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Assessing the Impact of Digitisation on Progress in Agriculture: A Bibliometric Analysis

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Abstract. *The paper shows how the agri-sector is influenced by the emergence and development of the digitisation process. This is presented using a bibliometric analysis. The importance of studying and understanding the current challenges facing the agricultural sector including the emergence and development of the digitisation process of the sector is the main aim of this paper. All these challenges are felt by both the agricultural sector and the economy as a whole. This paper contributes to the literature. This is due to the bibliometric analysis through which the most important aspects of the challenges facing the entire agricultural sector today are observed. Among the current challenges facing the agricultural sector, climate change is among the most important. The results of the bibliometric analysis show that the keywords searched and their clustering confirm that the emergence and rapid development of digitisation brings both positive and negative effects to the whole agricultural sector. Following the search of Web of Science and Scopus databases, 203 papers were identified in Web of Science and Scopus using the phrase "the impact of digitization on agriculture". The bilbiometric analysis comprises several steps, including the analysis of the years of emergence of studies on the emergence of the digitisation process in agriculture. Thus, within this stage, the analysis of the years, it is signalled the transition from some aspects that concern the technological side to other economic and even human aspects. On the whole, there is a shift in research topics towards studying how the emergence and development of the digitisation process brings both positive and negative influences between the agricultural sector and society.*

Keywords: digitisation, agriculture, challenges for agriculture, climate change adaptation, food security, bibliometric analysis.

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Introduction

In recent times, the development of the digitisation process has contributed to the design, modification and modernisation of the entire agricultural industry. This technological shift introduces a myriad of innovations and advanced tools that profoundly influence the methods of agricultural practices, resource management, and the pursuit of sustainable development within the sector (Abbasi et al., 2022). Through the integration of artificial intelligence, data analytics, deployment of agricultural robots, and monitoring technologies, digitization is fundamentally altering the approaches taken by farmers, practitioners, and researchers when addressing challenges and harnessing opportunities in agriculture (Yunchuan et al., 2021).

The development of digitization processes applied to the whole agricultural sector is an important topic and is receiving increasing interest in academia. At the same time, the current agricultural sector is subject to very high forecasts and its digitization in the current context is the main purpose of the paper. In this context, digitization offers innovative tools and solutions that can improve efficiency, productivity and sustainability in the agricultural sector (Alekseeva et al., 2021). Through the digitization of the agricultural sector including the emergence of monitoring and analysis sensors, farmers obtain information on soil quality, crop quality and condition as well as many other real-time information. Through this, farmers are able to make better decisions in a much shorter time, contributing to higher yields.

The current literature on digitisation in agriculture is vast and diverse. Digitization contributes to redefining the routines of the population and also contributes to the production of both positive effects on the environment and, in particular, on the agricultural sector, and negative effects on the environment and the economy (Vial, 2019). The UN has predicted that by the year 2050 the world population will grow exponentially and that the agricultural sector will have to provide food for more than 9 billion people (FAO, 2018). The agricultural sector is sensitive to changes and for the agricultural sector to be able to feed 9 billion people without compromising the ecosystem, it is necessary to intervene by redesigning efficient and sustainable food production. Thus, various studies (Garcia et al., 2019; Eastwood et al., 2019) and reports (WEF, 2018; EOCD, 2019) state that the digitization process can contribute both to the improvement of agriculture, such as the use efficient use of all resources as well as improving rural communities.

In many other studies and scientific works, the process access to the digitization of the agricultural sector is presented and explained. Within these studies, this process presents various methods that have the ability to maintain the integrity of the agricultural sector in the current context of the challenges to which the sector is subjected today. However, many of the studies that address topics of digitalization of agriculture through the bibliometric method do not use tools such as scientific mapping and are limited in terms of the time interval and the databases used. This paper contributes to the literature on the digitisation of agriculture while presenting an overview of the whole agricultural sector.

Literature review

In an era defined by advanced technology and rapid transformations, digitization pervades all aspects of modern society, significantly influencing our approaches to business and problem solving (Meshesha et al., 2014). Agriculture, serving as a cornerstone of human subsistence, experiences a similar revolution. Digitization introduces technologies and innovations that challenge the traditional agricultural practices, promising substantial contributions to the industry's sustainable progress (Gremer et al., 2015).

