TRANSFORMING AGRICULTURE: THE IMPACT OF DIGITAL TECHNOLOGIES ON BIODIVERSITY CONSERVATION

Grosu (Simion) Petruța-Simona [1,2,*]
[1] *Bucharest University of Economic Studies, Bucharest, Romania*
[2] *Center for Study and Research for AgroForestry Biodiversity "Acad. David Davidescu", Romanian Academy, Bucharest, Romania*

Abstract
The integration of digital technologies in agriculture has the potential to revolutionize biodiversity conservation efforts. This article explores the role of regulations and recommended practices in promoting the adoption of digital technologies for biodiversity conservation in agricultural practices. Through a comprehensive review of the literature and analysis of current trends, the article highlights the importance of regulatory frameworks and recommended practices in shaping the adoption and implementation of digital technologies in agriculture. It examines various policies and initiatives aimed at stimulating the use of digital tools for monitoring, reporting, and mitigating the impact on biodiversity. Furthermore, the article discusses the challenges and opportunities associated with the adoption of digital technologies in agricultural practices for biodiversity conservation. It concludes by proposing recommendations for improving the regulatory framework and promoting the sustainable use of digital technologies to enhance biodiversity conservation in agriculture.

Keywords
Biodiversity, Agriculture, Digitalization, Recommended practices, Digital technologies

JEL Classification
O13, O33, Q10, Q16, Q57

Introduction

Agriculture plays a crucial role in biodiversity conservation, as agricultural landscapes often encompass diverse ecosystems and habitats. However, even under these conditions, we can affirm that biodiversity plays a very important role in agriculture for several reasons: plant pollination: Many pollinators, such as bees, butterflies, and other insects, contribute to plant pollination, including many crops. Approximately 75% of the world's food crops depend on pollination, and pollinator biodiversity is essential for agricultural production. For example, bees contribute to the pollination of important

* Corresponding author: Grosu (Simion) Petruța-Simona - grosupetruta11@stud.ase.ro

crops such as apples, peaches, strawberries, and sunflowers; pest and disease control: Natural biodiversity can provide essential ecosystem services, such as pest and disease control. Natural predators, such as birds, bats, insects, and other organisms, can keep pest populations under control in a healthy ecosystem. For example, birds and bats feed on harmful insects attacking crops, thus contributing to reducing the need for pesticides; soil fertilization and nutrient recycling: Soil biodiversity, including bacteria, fungi, and other organisms, is essential for maintaining soil fertility. These organisms decompose organic matter and recycle nutrients in the soil, helping to provide essential nutrients to plants. For example, nitrogen-fixing bacteria transform atmospheric nitrogen into a form usable by plants, contributing to soil fertility; adaptability to climate change: Biodiversity can enhance the resilience and adaptability of crops to climate change. Genetic diversity among plants and animals can provide vital genetic resources for selecting and creating new varieties adapted to changing climatic conditions. For example, conserving genetic diversity in gene banks allows for the identification and use of varieties with drought tolerance, extreme temperature tolerance, and other adverse conditions. These examples demonstrate how important biodiversity is for agriculture and underscore the need to protect and conserve it for the sustainability of agricultural systems and future food security. However, traditional agricultural practices have posed significant threats to biodiversity, including habitat destruction, pollution, and loss of genetic diversity. In recent years, there has been an increasing recognition of the potential of digital technologies to address these challenges and promote biodiversity conservation in agriculture. This article examines the role of regulations and recommended practices in facilitating the adoption and integration of digital technologies for biodiversity conservation in agricultural systems.

This research aims to analyze the impact of digital technologies on biodiversity conservation in agriculture. Among the specific objectives of this study, we mention: Evaluating the effectiveness of digital technologies in monitoring and managing agricultural biodiversity; Identifying the benefits and challenges associated with the adoption of digital technologies in agricultural practices for biodiversity conservation; Investigating the role of regulatory frameworks and recommended practices in promoting the use of digital technologies for biodiversity conservation in agriculture; Analyzing the perspectives of farmers and other stakeholders on the use of digital technologies in biodiversity conservation and identifying the main barriers and opportunities in their implementation.

The article is highly detailed and covers a wide range of aspects related to the use of digital technologies for biodiversity conservation in agriculture. The author's opinion considers a connection between the chosen topic and the bibliographic resources, as they address the importance of biodiversity conservation in agriculture and explore ways in which digital technologies can contribute to this goal.

In Popescu G.'s work, "Agriculture over Time" (2017), a historical perspective is presented on the evolution of agriculture and its impact on biodiversity over time, while this article focuses on presenting and analyzing the use of digital technologies for biodiversity conservation in agriculture, including aspects related to regulations, recommended practices, and recent research findings.

