

The importance of standardization in nursery management and production: a blockchain approach

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Abstract

During the last few years, the agricultural sector has been increasing the use of technological solutions. Recently, the experts of the sector introduced the term Smart Agriculture when technologies like Internet of Things, sensors, location systems, robots and artificial intelligence are used in farms. The goal of Smart Agriculture is to obtain greater efficiency, sustainability, and competitiveness while increasing the quality and quantity of the crops. The main purpose of nurseries is to produce plants which, due to their genetic, morphological, physiological and health characteristics, can guarantee adaptability, rooting and growth. To grow quality fruits, it is necessary to start from quality plants. Quality production is achieved when all components of the nursery supply chain work in synergy. To achieve high quality agricultural production in fruit, vegetable and flower fields, appropriate agronomic choices, such as using plants that are certified from a genetic and health point of view, need to be implemented. To guarantee greater profitability to the farmers, once a quality agricultural product has been obtained, it is necessary to enhance it by certifying its origin while disseminating the methods used to produce it. For these reasons, it is essential to follow agronomic standards that can give the product a quality certification. By using blockchain solutions, producers can significantly increase the transparency and the traceability of the supply chain, and ultimately, they will be able to increase the commercial value of their products. For example, blockchain solutions can improve the growth of crops, save water consumption, reduce the time of monitoring operations, improve delivery times, maintain a persistent quality while minimizing human errors. This article will highlight the importance of standardization while using blockchain solutions. Standardization is a key step in the certification of the nursery sector.

Keywords: standardization, nursery, blockchain

INTRODUCTION

During the last few years, the agricultural sector has been increasing the use of technological solutions. Recently, the experts of the sector introduced the term Smart Agriculture when technologies like Internet of Things, sensors, location systems, robots and artificial intelligence are used in farms. The goal of Smart Agriculture is to obtain greater efficiency, sustainability, and competitiveness while increasing the quality and quantity of the crops. Agriculture 4.0 uses the Internet of Things (IoT), big data, artificial intelligence, and robotics to extend, speed up and increase the efficiency of the activities of the entire production chain (Aquaro, 2022). These emerging technologies aim to integrate devices that can communicate autonomously with each other (Karatas et al., 2022) and allow to process and to access real-time data on soil conditions, and to assess the crop quality and the climate (Nilesh Kumar et al., 2023). The need to develop intelligent systems that can verify, protect, monitor, and analyze agricultural data are leading to the use of blockchain-based IoT systems in precision agriculture (Torkya and Hassaneinb, 2020).

The tree nursery sector is preparing to face great challenges to satisfy an ever-

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increasing demand for certified plants, from a genetic and health point of view, suitable for very different environmental and growth conditions. Plants of dubious origin, not accompanied by any official document, may present risks, especially from a phytosanitary point of view, due to the spread of new and destructive epidemic plant diseases. Technological advances can help address the challenges that the agriculture sector is facing. The main purpose of nurseries is to produce plants which, due to their genetic, morphological, physiological and health characteristics, can guarantee adaptability, rooting and growth. To grow quality fruits, it is necessary to start from quality plants. Quality production is achieved when all the components of the nursery chain work in synergy. To have a quality agricultural production in fruit, vegetable and flower fields, appropriate agronomic choices, such as using plants that are certified from a genetic and health point of view. The propagating material sector regulates most of the nursery activity by indicating the requisites and characteristics for the purposes of their marketing. The genetic-sanitary certification of plant propagation materials represents the means of qualification of nursery production. Such certification offers greater guarantees, allowing to broaden the commercial horizons beyond national borders. Furthermore, it represents one of the tools for the prevention and fight against epidemic-spreading plant diseases, an aspect that has assumed great importance in recent decades. The certification represents the instrument of maximum guarantee of the nursery material and the only solution capable of protecting nursery operators and end users.

The objectives of this article are: 1) to analyze the current regulatory framework for nursery certification; 2) to introduce the blockchain technology in agriculture; 3) to highlight how standardization efforts can contribute to the growth of the agri-food sector by reducing intermediary costs, improving delivery times, maintaining persistent quality and minimizing human errors.

