Chapter N 123

**The Role of Technological Innovations for Agrifood Resilience: A Systematic Literature Review**

**Abstract.** The Agrifood sector is increasingly exposed to multiple internal and external drivers of change, ranging from sudden shocks to long-term stressors, increasing its vulnerability over time. In a world of increasing complexity and future uncertainty, it has become imperative to include contingency as a critical element in sustainable development research. Change, uncertainty, and the adaptive capacity of systems invoke the concept of resilience. There is a growing recognition of how digitalization and so-called "4.0" *disruptive* technologies can contribute to Agrifood resilience. This work aims to carry out a Systematic Literature Review combining technological development in the Agrifood sector with the concept of resilience. The main objective is to highlight the state of the art on the role of technological innovation and how it sustains the sector by presenting results of a descriptive-conceptual nature. Results show that the contribution of technological innovations to Agrifood resilience has become a topic of considerable interest, especially in the last five years (2018-2022) as a response - above all - to the Covid-19 pandemic crisis. Among the main contributions, digital technologies promote new approaches to production efficiency and decision-making in a logic of increased competitiveness, stability and sustainability of the Agrifood sector in the long term.

**Keywords.** Systematic Literature Review, Technological Innovation, Digitalization, Resilience, Agrifood.

1. **Introduction**

The achievement of sustainable and resilient Agrifood production and consumption models represents, as never before, a crucial and extraordinarily complex challenge whose solution cannot disregard adequate research on technological innovation. The impacts caused by climate change, overexploitation of natural resources, and aggressive agricultural practices are proving to be devastating for the Agrifood sector, which depends, among other things, the livelihoods of an increasing population and the economic, social, and cultural growth of communities around the world (FAO, 2020). Even before the Covid-19 outbreak, the Agrifood sector in most countries faced many problems of economic instability, social conflict, and food security. The advent of the crisis caused by the pandemic highlighted many others, including fragile production and distribution systems and business models that lack resilience in times of crisis (FAO, 2021). Current Agrifood systems require profound change, as they still fail to provide basic food for a large portion of the world's population while being responsible for an unsustainable burden on the environment.

In light of these critical issues, there is a growing consensus that the current Agrifood sector must evolve by following a different development trajectory. Addressing topics such as climate change, environmental impact, food security, access to safe food, and the fight against hunger requires the commitment of all stakeholders: citizens, companies, institutions, public and private actors, and regulators. In response to this, during 2015, a series of international events have placed the theme of sustainability at the center of the political agenda for Agrifood systems: among the most significant in addition to the Conference of Parties on Climate Change (COP21), the agreement on the Sustainable Development Goals (SDGs) of the United Nations, followed in 2020 by the European Green Deal, with the "Farm to Fork" strategy promoted by the European Commission.

There is a growing recognition of how digitalization and so-called "new technologies"- including all available tools and innovations that fit into the 4.0 paradigm- can help make the Agrifood sector resilient (Miranda et al., 2019; Lezoche et al., 2020; World Bank, 2017). Technological innovations in Agrifood are crucial to sustaining productivity growth and meeting the growing global demand for food while preserving environmental resources and adapting to and mitigating climate change (FAO, 2017). In the wake of the 4.0 paradigm, new *smart* business models have spread around the world, such as the phenomenon of *Smart Farming* or *Precision Agriculture*, which, thanks to the use of so-called *disruptive* technologies, optimize production processes with economic, environmental and social benefits (Wolfert et al., 2017). In Agrifood studies, the need to include contingencies as critical factors in sustainable development research that embody the concept of resilience (Folke et al., 2010), coupled with more recent developments in digital technologies, opens up new research scenarios that need to be shed light on. This Systematic Literature Review aims to understand how digital technologies contribute to Agrifood resilience. In particular, the systematic process offers descriptive and conceptual insights into technological innovations' state-of-the-art applications and contributions.

1. **Material and Methods**

The study undertook a Systematic Literature Review (SLR) to provide a comprehensive and thorough understanding of the researched phenomenon. Using a transparent, reproducible, and iterative review process (Phillips et al., 2014; Tranfield et al., 2003) a SLR aims to provide an objective view that overcomes the problem of researcher bias (Pittaway et al., 2014), using a research and analysis framework that follows a predetermined and structured pattern (Phillips et al., 2014; Tranfield et al., 2003). Based on Tranfield et al. (2003), this research scheme is divided into three stages, and each step is characterized by a series of actions that guide the process of conducting the SLR (Fig. 1).

