APPLICATION OF BLOCKCHAIN IN EU ORGANIC AGRICULTURE

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Abstract

In recent years Blockchain emerges as a promising technology for agriculture. Blockchain is applied in cryptocurrencies, but in recent years it has also been successfully implemented in the food supply chain. This paper aims to facilitate an understanding of the application of blockchain in organic agriculture. Within the EU where data records in the organic supply chain are in a paper form inaccessible to consumers, there are no uniform data records, etc. These structural shortcomings were the motive for analyzing blockchain as a solution to remove barriers in the supply chain. We rely on intensive literature research, consultations with organic farmers, retail chain representatives, organic products processors, organic certification bodies and experts in the field of production and marketing of organic foodstuff. The results show positive effects of applying blockchain to the organic food supply chain, such as strengthening organic production control systems, increasing consumer trust and reducing administrative and transaction costs.

Key words: *block-chain, digital agriculture, organic agriculture*

Introduction

This paper considers blockchain technology as a tool to improve transparency, traceability, and trust between participants in organic agriculture from producers/processors through to the final consumer, thus leading to the development of the domestic market. Blockchain can be a solution to the structural problems of organic agriculture, removing barriers in the supply chain.

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The most commonly used definition of organic agriculture is from the International Federation of Organic Agriculture Movements: "Organic agriculture is a production system that sustains the health of soils, ecosystems, and people. It relies on ecological processes, biodiversity and cycles adapted to local conditions, rather than the use of inputs with adverse effects. Organic Agriculture combines tradition, innovation, and science to benefit the shared environment and promote fair relationships and a good quality of life for all involved" (IFOAM, 2008).

Organic agriculture is increasing; a driving force is increased demand worldwide and in the EU (Kljajić et al., 2013; Kovačević, 2021). Added value products such as organic can significantly contribute to sustainable and profitable EU agriculture (Janković et al., 2018).

The main bottlenecks in EU organic agriculture found within this research are:

- All organic farmers and processors are obliged to keep records on production/processing. Aldo, all organic farming/processing is regulated under a single common EU legal framework - Regulation (EU) 2018/848 of 30 May 2018 on organic production and labelling of organic products, there is no single form for keeping records on production.
- Besides the difference in production record form, there is also a difference in format. Most of the production records are on paper, others in Excel, etc.

Consequences of difference in producers' records are that end consumers are not easily accessing the data on organic foodstuff, administrative costs for organic farmers are higher, consumers are lacking in confidence in organic foodstuff as the paper records on production are much easier to forge, and control system is less effective as the certification bodies and supervising institution are without real-time insight in organic production/processing having an additional effect on consumers mistrust in organic foodstuff and agrarian policy is less effective due to lack of real-time data on organic production. Our main aim is to analyze the effect of Blockchain applications on the above bottlenecks.

Blockchain technology emerged in recent decades as a decentralized digital database used firstly in cryptocurrencies. The 2008 white paper of the pseudonymous author Nakamoto, 'Bitcoin: A Peer-to-Peer Electronic Cash System', established the path for the development of Digital Ledger technologies and cryptocurrencies. Instead of relying on a centralized trusted par-

ty, a Blockchain is a digital transaction ledger, maintained by a network of participants. Individual transaction data files (blocks) are managed in a decentralized manner (Kamilaris et al., 2019). Every blockchain transaction is validated by all network nodes, which keep a collective eye on the blockchain data (Bano et al., 2017).

This research contributes to the literature by shedding light on an under-researched area of Blockchain application in organic agriculture. Also, according to our best knowledge, this is the first research to research the pros and cons of Blockchain application in organic agriculture, as well as to develop a concept for Blockchain application in the EU's organic sector.

Literature review

In recent years, blockchain technology has begun to be used for much more than cryptocurrencies and financial transactions (Tayeb and Lago, 2018). Its application in agriculture is increasing. The most common blockchain architecture in agriculture encompasses the following aspects (Tripoli & Schmidhuber, 2018):

1) Input suppliers as providers of information on the pesticides, fertilizers, and machinery used.
2) Agricultural producers generate information on the farm, farming practices, plant diseases/pests, weather conditions, and animal welfare/breeding.
3) Information on processing plants; i.e., processing methods, equipment, etc.
4) Information on transport and storage conditions.
5) Retailer information, including information on each foodstuff item; i.e., quality and quantity, expiration date, storage information, etc.
6) At the final stage, blockchain allows consumers to have all information associated with the product, from the producer and provider to the retail store, by simply scanning the QR code on the packaging.