Additionally, the importance of agriculture in the cultural and social context of Romania has been highlighted, providing an additional perspective on how the relationship between agriculture and society has evolved and the impact of this relationship on biodiversity and sustainable development.

Therefore, the connection between Popescu G.'s article and the subject of the article is evident, and the introduction focuses on establishing a solid foundation for the detailed analysis and discussion that follows in the rest of the article.

Biodiversity is a vital component of agricultural ecosystems, providing essential services such as pollination, pest control, and soil conservation. Agricultural landscapes have always been attractive to a wide variety of plant and animal species, but conventional agricultural practices have often put significant pressure on these fragile ecosystems. Habitat loss, excessive pesticide use, and the impact of climate change are just a few of the threats facing biodiversity in the modern agricultural context.

In recent years, with rapid technological advancement, there has been a growing recognition of the potential of digital technologies to contribute to biodiversity conservation in agriculture. From remote sensing and geographic information systems (GIS) to precision agriculture and artificial intelligence, digital tools offer farmers and land managers new and efficient ways to monitor, assess, and manage biodiversity.

This evolution has generated increased interest in research and practice to understand how digital technologies can be integrated into agricultural systems to promote biodiversity conservation. However, this endeavour does not come without challenges and implications. From issues related to data security and access to technology in rural settings to the impact on habitats and species, there are many aspects to consider in the adoption and implementation of digital technologies for biodiversity conservation in agriculture.

In this context, it is crucial to analyze not only the potential and benefits of digital technologies but also to identify the regulations and recommended practices that can facilitate their efficient adoption within agricultural systems. This article aims to examine the role of regulations and recommended practices in promoting the use of digital technologies for biodiversity conservation in agriculture, highlighting both the opportunities and challenges associated with this transition to more sustainable and environmentally friendly agricultural practices.

In recent decades, concern for the conservation of agricultural biodiversity has significantly increased among the scientific community and practitioners in the agricultural field. In this context, the use of digital technologies has become increasingly relevant for monitoring and conserving biodiversity in the agricultural environment.

1. Review of the scientific literature

Agriculture plays an essential role in biodiversity conservation, as agricultural landscapes often harbour a significant number of species and ecosystems (Bommarco, Kleijn & Potts, 2013). However, conventional agricultural practices have posed some threats to biodiversity, such as loss of natural habitats and excessive pesticide use (Tscharntke et al., 2012). In recent years, digital technologies have become a central theme in efforts to address these issues and promote biodiversity conservation in agriculture (Klümper & Qaim, 2014).

Agriculture and biodiversity are two interconnected elements of agricultural landscapes, with a significant impact on ecosystem health and society as a whole (Tscharntke et al., 2012). Modern agriculture, dominated by intensive practices such as monoculture and excessive pesticide use, has led to the loss of biological diversity and the degradation of natural habitats (Bommarco, Kleijn & Potts, 2013). While agriculture has often been perceived as a threat to biodiversity, it has been increasingly recognized in recent decades that sustainable agriculture can play an essential role in biodiversity conservation (Perfecto, Vandermeer & Wright, 2009).

Digital technologies have become a crucial tool in promoting sustainable agricultural practices and biodiversity conservation. For example, remote sensing technologies and Geographic Information Systems (GIS) enable precise monitoring and evaluation of habitats and species, contributing to data-driven decision-making (Lin, 2011). Additionally, precision agriculture technologies can support more efficient use of resources and reduce negative environmental impact.

The use of drones and aerial imagery, Geographic Information Systems (GIS), precision agriculture, artificial intelligence, and other digital technologies hold considerable potential in optimizing agricultural practices for biodiversity conservation. These technologies offer a wide range of tools and methods for monitoring and evaluating agricultural biodiversity while facilitating informed decision-making and the implementation of sustainable practices.

In this context, the literature review aims to provide a comprehensive perspective on the use of digital technologies in agricultural biodiversity conservation. Through the analysis of existing studies, we will explore the benefits, challenges, and future directions in integrating these technologies into agricultural practices for biodiversity conservation.

Thus, the literature review has focused on aspects such as the use of drones and aerial imagery in monitoring agricultural biodiversity, assessing the use of GIS technologies in biodiversity conservation, the impact of precision agriculture on agricultural biodiversity, integrating digital technologies into traditional agricultural practices for biodiversity conservation, the role of artificial intelligence in agricultural biodiversity conservation, and the effects of climate change on agricultural biodiversity and the role of digital technologies in adaptation.

The review of relevant literature in the field of digital technology use for agricultural biodiversity conservation highlights significant progress in understanding and applying these technologies. For instance, certain studies examine the use of drones and aerial imagery for monitoring agricultural biodiversity, highlighting the advantages and challenges associated with these techniques. Other studies analyze the evaluation of GIS technology use in agricultural biodiversity conservation, emphasizing perspectives and advancements in this field, as well as the challenges encountered.