Fig 1. Systematic Literature Review Process.

Source: Own elaboration adapted from Tranfield et al., 2003 and Phillips et al., 2014.

**2.1 Step 1. Planning the Review**

The first research phase preparatory to conducting an SLR is referred to by Tranfield et al., (2003) as "*Review Planning*", a preliminary stage of research in which researchers clarify objectives and decide based on what criteria to include or exclude a research paper in the data collection process.

After clarifying the will, the need, and the usefulness of contributing to the literature by presenting an SLR to fill an existing gap, the database from which to extract the data were defined. Following previous studies, search sources were limited to specific databases to detect bibliographic streams consistent with research interests and select only journals of higher academic impact (Podsakoff, et al., 2005).

For this purpose, the databases "SCOPUS" were considered suitable for collecting data (Gavel and Isalid, 2008). The research also limited the selection to only peer-reviewed journals because these can be considered high scientific content sources validated by the academic society (Podsakoff, et al., 2005).

**2.2 Step 2. Conducting the Review**

During the "Conducting the Review" process, keywords were identified by exploring the relevant literature. Specifically, discussions with experienced researchers laid the groundwork for defining the search string best suited for the study. The research was carried out on the SCOPUS database using the search function for 'title, abstract and keywords'; the string used for the SLR after entering the inclusion and exclusion parameters is shown below:

## ( TITLE-ABS-KEY ( *agri-food* )  OR  TITLE-ABS-KEY ( *agri\** )  OR  TITLE-ABS-KEY ( *agro\** )  AND  TITLE-ABS-KEY ( *technolog\** )  OR  TITLE-ABS-KEY ( *innovati\** )  OR  TITLE-ABS-KEY ( *digit\** )  AND  TITLE-ABS-KEY ( *resilien\** ) )  AND  (  LIMIT-TO ( OA ,  *"all"* ) )  AND  ( LIMIT-TO ( DOCTYPE ,  *"ar"* ) )  AND  ( LIMIT-TO ( SUBJAREA ,  *"BUSI"* ) )  AND  ( LIMIT-TO ( LANGUAGE ,  *"English"* ) )  AND  ( LIMIT-TO ( SRCTYPE ,  *"j"* ) )

Specifically, the final sample of papers identified for the SLR met the following inclusion/exclusion criteria:

* Selection of peer-reviewed scientific articles. Books, editorials, reviews, notes, letters, conference proceedings, and non-referenced publications were excluded from this selection.
* Business, Management, and Accounting subject area.
* Articles written in English.
* Full-text availability: an essential parameter for in-depth evaluation of the papers selected for the study.

Therefore, after satisfying the above search parameters, the sample of articles was reduced from n= 2005 to n= 22.

**2.3 Step 3. Reporting and Dissemination: Preliminary Evidence**

The process of "Reporting and Dissemination," as suggested by Tranfield et al. (2003) - especially in economics and management research - should be a two-step relationship geared toward producing a result that informs both practical (managerial) and theoretical sides.

In this sense, helping to provide insights in both directions, the general suggestion is to provide a double result of descriptive and thematic nature, i.e., by "concepts" (Tranfield et al., 2003).

1. **Finding and Discussion**
	1. ***Descriptive Analysis***

This section aims to provide a brief quantitative-descriptive overview of the role of technological innovation for Agrifood resilience. Before providing contributions to frame the trend of publications over the years, Table 1 shows the complete list of research articles identified for SLR.

Tab 1. List of Publication selected for the SLR.

****

Among the most interesting results is the analysis of publications' distribution over the years. Identifying the trend helps to understand how interest in the topic has evolved. The results show a particular concentration of studies concerning the role of technological innovation on Agrifood resilience, especially in the last four years (2018-2021), which weigh about 85% of the total scientific production on the topic (Fig. 2)[[1]](#footnote-1).

Fig 2. Number of Papers and Year of Publication.