One of the first applications of the blockchain in the food supply chain is by Walmart and Kroger. The application of Blockchain in the supply chain is expected to grow by 87% annually (Tribiset al., 2018; Chang et al., 2019). So far, 49 blockchain application initiatives have been identified in food supply chains (Kamilaris et al., 2019).

Blockchain is a promising technology for small farmers. AgriLedger has found an example of blockchain being used to increase trust among small cooperatives in Africa (AgriLedger, 2017). Another positive example is the blockchain B2B platform OlivaCoin, which reduces costs, increases transparency, and provides easier access to markets for the olive oil trade. Davcev et al. (2018) recognize the importance of blockchain in the agri-food chain in improving trust among small farmers and cooperatives, and online marketing and digitalization in the agricultural sector can also improve firms' efficiency (Medina-Viruelet et al., 2015).

According to the United Nations Food and Agriculture Organization (FAO), distributed ledger technologies can transform the global food system by introducing substantial efficiency gains along value chains and improving trust, transparency, and traceability (Tripoli and Schmidhuber, 2018).

To date, blockchain has not been implemented in organic agriculture, although governments worldwide are considering blockchain implementation at the national level. The proposal of the Agricultural Marketing Service of the U.S. Department of Agriculture to use blockchain for organic food supply chain traceability (USDA, 2020) is one of the first initiatives to do so.

According to the FAO, Blockchain has a fivefold effect (Tripoli and Schmidhuber, 2018):

1) A positive impact on food safety, quality, and sustainability.
2) Smart contracts enable secure real-time payments.
3) The transparent data generated in the Blockchain is easily accessible to consumers and other market participants.
4) By providing timely and accurate information, blockchain reduces information asymmetry among supply chain actors.
5) The real-time information and evidence enable better public policy.

According to Van Hilten et al. (2020), blockchain has the potential to improve organic food traceability. An example of Blockchain efficiency was found when tracking a package of mangoes from a retail outlet back to the producers this normally takes six and a half days, but with the Blockchain application, the tracking was instantaneous.

Kamble et al. (2020) investigate the effects of blockchain application in the agricultural supply chain by applying combined Interpretive Structural Modelling and Decision-Making Trial and Evaluation Laboratory methodology to evaluate causality between the blockchain enablers. The results show that traceability is the most significant reason for blockchain implementation in the agricultural supply chain, followed by suitability, immutability, and provenance.

An important positive effect of blockchain application in the food supply chain has also been found in Blockchain's smart contract, digital signature, and authentication, which support businesses through lower costs (Li et al. 2018). A smart contract is a digitized business arrangement, which is triggered automatically when certain criteria are met to validate and verify chain partners (Mistry et al., 2020.)

Material and methods

The methodology applied in this research relies on:

- Intensive literature research;
- Consultations with organic farmers;
- Consultations with retail chain representatives;
- Consultations with organic foodstuff processors;
- Consultations with organic certification bodies and supervising institution representatives;
- Consultations with experts in the field of production and marketing of organic foodstuff.

The main data sources are the Research Institute of Organic Agriculture (FiBL), Frick, and IFOAM Organic International

Discussion

This research has twofold goals, first to evaluate the pros and cons of the Blockchain application in organic agriculture and to develop a concept for the implementation of the Blockchain in EU organic agriculture. SWOT analyses are summarizing Straights, Weaknesses, Opportunities, and Treats in EU's Blockchain application in organic agriculture.

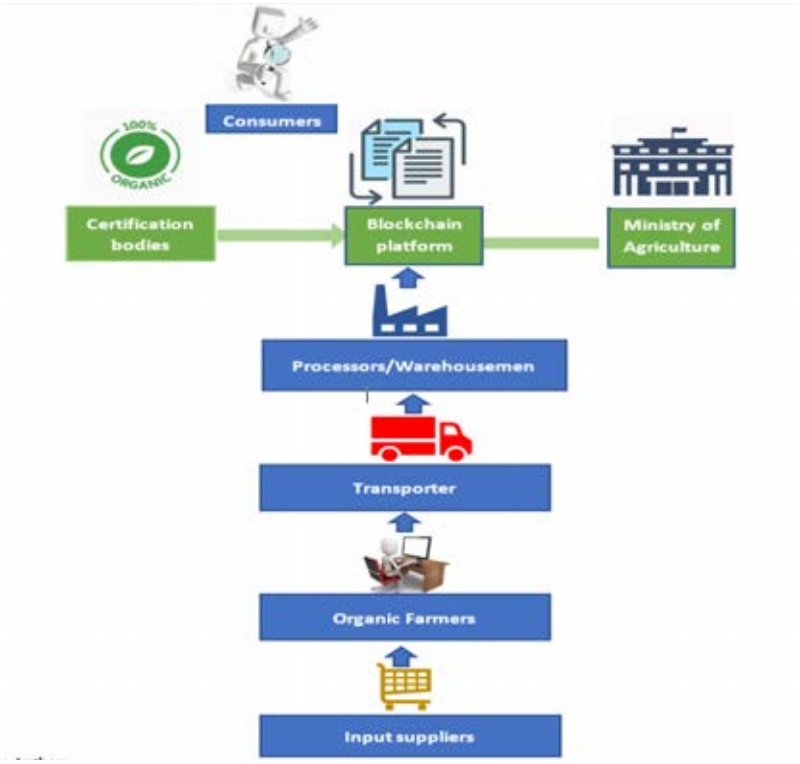
Table 1. *EU' Blockchain application in organic agriculture SWOT analyses*