Some researchers have investigated the use of digital technologies for agricultural biodiversity conservation in developing countries, providing insights into case studies and potential solutions. Others have examined the impact of precision agriculture on

agricultural biodiversity, highlighting the benefits and future research directions in this field.
In the view of certain researchers, the integration of digital technologies into traditional agricultural practices for biodiversity conservation has been explored, emphasizing the synergies and benefits brought by this integration. Additionally, the role of artificial intelligence in agricultural biodiversity conservation has been examined, highlighting the potential and challenges of this technology.
Furthermore, according to some researchers, the effects of climate change on agricultural biodiversity and the role of digital technologies in adaptation have been analyzed, emphasizing their importance in managing risks associated with climate change. From the perspective of other researchers, the use of digital technologies for monitoring and conserving agricultural pollinators has been examined, highlighting their importance in maintaining essential ecological functions in agricultural systems.
Together, these studies provide a comprehensive overview of the use of digital technologies in agricultural biodiversity conservation, highlighting the benefits, challenges, and future research and application directions in this field.
However, there are also challenges associated with the use of digital technologies in biodiversity conservation (Qaim & Kouser, 2013). For example, concerns exist regarding data security and privacy protection, as well as the socio-economic impact of digitization in rural communities. Additionally, it is important to consider digital inclusivity and access to technologies for all farmers to ensure that the benefits are distributed equally (Davidova, Fredriksson, Gorton, Mishev & Petrovici, 2012).
According to Todirică I. C., "the Romanian people have a unique characteristic, namely that the beginning of civilization and culture are strongly linked to the rural world and agriculture" (Todirică I. C., 2019). Similarly, in his speech "Praise of the Romanian Peasant" (1940), Rebreanu L. stated that agriculture has been practised in Romania since ancient times, and the presence of agriculture implies the presence of the peasant. Rebreanu L. also confessed in the same work that "Our land has a voice that the peasant hears and understands. It is the 'sacred inspiring land' that has shaped our body and soul, which through its sun and waters and mountains and plains has endowed us with all the qualities and defects with which we present ourselves today in the world. This land seems to be able to produce only Romanians." (p. 147) "Recourse to Heritage."
We all know that the Romanian peasant has always had to work for others without any reward, hope, or joy. There has always been antagonism between the inhabitants of the villages and those of the cities, that is, between peasants and urban dwellers. Perhaps for this very reason, the peasant does not trust the urban dweller, while the urban dweller feels embarrassed by the peasant, if not intimidated. However, the emancipation of the peasants was advocated and achieved by the urban dwellers. Our revolutions, more noisy than violent, were led from top to bottom, until the expropriation of the large landowners and the redistribution of land to the peasants. The peasant himself, lacking the ability to organize and initiate social changes, would have remained under the yoke of servitude forever. Until even the great Romanian writers (Alecsandri V., Eminescu M., Creangă I., Coșbuc G.) could articulate the Romanian reality based on the Romanian peasant. We are and will always remain a nation of peasants. Therefore, our destiny as a people, as a state, and as a cultural force is linked to the purity of the gold

found in the heart of the peasant. However, to the same extent, our destiny depends on how this gold will be used and transformed into eternal values.
Another study highlighted the crucial role of digital technologies in biodiversity conservation in agriculture, emphasizing the benefits and challenges associated with their implementation. Additionally, other studies have examined the impact of government regulations on the adoption of digital technologies in agriculture for biodiversity conservation, highlighting the need for effective policies to promote the use of these technologies. From another perspective, recommended practices specific to the Romanian context for the use of digital technologies in biodiversity conservation in agriculture have been proposed, emphasizing the importance of adapting solutions to local conditions and farmers' needs.
Furthermore, according to some researchers, how digital technology can contribute to achieving sustainable development goals, such as poverty reduction, income growth, and food security, through innovations and increased efficiency in the agricultural sector, is examined (Liu, L., Liu, K., 2023).
Another study acknowledges the importance of technological advancements in optimizing agricultural practices and increasing efficiency, but also the need to address concerns related to the protection of farmers' sensitive data. This study employs a multidisciplinary approach to analyze the complex landscape of security and confidentiality in precision agriculture and proposes recommendations for the development and implementation of robust security protocols and confidentiality enhancement technologies (Ongadi, P. A., 2024).

2. Research methodology

To evaluate how digital technologies can contribute to biodiversity conservation in agriculture, we conducted a bibliographic analysis of relevant literature published in this field. We used the Web of Science database to identify relevant studies and articles, focusing on works that explore the relationship between the use of digital technologies and biodiversity conservation in the agricultural context.
I searched using the Web of Science database for articles that used "digital technologies for biodiversity conservation in agriculture" as keywords, resulting in a total of 26 articles for the analyzed time interval of 2016-2018. Additionally, for the time interval 2005-2020, I conducted searches for articles that used "agriculture and recommended practices" as keywords, resulting in a total of 13 articles. Another search focused on articles that used the keywords "digital technology in agriculture," resulting in a total of 239 articles for the interval 2005-2020.

