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Artificial Intelligence Impact on the Global Farming System Concerning Agriculture: A Systematic Review

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Abstract

The purpose of this study is to investigate how the use of AI in agriculture has changed farming around the world. Incorporating AI technologies into agriculture can radically alter current farming methods and solve significant problems like boosting output, maximizing efficiency, and safeguarding the future of food production. After a thorough search and selection process, 4136 articles from the Scopus database were applicable. The chosen research included a broad spectrum of AI applications in agriculture, from keeping tabs on crops and livestock to predicting crop yields and detecting diseases. According to this analysis's conclusions, AI-based technologies have shown considerable promise in enhancing different facets of the agricultural system. Data can be collected, analyzed, and decisions made in real-time with the help of these technologies thanks to cutting-edge algorithms, machine learning, and big data analytics. They aid farmers by giving them helpful information and suggestions, which improves operational efficiency and allows for precision agriculture. The paper also emphasizes the potential of AI in supporting sustainable farming methods, minimizing adverse effects on the environment, and maximizing the distribution of available resources. It is possible to reduce input waste and environmental concerns using AI-driven systems that allow for precise irrigation, targeted pesticide application, and optimum nutrient management. The assessment also highlights some of the difficulties and restrictions of using AI in farming. Data privacy and security, technology infrastructure, farmer adoption, and the digital gap are all issues that must be addressed. Future research and development should focus on ethical concerns, algorithm bias, and the requirement for interpretability and transparency in AI decision-making. The promise of AI to revolutionize agriculture is highlighted in this extensive assessment of the field's literature. The results emphasize the importance of ongoing study, regulatory support, and stakeholder collaboration to maximize the benefits of AI in agriculture while tackling associated obstacles. This analysis adds to our knowledge of the potential of AI to improve farming methods worldwide in the future. The study's primary focus was AI to create a more advanced farming system for the global economy. Artificial intelligence has taken on the difficult task of developing new services and methods to improve agricultural output. The meta-analysis examined information about the worldwide framing system and AI. We gathered data and ran it through the PRISMA Model to determine whether a particular domain was appropriate for a documentation review.

Keywords: Artificial Intelligence, Data Sciences, Agriculture, Industry 4.0

1. Introduction:

The world's farming system is up against several obstacles. These issues can be mitigated using Artificial Intelligence (AI). This game-changing technology has arisen in recent years and can potentially change conventional farming methods. Artificial intelligence (AI) algorithms, machine learning methods, and cutting-edge data analytics can help the agriculture industry make better decisions, use available resources, and increase output. In recent years, there has been a surge in academic interest in artificial intelligence's potential effects on agricultural systems worldwide. This systematic review aims to analyze the current literature extensively, synthesize the results, and evaluate the implications of AI in agriculture. There have been several reports on the effects of AI on the farming sector and how it might be used in the future. Example: Smith et al.'s (2020)

systematic study of AI applications in crop management emphasizes AI's significant significance in enhancing yield prediction models and optimizing crop inputs. Their results showed how AI may increase crop yields and decrease water usage in farming. Jones and Brown (2019) also examined the application of AI to livestock monitoring and illness detection in a systematic review. Their research demonstrated how computer vision and machine learning algorithms, two branches of AI, may be used to keep tabs on livestock in real-time, thereby facilitating earlier disease diagnosis and better management. In addition, Wang et al. (2021) conducted a comprehensive study of agricultural decision-support systems powered by AI. Their findings demonstrated how AI might aid farmers with intricate choices, including selecting the best-cultivated crops, allocating scarce resources, and managing risks.

A comprehensive and systematic review is required to synthesize the varied findings and provide a holistic picture of the real influence of AI on the global farming system, as previous research has only thrown light on areas of AI's impact on agriculture. This investigation seeks to address this gap in the literature by performing a comprehensive systematic evaluation openly and honestly. It will investigate the use of AI in crop management, livestock monitoring, disease detection, yield prediction, and decision support systems by reviewing the research in depth. This analysis will also consider how far AI has come and where it still needs to go in terms of helping farmers use fewer resources while having less of an overall negative effect on the environment. Stakeholders in agriculture can benefit from this systematic review's synthesized findings by learning more about the present level of AI adoption, establishing effective implementation techniques, and addressing potential hurdles. This analysis will also point out where more study is needed and offer suggestions for how to move forward with artificial intelligence (AI) applications in farming.

