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Can blockchain technology facilitate the adoption of urban agriculture: A Literature Review (November 2019)

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*Abstract*— A data delivering system that removes human control over produce traceability information, while decentralizing the process of providing accurate data for the whole supply chain, is proposed as a solution to agricultural sustainability. Literature surrounding Urban Agriculture and Blockchain are discussed and conclusion on future steps are given.

*Index Terms*—Blockchain, Agriculture, Urban Agriculture (UA), Sustainability, Supply Chain.

# INTRODUCTION

The purpose and focus of this literature review is to highlight the technological infrastructure that would facilitate market adoption of Urban Agriculture (UA) and the current constraints on the efficiency of agriculture operations that stem from bad data sharing along the supply chain. By the end of this review, the reader should understand where blockchain fits in the agriculture industry, in terms of risk reduction and trust, and how blockchain can help improve consumer knowledge of produce data. Thereby re-enforcing overall better consumer choice and creating an environment that incentivizes farmers, producers, distributors and wholesalers to achieve accurate source data and healthier produce, to not lose face in front of the final consumer.

## Data Decentralization, Open Source and Trust

Decentralization allows a system of data and rules on how to display and handle that data, to be quasi-autonomous and to require minimum trust. Decentralization is a very important term in this literature review. Blockchain is a type of ‘decentralized’ computer system. Blockchain allows for stakeholders to all provide information to the network (which is a collection rules for reading and writing data between nodes) and for the stakeholders to also have access to the data they need, all while making sure not a single stakeholder holds full ownership and control of the blockchain. Blockchains usually require the code or “rules” to handling data to be public or “open source,” so that anyone willing to go through the code and find a mistake can do so. This type of system has an advantage that allows for an equitable balance of rules to be achieved amongst all stakeholders, without the need for a middleman. These different blockchain systems can then compete on the market, based on how effective they are at being equitable to the entirety of the stakeholders in the network.

## Incentives and The Agency Problem in Food Supply Chains

As the world’s population steadily increases, agricultural businesses have, for decades, been using technology, chemicals and business data to maximize yield per square-meter on farms and production per second in factories, and to minimize prices in stores. These shortcuts employed by modern farms, manufacturers and stores have often been unhealthy and indirectly costly to the world’s economic growth. The problem is that agri-businesses want to share as little information about the quality of their food with the agent down the supply chain, and the final consumer have very little or no information about the source and quality of the produce, so everyday people cannot hold the source of their produce accountable by boycotting or switching to better producers. It is inefficient and quasi-impossible for all the nodes down the supply chain to verify whether the data passed on to them was accurate or not. The current solution to this is to simply trust third-party businesses and government agency standards, which are made of individuals with conflicting incentives than the consumers they serve, resulting in a classic version of “The Agency Problem”, where stakeholders in a supply chain have different incentives or value different things. Currently there is not a lot of incentive for the stakeholders to provide accurate information down the chain, because it allows the producers and suppliers to obfuscate their operations and produce quality.

A different solution would be a data delivering system that removes human control over produce traceability information, while decentralizing the process of providing accurate data for the whole supply chain.

# Literature Reviewed on Urban Agriculture.

Stephen Barthel and Christian Isendahl[1] used secondary sociology references and case studies done about Chicago’s early 19th century urbanization, as well as our current understanding of Classic Maya civilization’s city gardening and Byzantine Constantinople’s numerous periods of urban food security crises, for the purpose of painting a nomothetic argument for a change in sociology’s perspective on the usage of urban farming, waste and water management, in urban settings.

They argue the importance of food security within cities has been a low priority for the Chicago school of urban sociology, which established a modernist understanding of urbanism that “distinctly separated local agricultures as obsolete in futuristic and normative understanding of the city as an autonomous social system,” [p. 224] and that this pivotal perspective in sociology has led to mismanagement of city resources and a general reduction of the city’s and populace’s resilience, when it comes to fresh food prices and health. Barthel and Isendahl concluded that UA is not the antithesis of cities but must be as integrated as much as sewage, transportation, etc.

Urban agriculture has been on the rise in the past few decades and Tornaghi’s[2] purpose in his article was to establish a scope and agenda for a critical geography of UA. Tornaghi first did an overview of media and policy discourse surrounding UA, where he raised some concerns about regressive neoliberal agendas in social sciences and concludes that the reproduction of social inequality can be made real through urban agricultural projects, or the lack thereof.

## Types of Uncertainties

Borodin and colleagues[3] reviewed a collection of 111 publications, in Mathematics, Computer Science and Decision Sciences categories, for the purpose of summarizing the state of agricultural supply chain management in academia. The article argues that the agricultural sector is currently under increasing pressure, not only from providing food and resources for humankind, but also from having to do it sustainably.

The article concludes by stating that “exogenous uncertainties” (probabilistic information along the supply chain that are not affected by human decisions) are more handled by the researched publications than “endogenous uncertainties” (probabilistic information along the supply chain that are affected by human decisions). Our trust in humans and separate third parties, and the non-standardization of accurate data availability is what causes the most uncertainty and requires the most research on.