3. Results and discussions

The literature analysis reveals that regulatory frameworks and recommended practices play a crucial role in shaping the adoption and implementation of digital technologies in agriculture for biodiversity conservation. Policies such as agri-environment schemes, biodiversity conservation programs, and sustainable agriculture initiatives provide incentives and support for farmers to adopt digital tools for monitoring, reporting, and managing biodiversity on their farms. Additionally, certification schemes and standards encourage the adoption of sustainable agricultural practices that promote biodiversity conservation.

However, the adoption of digital technologies in agriculture for biodiversity conservation also faces several challenges. These include technical barriers such as limited access to digital infrastructure and technical expertise, as well as economic and social barriers such as high implementation costs and farmer resistance to change. Furthermore, there are concerns about the potential negative impact of digital technologies on biodiversity, such as increased pesticide use and habitat fragmentation.

Despite these challenges, there are significant opportunities to improve biodiversity conservation through the sustainable use of digital technologies in agriculture. Innovative digital tools such as remote sensing technologies, geographic information systems (GIS), and precision agriculture technologies offer new opportunities for monitoring and managing biodiversity in agricultural landscapes. Furthermore, digital platforms and networks facilitate knowledge sharing and collaboration among farmers, researchers, and decision-makers, enabling more effective biodiversity conservation strategies.

To assess the scientific interest in the use of digital technologies in biodiversity conservation in agriculture and to track the evolution of this field, we conducted a bibliometric analysis of the works published in this field by querying the Web of Science database. For this quantitative analysis, we used VOSviewer software, which allowed us to analyze the keywords from the database and highlight the connections between them.

Figure no. 1. Cluster Map of Keywords Related to Digital Technologies for Biodiversity Conservation in Agriculture
Source: Web of Science results processed by the author using VOSviewer software on March 14, 2024.

Following the query of the Web of Science database using the keywords "digital technologies for biodiversity conservation in agriculture," a total of 26 articles were retrieved. However, the largest connected set of articles consists of 3 articles, as depicted in (Figure no. 1). Consequently, 2 clusters were identified, with the following number of articles for each cluster: cluster 1 (2 articles), and cluster 2 (1 article).

Figure no. 2. Dynamics of Core Research Themes Over Time
Source: Results from Web of Science processed by the author using VOSviewer software on March 14, 2024.

In terms of the analyzed time interval, 2016-2018, (figure no. 2) shows an unequal variation in their development over time of the 3 articles, 2 clusters, and 2 links. For articles that used "remote sensing" as a keyword, 2 clusters, 1 link (management), and 4 appearances resulted, with the year 2015 having the most publications; "management" resulted in 1 cluster, 2 links (remote sensing, biodiversity conservation), 3 appearances, with the year 2017 having the most publications; "biodiversity conservation" resulted in 1 cluster, 1 link (management), 3 appearances, with the year 2018 having the most publications.

Figure no. 3. Dynamics of Core Research Themes Over Time
Source: Web of Science results processed by the author using VOSviewer software on March 14, 2024

Looking at the time interval analyzed, between 2005 and 2020, (figure no. 3) highlights an unequal variation in the evolution of 3 articles, 2 clusters, and 2 connections over this period.

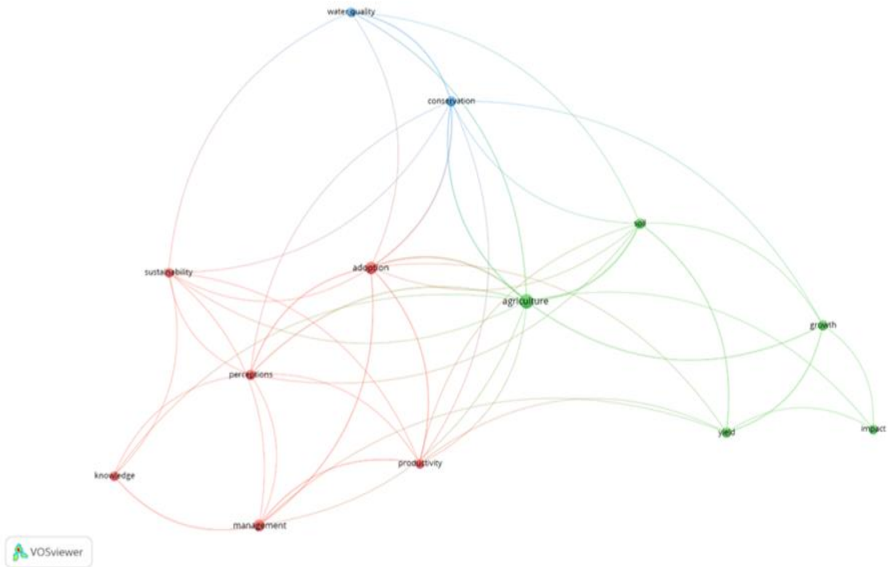

Figure no. 4. Cluster Map of Keywords Related to Agriculture and Recommended Practices
Source: Web of Science Results Processed by the Author Using VOSviewer Software on March 14, 2024