Assessing the impact of digitisation on agricultural progress not only offers a glimpse into the future but is a necessity amidst the increasingly intricate and interconnected challenges facing the global agricultural sector (Sodoma et al., 2022). The entire agricultural sector is facing difficult times. The growing need for food in the context of increasing population numbers, constraints on limited natural resources and the increasingly visible effects of climate change are all variables contributing to the worsening situation of existing agriculture. Within this context, digitisation emerges as a potential catalyst, providing tools and technologies capable of optimising production, streamlining resource allocation, and fostering better connectivity across the food supply chain (Dumitru et al., 2023).

In addition to the influence that digitisation has on the political aspect, this process also has a considerable influence on the behaviour of all consumers. Today, shoppers no longer shop only for the bare necessities. In this light, consumer preferences have a significant influence on shaping the trajectories of the food industry (Micu et al., 2022).

By providing transparency about the provenance, quality and environmental impact of food products, digitization offers consumers the opportunity to make informed and responsible choices (Motofeanu et al., 2022). With quick access to information, they can express their preferences for local, sustainable products with minimal environmental impact.

A number of publications have analyzed and reviewed the emergence of changes and revolutions that have taken place, especially in the agricultural sector, to be able to outline a picture of the effects of the adoption of various technologies, including their potential to withstand the challenges of food production for all, the generations, both for the current generation and for future ones (Kim et al., 2019; Raparelli and Bajocoo, 2019). The role of bibliometric analyses is essential, as they provide an objective picture of broad research areas.

The emergence and development of the digitization process in the agricultural sector contributes through its specific means to increasing and improving the productivity of crop yields and reducing production costs. At the same time, the digitization of agriculture represents a new direction for growth and development of the efficiency of the agricultural sector both from a structural and sustainability point of view (Stoica et al., 2022). With the emergence and development of the digitization process of agriculture a large part of the problems can be solved. These include the uncontrolled expansion of markets and the development and creation of new jobs.Progress in the field of digitalization of agriculture can contribute to changing the traditional ways of obtaining agricultural production as well as the exchange of agricultural information, in order to promote and develop it (Tang Chen, 2022). Achieving high quality agricultural production is fundamental for the further development of mankind. The supply chain has historically supported both agricultural income and the agricultural workforce. (Bathaei, 2023).

Methodology

Bibliometric analysis is the research method by which scientific research is evaluated and analysed and helps to quantify the impact and influence of scientific work, identifying research trends in the field under study (Iancu et al., 2022).

In the present study, a series of steps were followed. The first step consisted in selecting data sources, namely Scopus and Web of Science, due to the wide range of scientific articles produced in the field as well as due to the history of reliability among the scientific literature. The research found in the Web of Science database is more extensive in terms of the total number of publications found compared to the Scopus database. Also, Scopus focuses more on the European

side, while Web of Science focuses largely on the American side (Popescu et al., 2019). The key words used for database extraction were, the impact of digitization on agriculture". After exporting the databases, using Zotero software, we collected the articles and removed duplicates, so that an article is found only once in our database. Subsequently, the merging of the databases containing distinct articles was carried out and the bibliometric analysis was performed. An analysis of the top three most cited scientific papers written on our topic in each database was also performed.

Results and discussion

The researches of the Web of Science and the Scopus database identified 143 papers in the Web of Science and 84 papers in the Scopus database. After removing duplicates, the total number of papers is 203 scientific papers. In the case of the searches in the Web of Science database, most of the searches were categorized under Environmental sciences (27 papers), Green Sustainable Science Technology (17 papers), Environmental Studies (16 papers), Economics (12 papers), Agronomy (11 papers), while the searches in the Scopus database were placed in the following categories: environmental science (29 papers), engineering (25 papers), social science (25 papers), agriculture land biological science (21 papers).

In terms of the ecology of research by year, the WOS database shows papers written on the topic since 2003, while in the Scopus database, the first paper appeared in 2010. Most of the papers were published in both the WOS database (50 articles) and Web Of Science (23 articles) in 2022 (Figure 1).

