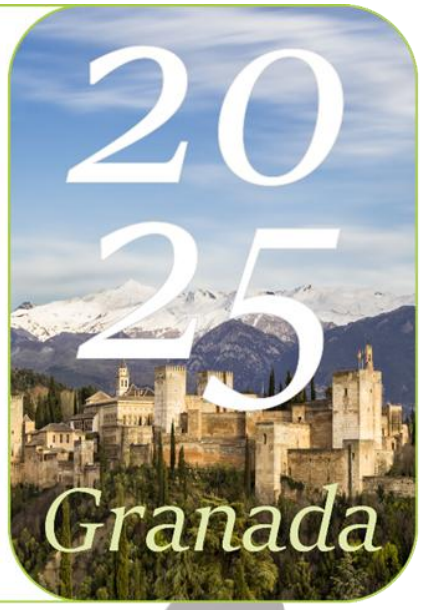


ASOCIACIÓN ESPAÑOLA DE ECONOMÍA AGROALIMENTARIA

XV CONGRESO DE ECONOMÍA AGROALIMENTARIA

I CONGRESO INTERNACIONAL DE LA RED IBEROAMERICANA DE ECONOMÍA AGRO-ALIMENTARIA Y DE RECURSOS NATURALES

LIBRO DE ACTAS

XV Congreso de Economía Agroalimentaria

I Congreso de la Red Iberoamericana de Economía Agroalimentaria y de Recursos Naturales

Granada 3 - 5 septiembre 2025

MAPPING THE ADOPTION OF DIGITALIZATION IN THE FOOD SUPPLY CHAIN TO IMPROVE THE TRACEABILITY: A SCOOPING REVIEW

Somia Bekkouche[a], Jihan Halimi[a], Tiziana de Magistris[ab]*

[a] Centro de Investigación y Tecnologia Agroalimentaria (Zaragoza, tmagistris@cita-aragon.es). [b] Instituto Agroalimentario de Aragón-IA2 (CITA-Universidad de Zaragoza)

ABSTRACT

Traceability of food supply chain is crucial for ensuring food safety, quality, and regulatory compliance. Digitalization tools such as blockchain, IoT, and artificial intelligence are increasingly used to improve transparency and enhance regulatory compliance. These technologies allow for real-time tracking of food products from production to consumption, reducing fraud risks, enhancing recall management, and boosting consumer trust. However, their adoption varies due to difference in technological readiness, economic constraints, and regulatory frameworks. This paper presents a comprehensive scooping review of digital technologies implementation in the food supply chain, shedding light on the reported outcomes in academic literatures, examining the evolving landscape of agricultural technology and its implications for sustainable food and the impact on food security. An exhaustive search of ProQuest Web of Science, IEEE-Xplore and Alcorze turned up 1495. references. Duplicates were deleted using RAYYAN software, followed by title and abstract screening, 171 references were retained, with 79 selected for detailed data extraction and analysis. Preliminary results suggest that the integration of digital tools significantly enhances supply chain transparency and contributes to improved sustainability outcomes. The adoption of digital technologies, particularly blockchain, RFID, and IoT, has advanced traceability, efficiency, transparency, and food safety within the European agri-food supply chain.

Keywords: Digitalization tools, European food supply chain, scooping review, traceability.