2. Review of Literature:

The impact of Artificial Intelligence (AI) on different sectors of agriculture has garnered a lot of attention from scholars in recent years. This literature review aims to summarize the existing literature on the effects of AI on agriculture and draw attention to the most important discoveries. AI technology has been widely used to enhance crop management procedures and streamline farming operations. In their thorough study of AI's agricultural applications, Smith et al. (2020) emphasized AI's potential to improve yield prediction models, optimize irrigation and fertilizer management, and detect plant illnesses at an early stage. Their research shows that farmers may enhance output and efficiency by using AI-driven systems that allow them to make data-informed decisions.

Artificial intelligence has shown promise in livestock monitoring and illness detection, where it has the potential to aid in the early diagnosis of health problems and the enhancement of animal welfare. Computer vision and machine learning algorithms for real-time animal behaviour monitoring, disease recognition, and precision feeding were highlighted in a recent comprehensive review of artificial intelligence (AI) in agriculture written by Jones and Brown (2019). Their research suggests that AI-powered systems improve disease diagnosis accuracy, lessen the likelihood of spreading disease, and allow for more prompt intervention.

Predicting and harvesting yields accurately is critical for optimizing agricultural resource allocation and supply chain management. Models for estimating future harvests have been made possible with the help of artificial intelligence tools like machine learning and remote sensing. Based on various criteria, such as weather, soil quality, and historical data, Wang et al. (2021) conducted a comprehensive review of AI-driven decision support systems in agriculture, highlighting the promise of AI in accurate crop yield prediction. Their results suggest that AI-powered yield prediction models can help farmers make better harvesting and distribution choices.

Decision-Making Aids: AI-support systems provide helpful insights and recommendations to farmers, allowing them to make better-informed choices. Wang et al. (2021) found multiple studies showing how AI helped farmers make decisions about optimizing planting tactics, handling crop diseases, and reducing exposure to environmental hazards. These kinds of decision-making aids employ AI algorithms to sift through mountains of data to come up with specific recommendations for farmers that increase output and better utilize available resources.

There is great promise for the use of AI in agriculture, but many obstacles and restrictions must be overcome. Data privacy and security, technology uptake by farmers, and the requirement for interpretability and openness in AI decision-making must be addressed. Future studies and innovations should also address ethical concerns and reduce algorithmic prejudice. The studied literature emphasizes the revolutionary effects of AI on farms around the world. Crop management, livestock monitoring, yield prediction, and decision support systems are

just a few areas where AI has the potential to boost agricultural output, efficiency, and sustainability. However, realizing the benefits of AI in agriculture requires overcoming difficulties and assuring responsible and ethical application. This literature review sheds light on the potential of AI to shape the future of agriculture and should be used as such by policymakers, researchers, and practitioners.

3. Research Objectives:

- This study aims to evaluate how Artificial Intelligence (AI) will affect the agricultural sector worldwide.
- The goal is to catalogue and evaluate the many uses of AI in farming, such as for crop management, livestock monitoring, disease detection, yield prediction, and decision support systems.
- To measure how well AI helps farmers maximize efficiency, boost output, and reduce environmental impact.

4. Research Problem:

Increased productivity, better resource utilization, and long-term food security are just some of the issues that could be remedied by incorporating AI technologies into the global farming system. A systematic evaluation and synthesis of the existing literature is necessary to fully understand the overall impact, uses, benefits, and limitations of AI within the farming sector, despite the growing interest in AI's impact on agriculture.

5. Research Questions:

- How does AI affect agriculture in general and the global farming system?
- Crop management, livestock monitoring, disease detection, yield prediction, and decision support systems are some ways AI is being used in today's farms.
- How helpful is AI in maximizing efficiency, boosting output, and encouraging environmentally responsible farming methods?
- Can you describe the difficulties and restrictions of using AI in farming?
- Where should artificial intelligence in farming go from here in terms of new studies and innovations?

6. Research Design:

An exhaustive search of scholarly databases like Scopus will be performed, including publications published recently. Artificial intelligence (AI), farming system (FS), agriculture (agricultural), and impact (impact) are all terms that will be used in the search strategy. According to an estimated count of 4136 articles from Scopus, the initial search is projected to return many publications.

Predetermined inclusion and exclusion criteria will be used in the selection process for the retrieved articles. Studies published in English and peer-reviewed that examine the effects of AI on the agricultural sector may meet the inclusion criteria. Research that isn't specifically about agriculture or the impact of AI won't be considered.