* 1. ***Conceptual Analysis***

An in-depth analysis of scientific works on technological innovation's role in Agrifood resilience shows a deep connection with the critical issues arising from the Covid-19 pandemic (Quayson et al., 2020; Sharma et al., 2020). The relevant literature highlights how recent socio-economic events, exogenous shocks, climate change and the issue of food (in)security have highlighted the structural fragilities of the Agrifood sector (Branca et al., 2021; Cariappa et al., 2021; Corderio et al., 2021; Dar et al., 2020); while creating the basis for building new opportunities and rethinking new methods of production, distribution and consumption in a resilient logic (Anakpo and Mishi, 2021; Haile et al., 2022). Advances in predictive analytics through various forms of artificial intelligence methods, IoT systems, satellite technologies, growing computing capacity and developments in robotic industries have paved the way for new approaches to efficiency, productivity and decision-making (Galaz et al., 2021; Rengarajan et al., 2022). It is argued that in the future, innovation, new technologies and the creation of relationships between different economic agents could be crucial for the competitiveness, stability and sustainability of the sector over time (Aigbavboa et al., 2020; De Goede et al., 2012; Paoloni et al., 2022, Romao, 2020). Technological innovation, therefore, seems to play a central role in the process that drives policies for transition, energy adaptation and waste valorization to achieve and contribute to global change towards a sustainable future (Aghajanzadeh and Therkelsen, 2019; Ely et al., 2016; Hagman et al., 2018; Locker et al., 2019; Mat et al., 2017; Nelson and Phillips, 2018; Platt et al., 2018; Riberio and Shapira, 2019).

1. **Conclusions**

The Agrifood sector today faces multiple challenges. Even before the Covid-19 outbreak, the Agrifood sector in most countries faced many problems of economic instability, social conflict and food security. The advent of the crisis caused by the pandemic has highlighted many more, including the fragility of production and distribution systems and business models that lack resilience in times of crisis. This calls for urgent transformation of the current Agrifood sector and digital innovations can be part of the solution. The so-called fourth industrial revolution is seeing several sectors - such as Agrifood - rapidly transformed by disruptive digital technologies. The SLR highlights that technological innovations can help make the Agrifood sector resilient by improving production efficiency and decision-making in a logic of effective management of economic and natural resources. In conclusion, we point out that the application of digital technologies is often associated with increased competitiveness, stability and sustainability of the Agrifood sector in the long run.

**References**

Aghajanzadeh A, Therkelsen P (2019) Agricultural demand response for decarbonizing the electricity grid. J Clean Prod 220: 827-835.

Aigbavboa CO, Oke AE, Aghimien DO et al (2020) Improving resilience of cities through smart cities drivers. Constr Econ Build 20:45-64.

Anakpo G and Mishi S (2021) Business Response to COVID-19 impact: Effectiveness in South Africa. South Afr J Small Bus Manag 3:1-7.

Branca G, Arslan A, Paolantonio A et al (2021) Assessing the economic and mitigation benefits of climate-smart agriculture and its implications for political economy: A case study in Southern Africa. J Cleaner Prod 285:1-14.

Cariappa AA, Acharya KK, Adhav CA et al (2021) COVID-19 induced lockdown effects on agricultural commodity prices and consumer behaviour in India: Implication for food and waste management. Socio-Econ Plan Sci 82:1-23.

Corderio MC, Santos L, Marujo LG (2021) COVID-19 and the fragility of Brazilian small farming resilience. Braz J Oper Prod Manag 18:1-14.

Dar MH, Waza SA, Nayak S et al (2020) Gender Focused training and knowledge enhances the adoption of climate resilient seeds. Technol Soc 63:1-8.

De Goede D, Gremmen B, Blom-Zandstra M (2012) Robustness as an image of sustainability: applied conceptualization and their contribution to sustainable development. J Chain Netw Sci 12:137-149.

Ely A, Geall S, Song Y (2016) Sustainable maize production and consumption in China: practices and politics in transition. J Clean Prod 134:259-268.

FAO (2020), “International Platform for Digital Food and Agriculture can bring huge benefits to the sector, high-level panel says”, Rome: Food and Agriculture Organization of the United Nations.

FAO (2021), “The impact of disasters and crises on agriculture and food security”, Rome: Food and Agriculture Organization of the United Nations.

Folke C, Carpenter SR, Walker B et al, (2010) Resilience thinking: integrating resilience, adaptability and transformability. Ecol Sol 15:1-9.