1.Introduction

Traceability is now considered a vital component in ensuring food safety, quality control, and regulatory compliance, especially considering the increasing incidence of food fraud (Charlebois et al., 2024). In this context, the implementation of digital technology across the food supply chain plays a pivotal role in enhancing traceability, promoting sustainability, and improving operational efficiency. Blockchain, IoT, AI, and big data analytics technologies enable real-time tracking, increase data transparency, and automate procedures, which reinforce food safety guarantees(Patelli & Mandrioli, 2020). As modern supply chains become more complex, digital solutions can mitigate risks such as supply disruptions. These technological advances contribute to achieve United Nations Sustainable Development Goals (SDGs) by increasing productivity and sustainability in the agri-food sector ((Mondejar et al., 2021) At policy level, the European Uinon has taken a leading role in advancing digital transformation in the food system through initiatives such as the Farm to Fork strategy and the digital signal market. These efforts draw attention to how important digital adoption is to promoting efficiency, openness, and sustainability across food systems(European Commission, 2023). Although there is extensive research on digitalization in the food supply chain, most of it focuses on specific technologies rather than providing a comprehensive analysis of trends in digital adoption (Yadav et al., 2024). Furthermore, there aren't many comparative studies that examine how different European areas adopt digital technology at different levels. Determining the elements that impact digital adoption and evaluating their effects on traceability and supply chain resilience in general require an understanding of these discrepancies(Zhao et al., 2024) . By combining the body of available research, this scoping assessment seeks to close these gaps by mapping digitalization implementation and identifying chances to enhance traceability in the European food supply chain through digital innovation.

2.Objectives

This scoping review aims to provide a comprehensive overview of the current state of knowledge, regarding the use of digitalization in the European agri-food sector. Specifically, it seeks to identify current approaches, innovations, and technological developments; to assess how these digitalization efforts enhance traceability, efficiency, transparency, sustainability, resilience, and food safety; and to explore the factors influencing the adoption and integration of these tools across different stages of the supply chain.

3.Methodology

This paper adopts a scoping review methodology approach proposed by Arksey and O'Malley (2005) with enhancements outlined by (Levac et al., 2010) to analyse digital technology adoption trends in the European food supply chain. Relevant peer-reviewed articles were selected through targeted searches in databases such as Web of Science (WOS), Alcorze, ProQuest and IEEE-Xplore. Key inclusion criteria included studies focusing on blockchain, IoT, AI, or big data applications in food traceability, supply chain resilience, or sustainability in the European context.

3.1. Inclusion criteria

To ensure relevance and consistency, studies were selected based on predefined inclusion criteria **(Table 1).**

Table 1. *Inclusion criteria*

Focus	Type of Publication	Language	Keywords/Topics Covered	Aspects of Agro-Food System	Location
Studies focusing on the implementation and utilization of digitalization tools within the agri-food supply chain (food and beverages).	Research articles and scholarly publications.	Literatures available in English.	Studies covering topics related to the provided keywords, including: "digitalization tools", blockchain, RFID, IoT, “internet of things”, “QR code” and “traceability”.	Literature addressing aspects of the agro-food system such as Agrifood system”, agri-food, “food supply chain”,” food industry”, and “food safety".	Studies covering topics related to European countries.

3.2. Search and screening process

This study was developed based on the guidelines in the Preferred Reporting Items of Systematic Reviews and Meta-Analyses Extension for Scoping Reviews (PRISMA-ScR) (Tricco et al., 2018). After finalizing the search strategy, and selecting the databases, references were exported from each database and imported into the screening platform RAYYAN. Duplicates were identified and removed prior to screening:

- **Title and abstract screening:** A total of 1495. sources were initially identified, of which 171 met the eligible criteria for full text review, after screening abstracts and full texts. Data was extracted on digital tools used, adoption patterns, barriers and enablers, and outcomes related to food traceability and safety, while 850 were excluded.
- **Full text screening:** The full texts of 171 articles were assessed, resulting in 79 studies meeting the inclusion criteria. The remaining 92 were excluded based on predefined eligibility criteria.

3.3. Data extraction process

The data extraction process commenced upon completing the full-text screening. Information was extracted, using Covidence platform, from 79 studies.