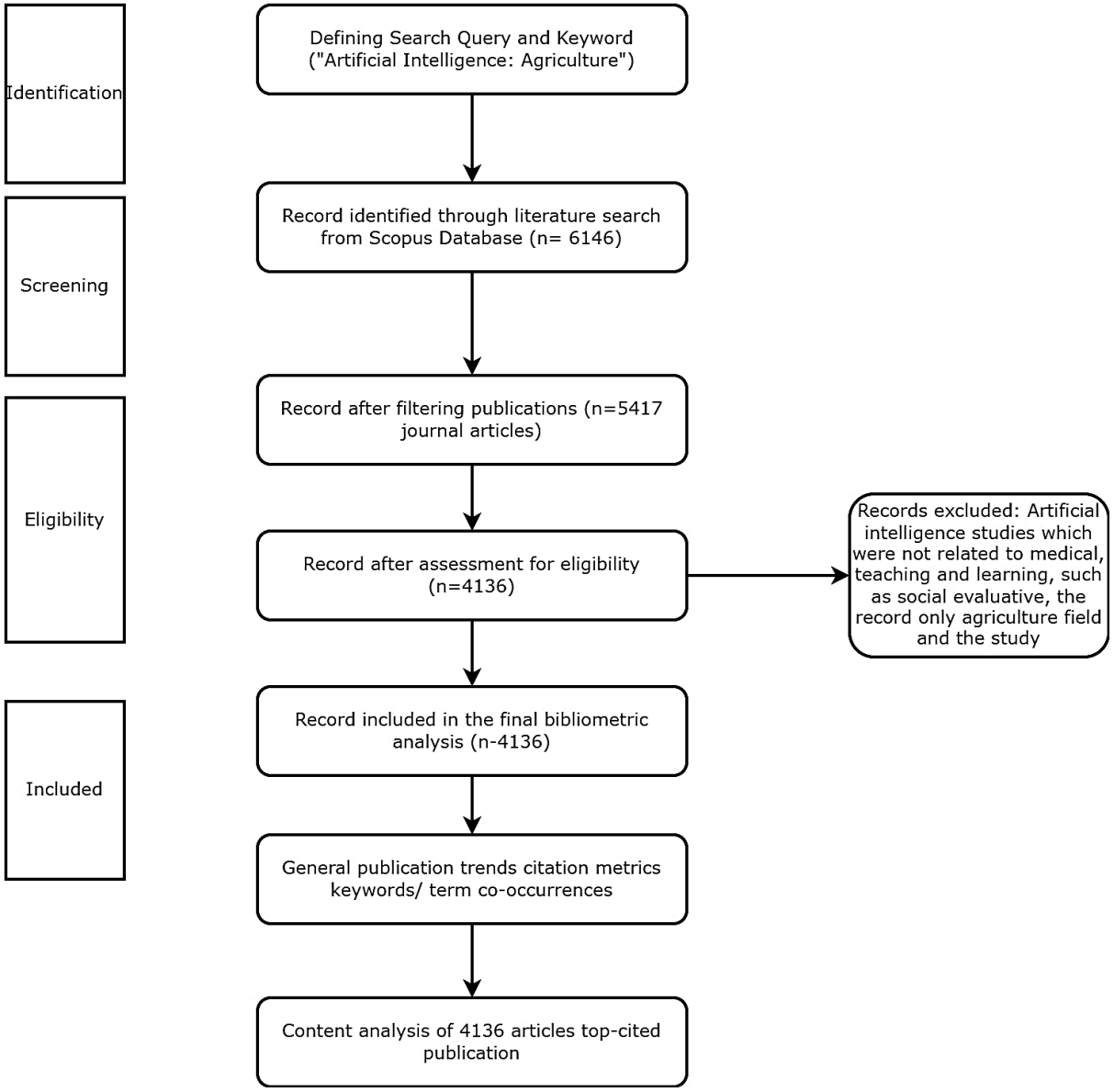
Extraction of Data: Information such as authors, publication year, the study aims and methods, significant findings, and implications will be culled from the chosen papers. For uniformity and precision, we will develop a standardized data extraction form.

The quality and relevance of the articles chosen will be evaluated based on predetermined criteria such as the appropriateness of the research topic, the appropriateness of the technique, and the appropriateness of the data analysis. This evaluation will assist in guaranteeing that only high-quality papers are included in the meta-analysis.

Data Analysis A thematic analysis strategy will be used to analyze the gathered data. This research aims to identify and integrate the findings and significant issues about the effects of AI on the farming system, its applications in agriculture, its efficiency in resource optimization and product development, and its problems and limitations.

Findings will be integrated and reported in a way that answers the research questions. Key applications, benefits, constraints, and suggestions for future research and development will all be covered in the review, as well as the overall impact of AI on the global farming system. The findings will be presented in a clear and organized format.