Strengths	**Weakness**
• Possible positive Blockchain application effect on decreasing of the Organic foodstuff production; • Possible positive Blockchain application effect on transparency improving consumer trust and widening organic foodstuff market; • A positive impact on food safety, quality, and sustainability; • Smart contracts enable secure real-time payments; • The transparent data generated in the blockchain is easily accessible to consumers and other market participants; • Removal of trade barriers for organic foodstuff within EU due to common EU production/processing data records EU will start to "speak in the same language in organic agriculture"; • Improvement in controlling the organic production by real-time data access by certification bodies and supervising institutions. • Improvement in agrarian policy due to the real-time data access in organic production by agrarian policymakers.	• The complicated process for adoption and managing the common EU records on organic production/processing; • Blockchain technology is newly and complicated to introduce. Even if the Blockchain is adopted form part of stakeholders, uniform common EU records on production will have a tremendous effect and different data formats will still be able to use in a single value chain.
Opportunities	**Threats**
• Common EU rules for organic agriculture, Regulation (EU) 2018/848 of 30 May 2018 on organic production and labelling of organic products creates a legal field for introduction of the common EU production ledger in Blockchain; • Demand for organic foodstuff is increasing in the EU by approximately 10% annually.	• Significant use of energy for Blockchain;

Our second aim is to propose a common EU Blockchain concept in organic agriculture. Mail stone is to introduce a single common EU ledger for keeping the records in organic production. Currently, each organic certification body has its own ledger for records of organic production. Also, each organic certification body required a different data format. Our main assumption is as the Regulation (EU) 2018/848 defines common requirements for organic agriculture, it will be possible to introduce unique EU records on common requirements. Joint EU regulation or/and management body governing the common form of records for organic production/processing is foreseen.

Figure 1 presents the flow of blockchain applications in organic agriculture. The blockchain schema in this paper adds two participants to the existing common agriculture blockchains: organic production certification bodies and the institution in charge of organic agriculture supervision (most often the ministries of agriculture).

Figure 1. *The EU' Blockchain concept in organic agriculture*



Source: authors' presentation

The introduction of blockchain to organic agriculture would have a significant effect on both the supply chain and organic agriculture policy. Figure 1 shows how the supervisory institutions can monitor data on the production, processing, transport, and storage of organic products in real-time, thus also enabling evidence-based agricultural policy.

The application of blockchain will provide a unique and reliable digital data record at all stages of production, processing, transport, storage, and marketing of organic products. Customers will be able to get all relevant data on organic products of interest via a digital online platform. Thus, the system will encourage consumer confidence in organic products, which to date has been one of the main obstacles to organic food production. Increased consumer confidence in organic products will lead to increased demand, thus increasing production and leading to improved profitability in organic agriculture.

Conclusion

The new blockchain technology is based on a decentralized digital database, which when applied to the agricultural sector, and to organic agriculture, in particular, can establish trust between stakeholders and consumers through transparency and traceability. This paper is the first to investigate the economic sustainability of blockchain technology in organic agriculture. The pros of Blockchain application within EU organic agriculture are (1) reducing administrative costs, (2) improving sales conditions, (3) expanding the market, (4) improving the supply chain, and (5) improving payment efficiency and security. Blockchain technology could also be used to improve agrarian policy related to organic agriculture, as policymakers would be able to monitor the production, processing, transportation and storage of organic products and conduct evidence-based policies. Research on the economic effects of blockchain technology in organic agriculture should be ongoing.

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