Upon querying the Web of Science database using the keywords "agriculture and recommended practices," a total of 13 articles were retrieved. As a result, 3 clusters were identified, with the following number of articles in each cluster: cluster 1 (6 articles), cluster 2 (5 articles), and cluster 3 (2 articles), as depicted in (Figure no. 4).

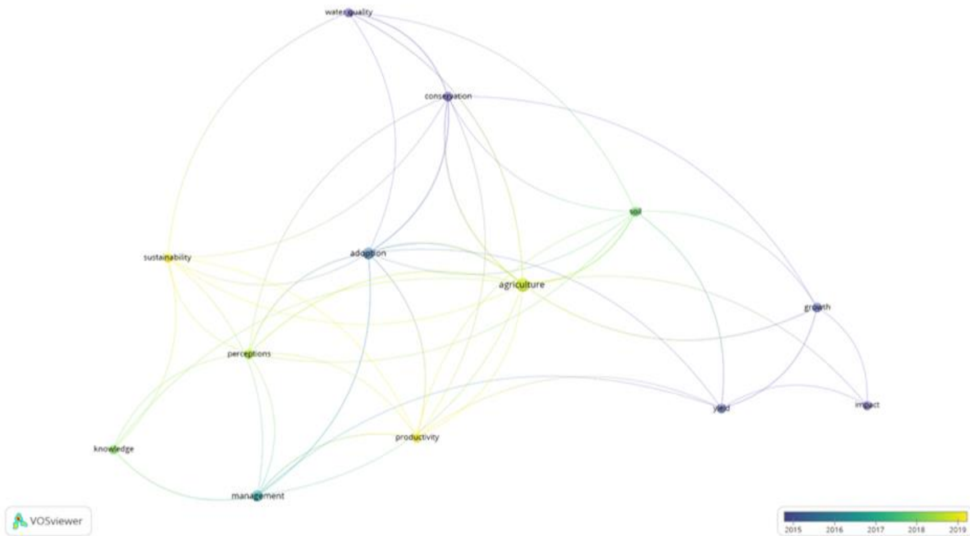

Figure no. 5. Dynamics of the fundamental research topics over time
Source: Results obtained from Web of Science processed by the author using VOSviewer software on March 14, 2024.

Considering the time interval analyzed, 2015-2019, (figure no. 5) shows an unequal variation in their development over time for the 13 articles, 3 clusters, and 45 connections. For articles that used "knowledge" as a keyword, there resulted in 1 cluster, 4 links (sustainability, perception, agriculture, management), with 5 appearances, and the year with the most publications being 2018. Management was identified with 1 cluster, 7 links (knowledge, sustainability, perception, productivity, adoption, agriculture, yield), with 8 appearances, and the year with the most publications being 2016. Productivity was identified with 1 cluster, 8 links (management, perception, sustainability, adoption, soil, conservation, agriculture, yield), 5 appearances, and the year with the most publications being 2019. Perception was identified with 1 cluster, 8 links (knowledge, management, productivity, sustainability, conservation, adoption, agriculture, soil), with 6 appearances, and the year with the most publications being 2018. Sustainability was identified with 1 cluster, 8 links (knowledge, management, perception, productivity, agriculture, adoption, conservation, water quality), with 5 appearances, and the year with the most publications being 2019. Adoption was identified with 1 cluster, 9 links (sustainability, perception, management, productivity, agriculture, yield, soil, conservation, water quality), with 9 appearances, and the year with the most publications being 2015. Agriculture was identified with 2 clusters, 11 links (productivity, management, perception, knowledge, sustainability, adoption, conservation, water quality, soil, yield), with 12 appearances, and the year with the most publications being 2018. Yield was identified with 2 clusters, 6 links (productivity, management, adoption, soil, growth, impact), with 6 appearances, and the year with the most publications being 2015. Impact was identified with 2 clusters, 3 links (yield, agriculture, growth), with 5 appearances, and the year with the most publications being 2014. Growth was identified with 2 clusters, 5 links (impact, yield, agriculture, soil, conservation), with 6 appearances, and the year with the most publications being 2015. The soil was identified with 2 clusters, 8 links (growth, yield, productivity, perception, agriculture, adoption, conservation, water quality), with 6 appearances, and the year with the most publications being 2017. Conservation was identified with 3 clusters, 8 links (growth, soil, agriculture, adoption, productivity, perception, sustainability, water quality), with 6 appearances, and the year with the most publications being 2014. Water quality was identified with 3 clusters, 5 links (sustainability, adoption, conservation, soil, agriculture), with 5 appearances, and the year with the most publications being 2015.