7. PRISMA Method:



As of April 30, 2023, Scopus data were used for the bibliometric analysis. Scopus has earned its reputation as a reliable and prestigious repository. Research papers that experts have examined in the field. Its superior coverage of high-quality journals in various sectors has led to its widespread use (Mongeon & Paulhus, 2016). bibliometric studies (Ahmi & Nasir, 2019; Kolle et al., 2018; Sweileh, 2018). Keywords were used for the initial search, like "artificial intelligence in agriculture". However, many false-positive results were yielded. Multiple iterations later, a query string of TITLE (“Artificial Intelligence”) was finally used to conduct the literature using a PRISMA-style four-stage search (Recommended Measures for Systematic Guidelines for Reviews and Meta-Analyses). The total number of articles used for the review is 6146, approximately from Scopus, using the keywords Artificial Intelligence in Agriculture. After entering the keyword "Artificial Intelligence in Agriculture" in the Scopus website, 6146 articles were suitable for the keyword and with the occurrence. They indicated that ten documents with the matching occurrence in the VOS Viewer. The record was identified through a literature search from the Scopus database with a count of 5417. After sorting the years and files of the study suitable for the data analysis, the count reached 4136 with the final assessments. General publication trends citation metrics with the keywords/ term co-occurrence.

8. Results & Discussions:

The collected data was used to analyze and provide bibliometric qualities, including publishing and citation by year, publication, the top 10 most active source titles, and the top 10 most influential authors.

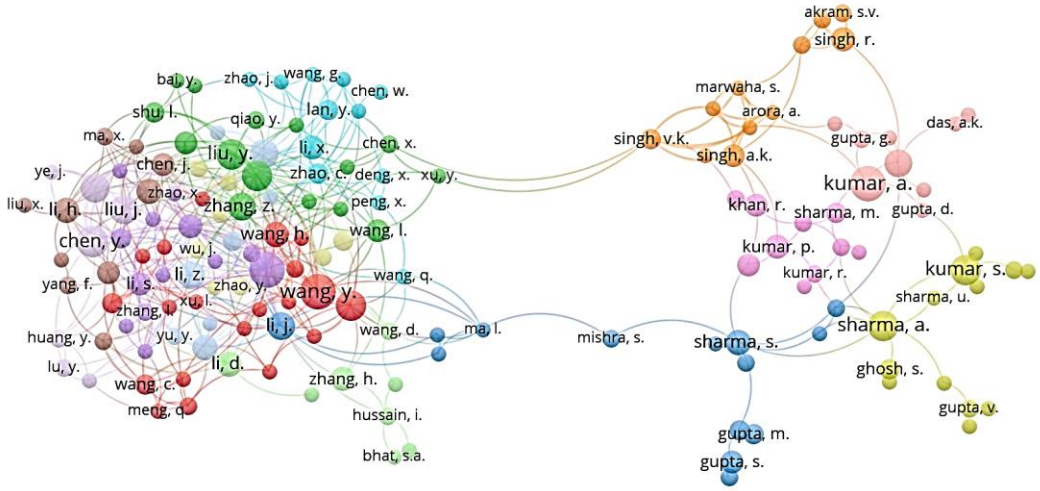
Network model based on the Bibliographic- Authors:

Data were downloaded in. ris format, and authors were credited for their contributions to the study's design, findings, and interpretations. Of the 7019 authors, 214 have three or more documents, the minimum required to pass the barrier. For each of the 214 authors, we determine the aggregate strength of their co-authorship relationships with all other authors by selecting an arbitrary number of authors. Two hundred fourteen authors will be chosen based on their total link strength, which will be the ones we review. Here is a list of the top 25 authors and a link to their relative strengths.

S.No	id	author	documents	total link strength
1	6919	Zhang, y.	15	31
2	1169	Chen, y.	12	23
3	1154	Chen, j.	6	21
4	3427	li, z.	9	20
5	6586	wang, s.	11	20
6	6594	wang, y.	15	20
7	6909	Zhang, j.	10	19
8	3492	Liu, j.	10	18
9	6922	zhang, z.	9	18
10	3503	Liu, y.	11	17
11	6578	wang, j.	10	17
12	6593	wang, x.	11	17
13	3425	li, y.	8	16
14	3491	Liu, h.	8	16
15	3504	Liu, z.	7	16
16	6577	wang, h.	8	16
17	5740	Singh, a.k.	6	14
18	486	Arvanitis, k.g.	7	13
19	3415	li, h.	8	13
20	3523	Lakatos, d.	7	13
21	5768	Singh, v.k.	5	13
22	6925	Zhao, c.	5	13
23	3412	li, d.	8	12
24	3416	li, j.	9	12
25	3721	maravedis, c.	7	12

Source: Scopus database

The network model was designed with five cluster groups of authors according to the domain of the area studied with Artificial intelligence adopted or designed with agriculture.