MATERIALS AND METHODS

In this paragraph, the regulations in force in Italy regarding nursery certification will be analyzed first and then the blockchain technology. The purpose of this article is to focus the attention on the importance of standardization in the management and production of nurseries using blockchain solutions. Standardization is the first step for subsequent nursery certification using the blockchain.

Reference legislation for nursery certification

With the entry into force of the New Phytosanitary Regime, the certification of nursery material was regulated at European Union level with the publication of Legislative Decree 2 February 2021, n.18. The decree, in force since 03/13/2021, has as its object the adaptation of national legislation for the purposes of applying the regulations (EU) 2016/2031 and 2017/625 of the European Parliament and of the Council. This decree concerns the production and marketing of propagating materials and fruit and vegetable plants (Gazzetta, 2021). The National Plant Protection Service is the national plant protection organization. It carries out the plant protection function through activities aimed at protecting agricultural production, the forest heritage, the territory and the environment from damage deriving from harmful plant organisms.

Blockchain technology in agriculture

The main applications of the blockchain are agricultural insurance, smart farming, traceability, land registration, food supply chain, security and safety of farms, e commerce of agricultural products (Guna Sekhar et al., 2023). Blockchain properties such as decentralization, transparency, immutability, autonomy, open source, anonymity and consensus are useful in agriculture sector applications (Miguel Pincheira et al., 2018).

RESULTS AND DISCUSSION

To guarantee greater profitability, once a quality agricultural product has been obtained, it is necessary to enhance it by certifying its origin and by disseminating the methods used to produce it. The quality of the final product is highly dependent on compliance with certain

specifications. For these reasons it is essential to follow agronomic standards that can give the product a quality certification. The certification represents the instrument of maximum guarantee of the nursery material, the only one capable of protecting nursery operators and end users. The genetic and sanitary certification of tree crops allows for safe international trade, prevents and combats phytosanitary emergencies, an aspect that is assuming strategic importance at a global level. Certification is a production process, governed by national standards, which makes it possible to obtain superior quality plants, with certain genetic characteristics that are guaranteed from a health point of view. The purposes of the certification can be summarized as follows: 1) production of superior quality material both for genetic and phytosanitary aspects; 2) prevention of the spread of quarantine and diseases; 3) improvement of the quality of fruit production; 4) traceability in the supply chain.

For the implementation of nursery certification in Italy, roles and tasks are established for the various players involved: the nursery companies that produce the plants, the Regional Phytosanitary Service, and the fruit producers (Figure 1). The nurseryman is primarily responsible for the characteristics of his product. The nursery companies are responsible for all the activities related to the production of finished plants and propagating material, from the constitution of new varieties to all the various stages of multiplication, up to the final marketing. A specific blue label-certificate bearing the words “certificate category” must always be applied to the marketed product. The nurseryman follows the provisions of the specific regulations, which establish how to carry out phytosanitary and genetic characteristics checks. The Phytosanitary and Production Protection Sector controls the certification process at all stages, through various field inspections and verification of the conformity of the documentation relating to the material to be certified. The Phytosanitary Sector is also responsible for recognizing the suitability of mother plant fields, micro-propagation laboratories, nurseries and the respective production structures. Having ascertained compliance with the provisions of the regulations, the Phytosanitary Sector issues the certification, attested by the certificate-tag affixed to the plants. More generally, the Phytosanitary and Production Defense Service has the task of monitoring the territory with respect to the spread of “quarantine” diseases. This is particularly important to ensure that the nursery activity takes place in suitable areas to prevent contamination of the nursery material. The fruit producer has a very important role as the end user of nursery products. If the end user chooses to purchase certified plants, the end user must make sure that the specific blue label-certificate is applied to each stem and report any omissions or counterfeits to the Phytosanitary Service (MASAF, s.d.).

