers to reduce their carbon footprint.

Despite the relatively new and innovative nature of the use of blockchain technologies in agricultural and livestock farms using organic production methods, there are some successful examples that can be pointed out. They cover individual or several of the potential applications of blockchain technologies discussed above.

1. *Provenance* (12) is a blockchain-based platform that aims to increase transparency and traceability in the food industry, including organic farming. They collaborate with various organisations and retailers to trace the path of organic products, such as seafood and vegetables, from the farm to the consumer. By scanning a QR code on the product packaging, consumers can access information about the origin, production methods and certifications of the organic products they purchase.
2. *IBM Food Trust* (13) is a blockchain-based platform that focuses on improving transparency and traceability in the food supply chain. They partner with major companies including Walmart and Carrefour to track and certify organic products. Walmart has implemented the use of blockchain technology to track the supply chain of mangoes in their stores, allowing consumers to verify the organic origin of the fruit.
3. *Farmsent* (14) is a blockchain platform for farmers and producers where they can directly supply goods to the consumers. Through decentralisation, Farmsent empowers various stakeholders, such as farmers, suppliers, and consumers, that actively participate in shaping the agricultural ecosystem. It connects producers from Indonesia and Columbia to buyers from the Arab peninsula.
4. *OriginTrail* (15) is based on a blockchain protocol that enables supply chain transparency and data interoperability. They partner with organisations in the organic farming sector to improve traceability and certification processes. They are working, for example, with a Slovenian organic poultry farm to create a blockchain-based tracking system allowing users to access detailed information on the farming and certification of organic poultry products.
5. *Earthbanc* (16) is a blockchain platform that focuses on carbon offsetting and sustainability. By integrating carbon footprint data from organic farming practices into the blockchain, farmers can participate in carbon offset initiatives and quantify the environmental benefits of their sustainable farming methods.
6. *GrainChain* (17) is a blockchain-based platform that aims to improve transparency and efficiency in agricultural supply chains, including organic farming. The platform allows farmers to directly receive payments for their produce through blockchain technology. It ensures transparency in pricing, reduces transaction costs and enables farmers to access fair markets for their organic products.
7. *OrganicNet* (18) is a blockchain-powered social network for organic farmers and consumers. It aims to connect farmers directly with consumers, promoting trust and transparency in organic food production. Through the platform, farmers can share information about their farming practices, certifications and product quality, while consumers can engage with farmers and access reliable information about the organic products they buy.
8. *AgriDigital* (11, 19) is an Australian company that has developed a blockchain-based platform for agricultural supply chain management. Their platform allows farmers, processors and retailers to track and manage the movement of agricultural products, including organic products. They collaborate with organic farmers to improve traceability and streamline transactions, ensuring the integrity of organic products throughout the supply chain.
9. *bext360* (20) is a company that uses blockchain and artificial intelligence (AI) to create transparent supply chains for goods, including organic products. They have implemented their technology in the coffee industry, where organic and fair-trade certifications are important. Through their platform, they enable farmers to track the journey of their organic coffee beans, ensuring transparency, fair payment and sustainability.

These real-world examples demonstrate how blockchain technology is being applied to the organic farming industry, providing consumers with reliable information about the origin and authenticity of organic products. Although specific applications may vary, the basic principles of transparency, data integrity and incentives can be used to promote the sustainability of organic farming and communicate the environmental benefits to consumers.

CONCLUSION

By using blockchain technology, traceability in organic farming becomes more efficient, reliable and transparent. Consumers gain confidence in the products they buy, knowing that information about their organic origin is securely recorded on the blockchain. This helps promote consumer confidence and encourages the growth of the organic farming industry. The secure and decentralised nature of blockchain

improves data integrity, reduces intermediaries and promotes collaboration between stakeholders. Ultimately, this can lead to improved productivity, reduced food fraud and increased sustainability in the organic farming industry. Blockchain ensures data integrity, increases transparency and promotes consumer confidence in the organic farming and livestock sectors. By using blockchain technology in payment systems, organic farmers can benefit from direct transactions, reduced costs, faster settlements, improved security and the ability to engage in cross-border trade. Through the use of blockchain technology, organic farming can more effectively track and report its environmental impact.

ACKNOWLEDGEMENT

The research leading to these results has received funding from the Ministry of education and science under the National science program INTELLIGENT ANIMAL HUSBANDRY, grant agreement №Д01-62/18.03.2021

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