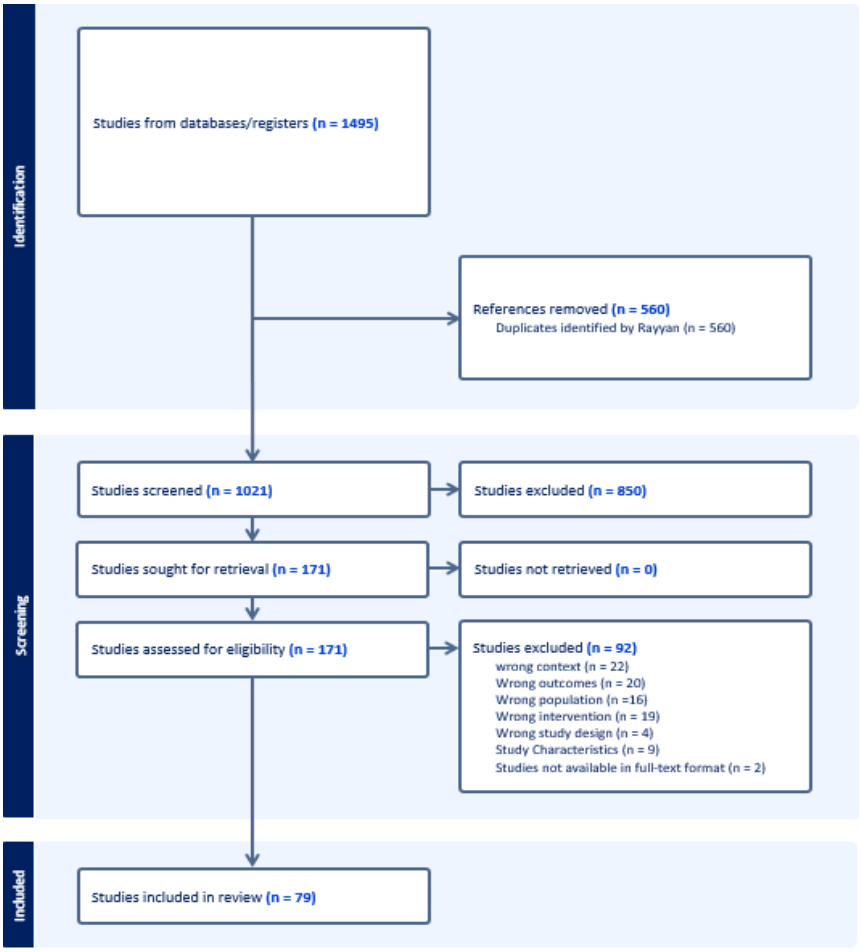
4.Results

We retrieved 1,493 studies from the initial search, of which 79 articles met our inclusion criteria and have been included in the analysis that were published between 2006 and 2025. **(Figure 1)**. The diagram below (**Figure 1**) outlines the identification, screening, eligibility assessment, and inclusion of studies in this review.

4.1. *Study populations and settings*

The included studies targeted primary production, processing, distribution, and retail activities in the European countries, focusing on different phases of the agri-food supply chain. Although the distribution was unequal, with a greater concentration of studies in Western Europe, the usage of digital technologies was noted in several countries and industries. The studies' sample sizes ranged widely, from pilot programs in a particular area to more extensive industry-wide implementations.

Figure 4.*PRISMA flow diagram of study selection*



4.2. ***Types of Digitalization Tools***

Seven main categories of digitalization tools were identified:

- Blockchain Technologies
- Internet of Things (IoT)
- Quick Response (QR) Codes
- Radio-Frequency Identification (RFID)
- Smart Contracts
- Artificial Intelligence (AI)
- Big Data Analytics
- DNA-based Traceability Tools

Among them, blockchain and RFID had the highest reported adoption rates, with blockchain in 36.1% and RFID in 26.9% of the studies.

4.3. ***Outcomes measured***

The studies evaluated a variety of outcomes related to food governance and supply chain performance, most frequently, including:

- Traceability Enhancement (e.g., tracking product origin and movement)
- Efficiency Improvements (e.g., reduced transaction costs, optimized logistics)
- Transparency Increase (e.g., open access to product histories)
- Food Safety Assurance (e.g., contaminant tracking, quality control systems)
- Environmental Impact Mitigation (e.g., improved resource management)

Notably, technologies like blockchain, RFID, IoT, and QR codes were the most frequently associated with achieving these outcomes.