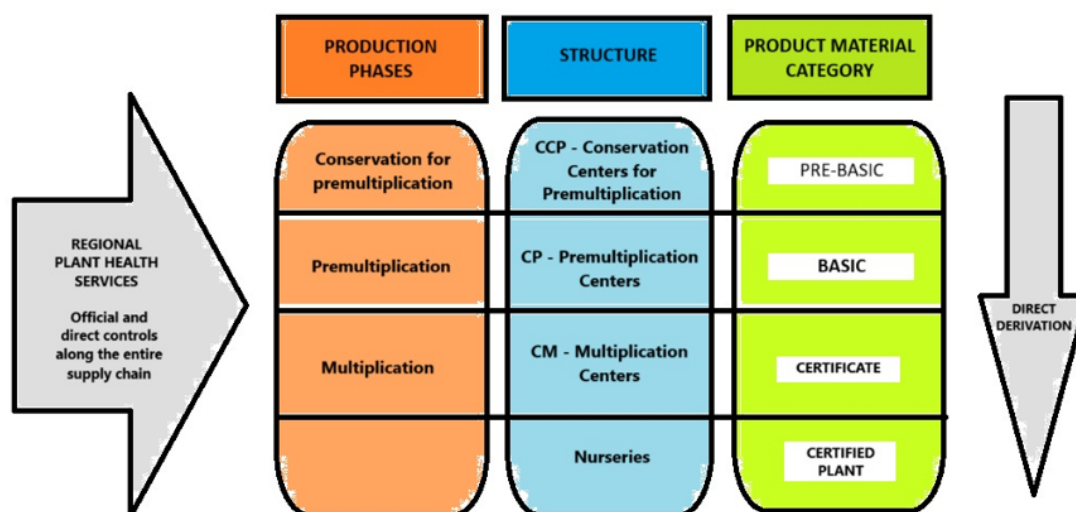


Figure 1. National Voluntary Certification System.

There is a growing demand for food safety in today's competitive market and industrial environment. The traceability of the food product in the supply chain is important for the consumers. One of the most challenging aspects of using technology in the life cycle of agri-food products is the robustness against fraud for the origin or processing of the product, the control of the phytosanitary treatments used, and the maintenance of the conservation chain.

Blockchain has quickly become an important technology in many applications of agriculture. Using blockchain solutions, producers can significantly increase the transparency and traceability of the supply chain and, as a result, they will be able to increase the commercial value of their products. Blockchain technology is one of the best solutions for securing information sharing in distributed systems (Kakali et al., 2023). Blockchain solutions play a vital role in replacing the classic methods of storing, sorting and sharing agricultural data in a more reliable, immutable, transparent and decentralized way. In this sense, the use of blockchain can help achieve traceability and transparency in the value chain of agricultural products, from planting and harvest monitoring, until the product reaches the consumer, through logistics and storage. For example, blockchain solutions can improve crop growth, save water consumption, reduce monitoring operation times, improve delivery times, maintain persistent quality while minimizing human errors. Therefore, making sure that the blockchain can be traced securely is a great way to connect suppliers and customers (Moyixi et al., 2022).

Several regulatory authorities have proposed their own standards to improve the transparency and traceability of the food supply chain. The European Commission has underlined the importance of developing advanced traceability systems as a strategic competitive advantage over traditional systems, in particular in regard to information archiving, privacy control and process transparency (Verzijl et al., 2015). Information technologies and the latest digital paradigms can be integrated to promote new digital traceability services (Ferrández-Pastor et al., 2022). Traceability allows to locate a product through the stages of manufacturing, processing and distribution (Ferrández-Pastor et al., 2022).

Properly integrated digitization and standardization can offer a secure path from field to fork. It is known that the quality of the final product strongly depends on the compliance with certain standards, which are often disregarded because the single steps are conditioned by the transparency of the facts. Standards are a common language that allows researchers, people, public institutions and industry to communicate, produce and market products and services. Once a quality product has been obtained, to reach higher revenues it is necessary to enhance the product, certifying its origin, the methods used to produce it, and the safeguard systems adopted. Hence the importance of standardization throughout the agri-food sector, an essential requirement for the achievement of the corresponding downstream quality certifications. Data analysis, blockchain and smart labels are tools that, in addition to certifying origin, make procedures faster, more standardized and therefore less subject to human error (Sortino et al., 2023).