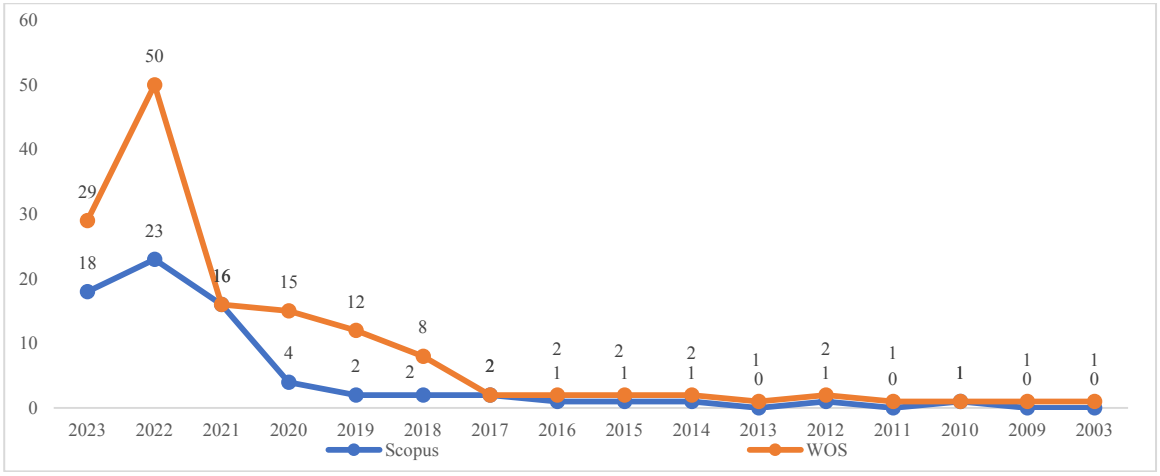

Figure 1. Evolution of research on the topic "the impact of digitalisation on agriculture"

Source: Processing based on WOS and Scopus data.

Figure number 2 shows the keywords most used in the publications on the analysed topic. They are grouped in clusters (nodes), and the lines connecting these nodes show the relationship between them. Thus, the first cluster (red) named ,,agriculture" includes: digitisation,, artificial itelligence, agricultural robots, sustainable agriculture, digitalization, digital technologies, and transformational transformation. The second cluster (green) called ,,digitization" includes: economic development, carbon emission, efficiency, article, climate change, pollution (Figure 2).