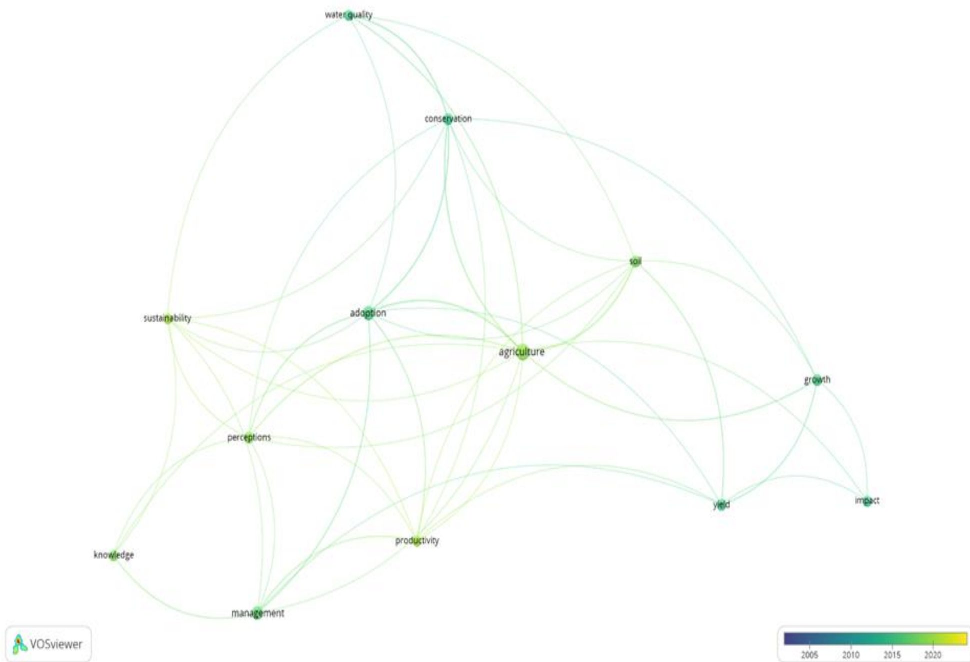

Figure no. 6. Dynamics of fundamental research topics over time
Source: Web of Science results processed by the author using VOSviewer software on March 14, 2024

Regarding the analyzed period, spanning from 2005 to 2020, (Figure no. 6) highlights an uneven variation in the evolution of the 13 articles, 3 clusters, and 45 links over this period.

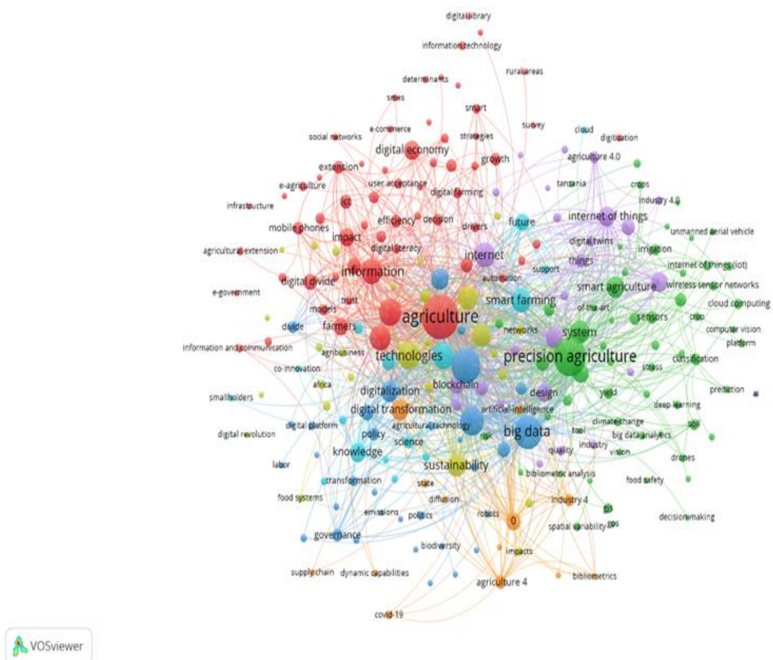

Figure no. 7. Cluster Map of Digital Technology-Related Words in Agriculture
Source: Web of Science results processed by the author using VOSviewer software on March 20, 2024

Following the interrogation of the Web of Science database using the keywords "digital technology in agriculture," a total of 239 articles were retrieved. Consequently, 7 clusters were identified, with the following distribution of articles for each cluster: cluster 1 (62 articles), cluster 2 (60 articles), cluster 3 (33 articles), cluster 4 (28 articles), cluster 5 (26 articles), cluster 6 (17 articles), and cluster 7 (13 articles), as depicted in (Figure no. 7).