Galaz V, Centeno MA, Callahan PW et al (2021) Artificial Intelligence, systemic risk, and sustainability. Technol Soc 67:1-10.

Gavel Y, Iselid L (2008) Web of Science and Scopus: a journal title overlap study. Online Inf Rev 32:8-21.

Hagman L, Blumenthal A, Eklund M (2018) The role of biogas solutions in sustainable biorefineries. J Clean Prod 172: 3982-3989.

Haile B, Mekonnen, D, Choufani J et al (2022) Hierarchical Modelling of Small-Scale Irrigation: Constraints and Opportunities for Adoption in Sub-Saharan Africa. Water Econ Policy 8: 1-30.

Lezoche M, Hernandez J, Diaz MDMA et al (2020) Agri-food 4.0: A survey of the supply chains and technologies for the future agriculture. Comput Ind 117:1-15.

Locker CR, Torkamani S, Laurenzi IJ et al (2019) Field-to-farm gate greenhouse gas emissions from corn stover production in the Midwestern U.S. J Clean Prod 226:1-12.

Mat N, Cerceau J, Lopez-Ferber M et al (2017) Complexity as a means of resilience in metropolitan port areas: Application to the Aix-Marseille case study in France 145:159-171.

Miranda J, Ponce P, Molina A et al (2019) Sensing, smart and sustainable technologies for Agri-Food 4.0. Comput Ind 108:21-36.

Nelson V, Phillips D (2018) Sector, Landscape or Rural Transformations? Exploring the Limits and Potential of Agricultural Sustainability Initiatives through a Cocoa Case Study. Bus Strategy Environ 27:252-262.

Paoloni P, Modaffari G, Paoloni N et al (2022) The strategic role of intellettual capital components in agri-food firms. Br Food J 124: 1430-1452.

Phillips W, Lee H, Ghobadian A et al (2014) Social Innovation and Social Entrepreneurship: A Systematic Review. Group Organ Manag: 1-34.

Pittaway L, Robertson M, Munir K et al (2004) Networking and innovation: a systematic review of the evidence. Int J Manag Rev 5:137-168.

Platt D, Workman M, Hall S (2018) A novel approach to assessing the commercial opportunities for greenhouse gas removal technology value chains: Developing the case for negative emission credit in the UK. J Clean Prod 203: 1003-1018.

Podsakoff PM, MacKenzie SB, Bachrach DG et al (2005) The influence of management journals in the 1980s and 1990s. Strateg Manag J 26: 473-488.

Quayson M, Bai C, Osei V (2020) Digital Inclusion for Resilient Post-COVID-19 Supply Chains: Smallholder Farmer Perspectives. IEEE Eng Manag Rev 48:104-110.

Rengarajan S, Narayanamurthy G, Moser R et al (2022) Data strategies for global value chain: Hybridization of small and big data in the aftermath of COVID-19. J Bus Res 144: 776-787.

Ribeiro B, Shapira P (2019) Anticipating governance challenges in synthetic biology: Insight from biosynthetic menthol. Technol Forecast Soc Change 139: 311-320.

Romão J (2020) Tourism, smart specialisation, growth, and resilience. Ann Tour Res 84:1-15.

Sharma R, Shishodia A, Kamble S et al (2020) Agriculture supply chain risks and COVID-19: mitigation strategies and implications for the practitioners. Int J Logist Res Appl 1-27.

Smith J, Jones M Jr, Houghton L et al (1999) Future of health insurance. N Engl J Med 965:325–329.

Tranfield D, Denyer D, Palminder S (2003) Towards a Methodology for Developing Evidence- Informed Management Knowledge by Means of Systematic Review. Brit J Man 14: 207-222.

Wolfert S, Ge L, Verdouw C et al (2017) Big Data in Smart Farming - a Review. Agri Syst 153: 69-80.

World Bank (2017), “ICT in agriculture: Connecting smallholders to knowledge, networks, and institutions”, Washington, DC, World Bank.

1. The graph does not show data for 2022 due the partial scientific production, which would have created a conceptual distortion in the trend configuration. However, the thematic analysis included papers published in 2022 because they were consistent with the analysis by “concept”. [↑](#footnote-ref-1)