# Literature Reviewed on Blockchain and Traceability

In 2011, Bhatt and his team[4] were present at The Institute of Food Technologists’ Traceability Research Summits in Chicago, where about 50 individual stakeholders in food traceability met for the purpose of discussing the desired principles, language and approach to food supply chain traceability. The guests included non-for-profit corporations, local, state and federal governments, food companies, 3rd party traceability providers, trade associations and consumer groups.

Through small and large group meetings, concepts and values were distilled down to key principles of data structure that would allow the fullest level of traceability for all stakeholders. Consensus was achieved on 10 Operational Principles such as (5) “A singular database is not considered a feasible solution. There may be a national “data mining tool” that requests data; however, a single system that contains all traceability data is not considered a practical solution,” amongst others. [p. B22]

The 5th operational principle above coincides with the idea that data should not be entrusted to a single source of control, which is a core argument of this article. Data network solutions that follow globally recognized and verifiable rules can be achieved using a combination of all the node systems in the network, in this case the agriculture stakeholders, thereby effectively allowing the users of the system to also be the providers.

Expected challenges are foreseen to be mostly financial, business, organization, legal and cultural. Current food supply chain data elements are ready for enhancement through technology and data standardization, but global consensus would take time in full scale deployment of such a system and further research needs to be conducted on just how secure and impartial such a system would be.

A data system that is standardized and is as impartial as possible, would give a large amount of data to the world’s scientists, in an anonymous manner. Some data can be operated on and produce results with anonymity preserved. This would reduce the time it takes to conduct surveys on health, food and general public wellbeing.

## Blockchain as a Solution to Supply Chain Data Traceability

Casado and his team[5] begin by observing that the current global alimentary supply chain uses a linear model for sharing information about the produce. This linear model has many disadvantages including: the data sharing between traders and the lack of consumer access to information of produce origin; all for the purpose of then presenting a decentralized blockchain model of sharing information. Blockchain is thought of as a potential solution for this information problem, because it allows for the eradication of the trusted middle man or intermediary and allows for circular economics. With decentralization, a network can be created, where each member’s rights are respected, but their speed of request for produce verification is much faster and trustworthy, since endogenous uncertainty created by human decision making is eliminated, as meta-rules maintained by stakeholders’ computers and sensors can be more trusted along the way.



*Fig. 1. Current supply chain versus the supply chain via blockchain. The blockchain diagram does not involve the customer, however our article would include the customer in the network.*

A whole new model for agricultural tracking using blockchain and smart contracts was created for this article and the disadvantages and advantages of the current model are compared to the disadvantages and advantages of a blockchain model. The current model’s main disadvantage “is that the data is centralized in each of the elements of the supply chain and the remaining elements cannot see the transactions. The main implication of this disadvantage is that the consumer has no way of verifying the source of the food to be purchased. In addition, there is no way to ensure that the consumer’s data is reliable,” [p.393] while the proposed blockchain model requires “all members of the supply chain save all their transactions in the blockchain. This enables a higher security in the transactions. In addition, this new model corrects the disadvantages of the current supply chain. The data is decentralized, and each member can read important data for its operations in the blockchain. For instance, the producer can view the product info of the processor and the pickup details of the transport provider.” [p. 395]

# Conclusion

## The networking system proposed in this article would allow for faster communication, deployment and quality standard rule changes along the entire supply chain. Such an information system, supported with sensing machinery, would incentivize the stakeholders along the supply chain to invest in collecting and supplying more accurate data on how their produce is superior because each one of the stakeholders down the chain would come to expect high quality data. Capitalism is a game where the rules only work if the right data is accessible by the right people, otherwise uncertainty and resource inequality take over. The spreading of produce information to the public forces the producers to adhere more to the public view, which is made clearer with easily digestible information. This could revolutionize the way nations talk about food quality and health.

## Sensing and recording devices used in the proposed article are not the focus of this review and further research needs to be conducted on how to improve and deploy these devices to the world’s food supply chain. Economic incentives surrounding both a blockchain solution to food supply chain traceability and Urban Agriculture as a solution to socio-economic stability, health and population resilience. Socio-economic problems are the biggest ones facing UA, any research on the economics surrounding UA would be a big step forward for humanity. UA itself requires scientific advances in food growing technology. Many shortcuts are taken to make fields produce more. Some of these shortcuts are bad and others are perfectly fine and healthy. Distinguishing which shortcuts are useful and which ones are detrimental is a vital part of making agriculture healthier

## A possible outcome could be that many agricultural blockchains end up competing for the best spot, however government standards should still be outlined on paper for how agricultural businesses communicate produce source information. Deployment of such a system could include open sourcing the code in order to get as much public opinion from universities and global researchers, all for the purpose of creating a culture of expecting the highest level of produce information availability and everyday consumer readability. Food sovereignty is not always possible in our modern world and the individual is now further removed from his source of food than ever in human history. This article hopefully has highlighted the potential areas of further research and socio-economic potential in the merging of science, technology and agriculture to solve one of humanity’s greatest challenges faced: individual resource sovereignty.

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References and Footnotes

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