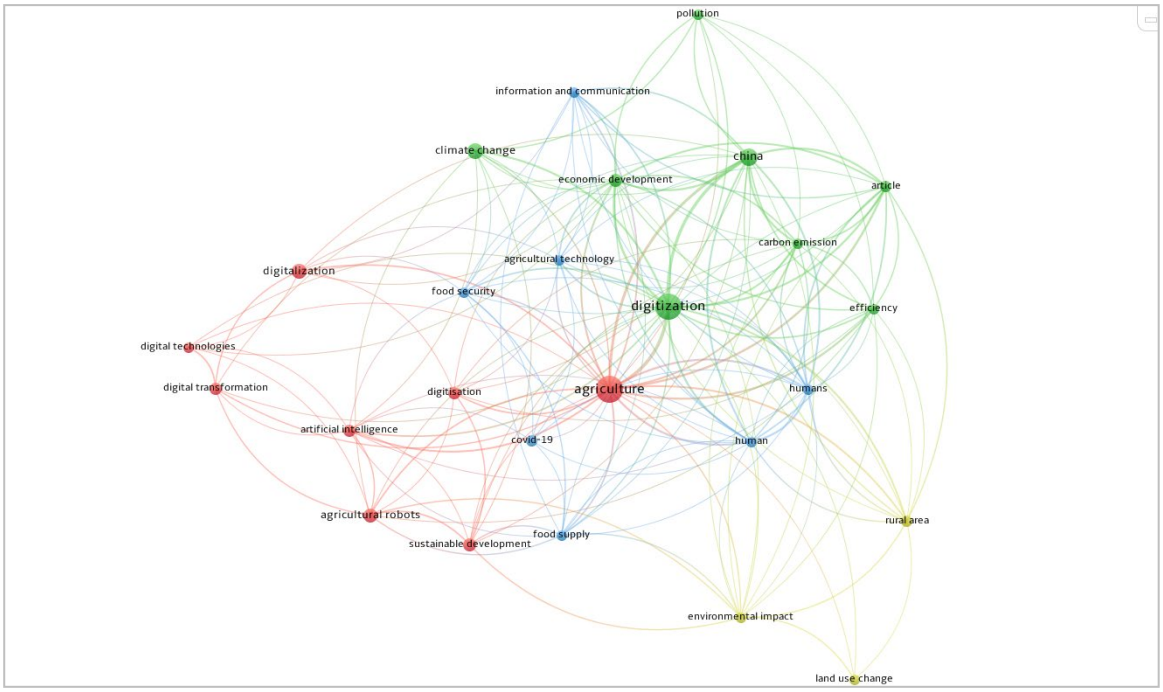

Figure 2. Connectivity of keywords used

Source: Processing based on WoS results using VOSviewer.

The third group (blue) called ,,food security" includes: agricultural terminology, covid-19, humans, information and communication. The fourth group (yellow) called ,,environmental impact" includes: change in land use and rural area (Figure 2). In terms of keywords used by year, in 2020 and 2021, researchers focused on climate change, environmental impact, agricultural robots, digital technologies, digitalisation, digital transformation, sustainable development, food supply, rural area, change of land use.

Later, in 2022 and 2023, the main topics were human, carbon emission, article, economic development, food security, digitisation food security, information and communication (Figure 3).

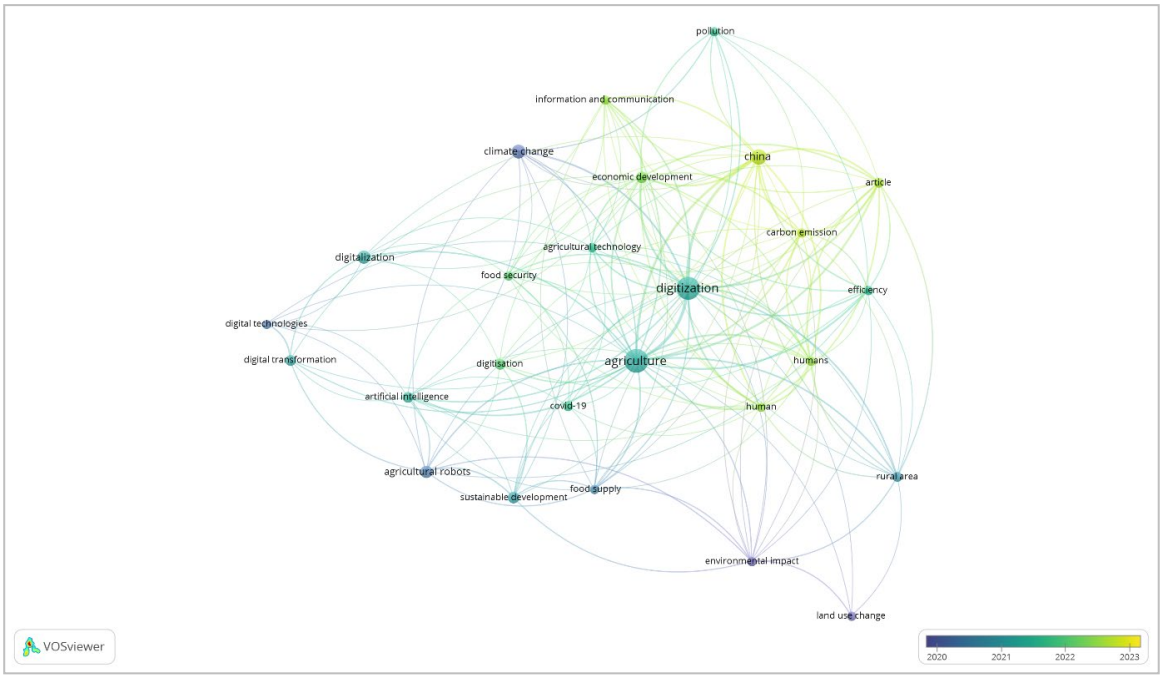

Figure 3. Connectivity of keywords used by year

Source: Processing based on WoS results using VOSviewer.

Towards a sustainable biobased industry: Highlighting the impact of extremophiles is the most cited paper on the subject. In this paper, the authors focused on how these organisms are able to survive under the pressure of poor conditions. It also looks at how these organisms can be used to combat and address the current challenges facing the sector. (Table 1).