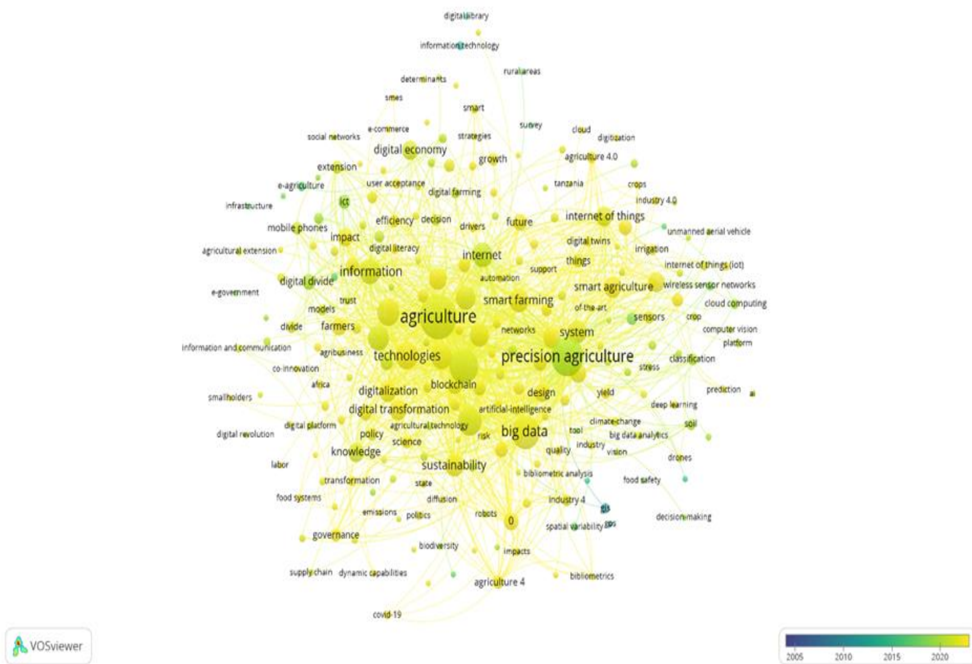

Figure no. 8. Dynamics of fundamental research topics over time
Source: Web of Science results processed by the author using VOSviewer software on March 20, 2024.

Regarding the examined time interval, between 2005 and 2020, (figure no. 8) illustrates an uneven variation in the evolution of 239 articles, 7 clusters, and 6016 connections over this period.
To better understand the use of digital technologies for biodiversity conservation in agriculture, a SWOT analysis was conducted:

Strengths:

- Improved Efficiency: Digital technologies allow for more efficient monitoring and management of natural resources and habitats, contributing to biodiversity conservation.
- Increased Precision: The use of digital technologies such as remote sensing and GIS provides precise and detailed data for the analysis and assessment of agricultural ecosystems and natural habitats.
- Automation: Automated systems and robots can be used for implementing sustainable agricultural practices and efficiently managing natural resources, thus contributing to biodiversity protection.

- Continuous Surveillance: Digital technologies enable continuous monitoring of ecosystems and species, aiding in the rapid detection of changes and threats to biodiversity.

Weaknesses:

- High Initial Costs: Implementing digital technologies can be costly, requiring significant investments in equipment and infrastructure.
- Technology Dependence: Farmers may become reliant on digital technologies, which can lead to issues in case of technical failures or lack of internet access in rural areas.
- Complexity: The use of digital technologies can be challenging for farmers, especially those with limited experience in technology use, requiring additional training and support.

Opportunities:

- Continuous Innovation: The development and adoption of digital technologies in agriculture are constantly evolving, offering opportunities for innovations and solutions for biodiversity conservation.
- Collaboration and Partnerships: The use of digital technologies facilitates collaboration among various stakeholders, including farmers, researchers, non-governmental organizations, and public authorities, to promote biodiversity conservation.
- Access to Data and Information: Digital technologies provide quick and easy access to biodiversity data and information, facilitating informed decision-making and the implementation of sustainable agricultural practices.

Threats:

- Data Security: The use of digital technologies raises concerns regarding data security and privacy protection, especially regarding the collection and storage of sensitive information about habitats and species.
- Urban Development and Agricultural Expansion: Urban development and agricultural expansion can lead to the loss of natural habitats and agricultural lands, endangering biodiversity and ecosystems.
- Digital Divide: The digital divide can create inequalities in access to digital technologies and information, negatively affecting farmers' ability to adopt sustainable agricultural practices for biodiversity conservation.