CONCLUSIONS

Nursery is a very complex sector. The legislation on certification for the qualification of propagation materials plays a decisive role for the nursery activity, both for the domestic market and for international trades. Producing healthy and certified nursery material allows to create the foundations of a production chain in line with quality, food safety and environmental and ethical sustainability.

This article covered the importance of standardization while using blockchain solutions for the nursery industry. Standardization can contribute to the growth of the agri-food sector by reducing intermediary costs, improving delivery times, maintaining persistent quality and minimizing human errors. Standardization is a fundamental requirement for obtaining the corresponding quality certifications in the nursery sector.

Literature cited

Aquaro, P. (2022). L'agricoltura 4.0 Vale il 4% del Giro Mondiale. Corriere della Sera.

- Ferrández-Pastor, F.-J., Mora-Pascual, J., and Díaz-Lajara, D. (2022). Agricultural traceability model based on IoT and Blockchain: application in industrial hemp production. *J. Ind. Inf. Integr.* 29 (100381), 100381 <https://doi.org/10.1016/j.jii.2022.100381>.
- Gazzetta, U. (2021). Decreto Legislativo 2 Febbraio 2021, n. 18 (Roma: Repubblica Italiana).
- Guna Sekhar, S., et al. (2023). Towards applicability of blockchain in agriculture sector. *Mater. Today Proc.* 80, 3705–3708 <https://doi.org/10.1016/j.matpr.2021.07.366>.
- Kakali, C., Ashish, S. & Neha. (2023). A blockchain-enabled security framework for smart agriculture. *Comput. Electr. Eng.* 106 (108594).
- Karatas, M., Eriskin, L., Deveci, M., Pamucar, D., and Garg, H. (2022). Big data for healthcare industry 4.0: Applications, challenges and. *Expert Syst. Appl.* 200 (116912), 116912 <https://doi.org/10.1016/j.eswa.2022.116912>.
- Liu, F., Yang, C., Yang, J., Kong, D., Zhou, A., Qi, J., and Li, Z. (2022). A hybrid with distributed pooling blockchain protocol for image storage. *Sci. Rep.* 12 (3457), 3457 <https://doi.org/10.1038/s41598-022-07494-9>.
- MASAF. s.d. Ministero dell'agricoltura, della sovranità alimentare e delle foreste. <https://www.politicheagricole.it/flex/cm/pages/ServeBLOB.php/L/IT/IDPagina/202>.
- Miguel Pincheira, C., Muhammed Salek, A., Vecchio, M., and Giaffreda, R. (2018). Blockchain-based traceability in Agri-Food supply chain management: a practical implementation. *Tuscany. IOT Tuscany 2018*, 1–4.
- Moyixi, L., et al. (2022). Trusted-auditing chain: a security blockchain prototype used in agriculture traceability. *Heliyon* 8 (11).
- Nilesh Kumar, J., et al. (2023). Blockchain and artificial intelligence-empowered smart agriculture. *Comput. Electr. Eng.* 105 (108486).
- Sortino, A., De Leo, G., Caruso, T., Zinnai, A., and Beltrame, F. (2023). Agri-food: which technologies to guarantee our health? *Acta Hort.* 1360, 113–120 <https://doi.org/10.17660/ActaHortic.2023.1360.15>.
- Torkya, M., and Hassaneinb, A.E. (2020). Integrating blockchain and the internet of things in precision agriculture: analysis, opportunities, and challenges. *Comput. Electron. Agric.* 178 (105476), 105476 <https://doi.org/10.1016/j.compag.2020.105476>.
- Verzija, D. et al. (2015). Traceability across the value chain-standards, processes and traceability (European Union: Business Innovation Observatory).
- Wei, L., Xue-Feng, S., Chia-Huei, W., and Ping, Q. (2021). A systematic literature review on applications of information and communication technologies and blockchain technologies for precision agriculture development. *J. Clean. Prod.* 298 (126763).
- Zhenjun, X., Hua, K. and Bin, W. (2022). Dual-chain blockchain in agricultural e-commerce information traceability considering the vniar algorithm. *Scientific Programming and Artificial Intelligence for Sensor Data Stream Analysis*. 1.