4.4. ***Key findings***

Several significant concepts appeared from the studied literature:

- Blockchain was consistently associated with considerable increases in traceability (29.9%) and transparency (35.7%)
- RFID systems were strongly associated with food safety (43.5%) and traceability (28%)
- IoT applications were linked with increased efficiency (28.1%) and transparency (16.3%)
- While not widely employed, big data and AI tools have shown promise in enhancing operational efficiency and transparency.
- Environmental benefits were also noted, particularly when IoT and blockchain were implemented to optimize resource use and reduce waste.
- Supply chain stages. The retail and distribution stages have the highest levels of technological where Blockchain and IoT are the most used technology, particularly in the retail, distribution, and production stages.

5.Conclusion

This scoping review emphasizes the importance of digital technology in improving traceability, efficiency, transparency, and food safety throughout the European agri-food supply chain. While blockchain and RFID emerged as dominant technologies tools, such as IoT, QR codes, and big data analytics are gaining traction and diversification of their applications. However, issues including scalability, data standardization, interoperability, and regulatory constraints remain. Future research should focus on comparative analyses of regional adoption patterns and the long-term impacts of digitalization on food safety, sustainability, and resilience. By addressing current barriers, Europe can fully leverage digital innovation to create a transparent and sustainable food system.

Acknowledgements

Grant project PCI2022-132917 "Development of a blockchain-based ecosystem that allows an improved positioning of small producers of honey on local and international markets (TECHONEY). PRIMA, SECTION 2 (2021– 2025)", supported by MCIN/AEI/10.13039/501100011033 and by European Union "NextGenerationEU"/PRTR.

References

Charlebois, S., Latif, N., Ilahi, I., Sarker, B., Music, J., & Vezeau, J. (2024). Digital Traceability in Agri-Food Supply Chains: A Comparative Analysis of OECD Member Countries. In *Foods* (Vol. 13, Issue 7). Multidisciplinary Digital Publishing Institute (MDPI). https://doi.org/10.3390/foods13071075

European Commission. (2023). Adoption of sustainability innovations by operators in the EU food supply chain. https://doi.org/10.2760/010598

Levac, D., Colquhoun, H., & O'brien, K. K. (2010). Scoping studies: advancing the methodology. http://www.cihr-irsc.ca

Mondejar, M. E., Avtar, R., Diaz, H. L. B., Dubey, R. K., Esteban, J., Gómez-Morales, A., Hallam, B., Mbungu, N. T., Okolo, C. C., Prasad, K. A., She, Q., & Garcia-Segura, S. (2021). Digitalization to achieve sustainable development goals: Steps towards a Smart Green Planet. In Science of the Total Environment (Vol. 794). Elsevier B.V. https://doi.org/10.1016/j.scitotenv.2021.148539

Patelli, N., & Mandrioli, M. (2020). Blockchain technology and traceability in the agrifood industry. In Journal of Food Science (Vol. 85, Issue 11, pp. 3670–3678). Blackwell Publishing Inc. https://doi.org/10.1111/1750-3841.15477

Tricco, A. C., Lillie, E., Zarin, W., O'Brien, K. K., Colquhoun, H., Levac, D., Moher, D., Peters, M. D. J., Horsley, T., Weeks, L., Hempel, S., Akl, E. A., Chang, C., McGowan, J., Stewart, L., Hartling, L., Aldcroft, A., Wilson, M. G., Garritty, C., … Straus, S. E. (2018). PRISMA extension for scoping reviews (PRISMA-ScR): Checklist and explanation. In Annals of Internal Medicine (Vol. 169, Issue 7, pp. 467–473). American College of Physicians. https://doi.org/10.7326/M18-0850

Yadav, S., Luthra, S., Kumar, A., Agrawal, R., & Frederico, G. F. (2024). Exploring the relationship between digitalization, resilient agri-food supply chain management practices and firm performance. Journal of Enterprise Information Management, 37(2), 511–543. https://doi.org/10.1108/JEIM-03-2022-0095

Zhao, G., Ye, C., Dennehy, D., Liu, S., Harfouche, A., & Olan, F. (2024). Analysis of barriers to adopting Industry 4.0 to achieve agri-food supply chain sustainability: A group-based fuzzy analytic hierarchy process. Business Strategy and the Environment. https://doi.org/10.1002/bse.3928