In this article, the analysis of the impact of digital technologies on biodiversity conservation in agriculture is based on a comprehensive evaluation of the strengths, weaknesses, opportunities, and threats (SWOT) associated with this field. With the help of the SWOT analysis, key aspects influencing the adoption and use of digital technologies in agriculture for biodiversity conservation have been highlighted.
The identified strengths are supported by recent research findings, which have shown the improved efficiency, increased precision, automation, and continuous monitoring

capabilities brought by digital technologies in monitoring and managing agricultural biodiversity.

Regarding the weaknesses, the analysis has revealed the high initial costs, dependence on technology, and complexity of using digital technologies in agriculture.

The opportunities identified in the SWOT analysis are supported by research highlighting continuous innovation in digital technology and the facilitation of collaboration among various stakeholders in agriculture.

Finally, the threats identified, such as data security, urban development, and digital exclusion, are supported by research that has highlighted the risks associated with the use of digital technologies in agriculture.

Thus, the SWOT analysis presented in the article is supported by research and findings in the field of using digital technologies in biodiversity conservation in agriculture, providing a comprehensive and well-founded perspective on this subject.

Conclusion

Bibliometric analysis and literature review in the field of digital technology use for biodiversity conservation in agriculture reveal a comprehensive picture of the existing progress and challenges.

The significant increase in interest in digital technologies in agriculture, particularly concerning biodiversity conservation, is evident from the results of the bibliometric analysis. The large number of published articles and the diversity of identified clusters indicate that this field is active and diversified, attracting researchers from around the world.

The literature review underscores the importance of digital technologies in promoting sustainable agricultural practices and biodiversity conservation. The use of various technologies such as drones, satellite imagery, GIS, precision agriculture, and artificial intelligence contributes to the monitoring, evaluation, and management of agricultural biodiversity.

The benefits brought by digital technologies in agriculture include the ability to precisely monitor and evaluate habitats and species, supporting data-driven decisions and the implementation of sustainable practices. However, there are also challenges, such as data security and socio-economic impact in rural communities, which require attention and appropriate solutions.

The use of digital technologies in agriculture provides significant opportunities for promoting sustainable agricultural practices and biodiversity conservation. Advances in this field indicate promising directions for the future, but continuing research and policy development are crucial to maximizing benefits and minimizing associated risks.

Regulations and recommended practices play a crucial role in promoting the use of digital technologies for biodiversity conservation in agriculture. Collaboration among researchers, farmers, and decision-makers is essential for the efficient implementation of these technologies in the Romanian agricultural context.

By deeply understanding the literature and best practices, future research directions and necessary policy interventions are identified to promote the conservation of agricultural biodiversity through the effective use of digital technologies.

References

[1] Bommarco, R., Kleijn, D., & Potts, S. G. (2013). Ecological intensification: Harnessing ecosystem services for food security. Trends in Ecology & Evolution, 28(4), 230-238.

[2] Klümper, W., & Qaim, M. (2014). A meta-analysis of the impacts of genetically modified crops. PloS one, 9(11), e111629.

[3] Lin, B. B. (2011). Resilience in agriculture through crop diversification: adaptive management for environmental change. BioScience, 61(3), 183-193.

[4] Liu, L., & Liu, K. (2023). Can digital technology promote sustainable agriculture? Empirical evidence from urban China. Cogent Food & Agriculture, 9(2), 2282234.

[5] Ongadi, P. A. (2024). A comprehensive examination of security and privacy in precision agriculture technologies. GSC Advanced Research and Reviews, February 2024, 18(1):336-363 DOI: 10.30574/gscarr.2024.18.1.0026

[6] Perfecto, I., Vandermeer, J., & Wright, A. (2019). Nature's matrix: linking agriculture, biodiversity conservation and food sovereignty. Routledge.

[7] Popescu, G., (2017), Agriculture Through Time, Bucharest, Romanian Academy Publishing House

[8] Qaim, M., & Kouser, S. (2013). Genetically modified crops and food security. PLOS ONE, 8(6), e64879.

[9] Rebreanu, L., (1940), Praise to the Romanian Peasant, Acceptance Speech at the Romanian Academy

[10] Todirică, I. C., The Market for Traditional Products in the Context of the Industrialization of Agricultural Production Processes, 2019

[11] Tscharntke, T., Clough, Y., Wanger, T. C., Jackson, L., Motzke, I., Perfecto, I., ... & Whitbread, A. (2012). Global food security, biodiversity conservation and the future of agricultural intensification. Biological Conservation, 151(1), 53-59.