Table 1. Top 3 most cited papers found in the Scopus database on the topic „the impact of digitalisation on agriculture"

Nr. crt.	Name	Year	Number of citation
1	Toward a sustainable biobased industry – Highlighting the impact of extremophiles	2018	75
2	Artificial intelligence, systemic risks, and sustainability	2021	68
3	The impact of COVID-19 on the Chinese stock market: Sentimental or substantial?	2021	64

Source: Scopus database.

The second most cited paper in the Scopus database is "Artificial intelligence, systemic risks, and sustainability," written by Galaz, V., Centeno, M.A., Callahan, P.W. and collaborators. This paper highlights the effects of IA on systemic risks and sustainability. The authors of the study have observed how developments in the field of AI can have significant effects on society as a whole. The study presents both the positive effects and the challenging elements of developing and introducing AI in the current context of developing viable and sustainable solutions over time. (Stoica et al., 2022).

The third most cited paper is "The impact of COVID-19 on the Chinese stock market: Sentimental or substantial?", focuses on the influence that the COVID-19 pandemic had on the Chinese stock market: sentimental or substantial impact. In cadrul celui de-al treileacel mai citat studiu, autorii s-au axat pe analizarea efectelor pandemiei si daca aceasta a contribuit la

schimbarile din piata. Acest studiu se axeaza pe impactul pe care COVID 19 l-a a avut asupra pietei bursiere din China. (Victor et al., 2021) (Table 1).

Table 2. Top 3 most cited papers in the Web of Science database on " the impact of digitalisation on agriculture"

Nr. crt.	Name	Year	Number of citation
1	Desert grassland responses to climate and soil moisture suggest divergent vulnerabilities in the southwestern United States	2015	71
2	Land-use change and its socio-environmental impact in Eastern Ethiopia's highland	2014	67
3	Extinction debt for plants and flower-visiting insects in landscapes with contrasting land use history	2021	66

Source: WOS database.

The most cited work on this topic is "Desert grassland responses to climate and soil moisture suggest divergent vulnerabilities across the southwestern United States", where the authors analyzed and evaluated the impact that the digitization process of the agricultural sector had on the entire ecosystem. In this study, the authors introduced and presented the influence of this process on the desert pastures of the SW USA. By highlighting these issues, the paper provides a comprehensive perspective on how digital technologies can help build sustainable solutions for agriculture in the context of climate change and soil moisture variability in the southwestern United States (Dumitru et al., 2023).

The second most cited paper is "Land-use change and its socio-environmental impact in Eastern Ethiopia's highland", in which the authors foreground the importance of digitization in the context of agriculture and analyze land-use change and its socio-environmental impact in the highland of eastern Ethiopia. (Krüger et al., 2018).

The third most cited paper is "Extinction duty for flower-visiting plants and insects in landscapes with contrasting land use history", which shows how important the development of the digitization process of the agricultural sector actually is and evaluates the phrase "duty of extinction" for plants and flowers. (Bommarco et al., 2014) (Table 2).

Conclusion

The main purpose of this paper is to enrich the current literature and to study and understand the current challenges facing the agricultural sector, including the emergence and development of the digitalization process of the agricultural sector. Using the bibliometric technique, the most relevant for this research were identified, at the same time distinguishing very promising research directions.

Bioeconomy is an important aspect in the grouping of keywords, which suggests that the development of the digitization process in agriculture includes a varied range of subjects. Analysis of keywords by year shows a shift in researchers' priorities over time. In 2020 and 2021, the focus has shifted to issues such as climate change, environmental impacts, digital technologies and digital transformation. Later, in 2022 and 2023, there was a shift towards topics related to human (human) impact, carbon emissions, economic development, food security, and digitisation of food security. This reflects an adaptation to the current context and new challenges, highlighting how research is evolving as technology and society develop.

In general, the bibliometric analysis represents a way of transfer from the focus on various technological problems and from the various environmental problems to the interest given to human, economic and social activities. This transition shows the ability to adapt research to the rapid evolution of all current sectors.

The development of the digitization process includes, among other elements, various technologies. Among these technologies, we specify AI, agricultural robots, etc.

The grouping of keywords into various themes such as agriculture, digitization, food security and the environment demonstrates that these issues are interconnected and require a comprehensive perspective to develop effective solutions.

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