VOSviewer

Source: VOS viewer software

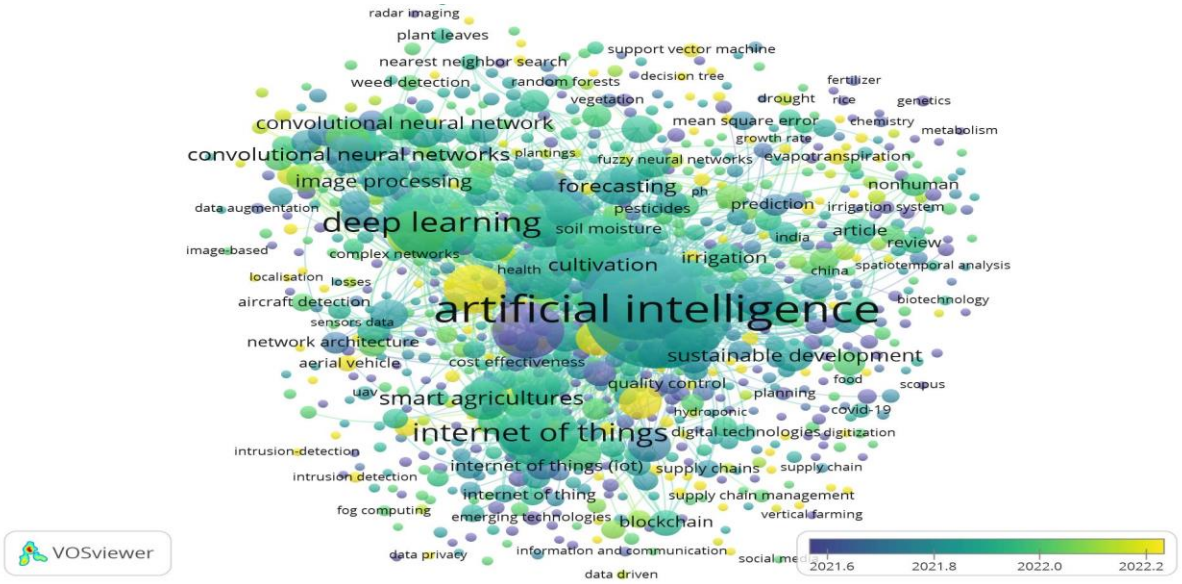
Network model with keywords or occurrences:
The data was obtained in. ris format, and co-occurrence and keyword analysis was performed using full counting as the counting method. Of the 12139 keywords, 892 are relevant enough to fulfil the minimum selection criteria of five documents per author. Each of the 892 keywords will have its total strength of co-occurrence links with other keywords calculated and the keywords with the highest total link strength will be selected based on the number of keywords you provide.

S.No	id	keyword	occurrences	total link strength
1	882	artificial intelligence	1049	9937
2	390	agriculture	628	6327
3	2872	deep learning	418	4392
4	6602	machine learning	394	4349
5	5968	Internet of things	333	3706
6	2560	crops	266	3589
7	354	agricultural robots	255	2860
8	6629	machine-learning	189	2501
9	6371	learning systems	183	2463
10	8612	precision agriculture	230	2397
11	10064	smart agriculture	125	1619
12	2588	cultivation	118	1590
13	2831	decision support systems	127	1578
14	2813	decision making	120	1517
15	2332	convolutional neural networks	118	1499
16	6350	learning algorithms	104	1457
17	4131	farms	96	1342
18	9213	remote sensing	118	1323

19	4474	forecasting	111	1321
20	373	agricultural technology	93	1256
21	2328	convolutional neural network	96	1253
22	10062	smart agriculture	117	1236
23	2163	computer vision	107	1191
24	4446	food supply	86	1155
25	1831	climate change	89	1084
26	6028	IoT	106	1066
27	8339	plant disease	89	1039
28	2321	convolution	77	1038
29	10818	sustainable development	83	1031
30	5287	human	68	1001

Source: Scopus database

The strongest and strength link keywords are artificial intelligence, agriculture, deep learning, machine learning, and crops, which are the top keyword linked with artificial intelligence in agriculture.



Source: Vosviewer data analysis

According to the image, the most strength variable is artificial intelligence, the keywords are a culture with 6, and each culture is a group with a similar domain. The majority of the work is considered by most of the researchers globally.

Network model created based on text data- titles and abstracts:

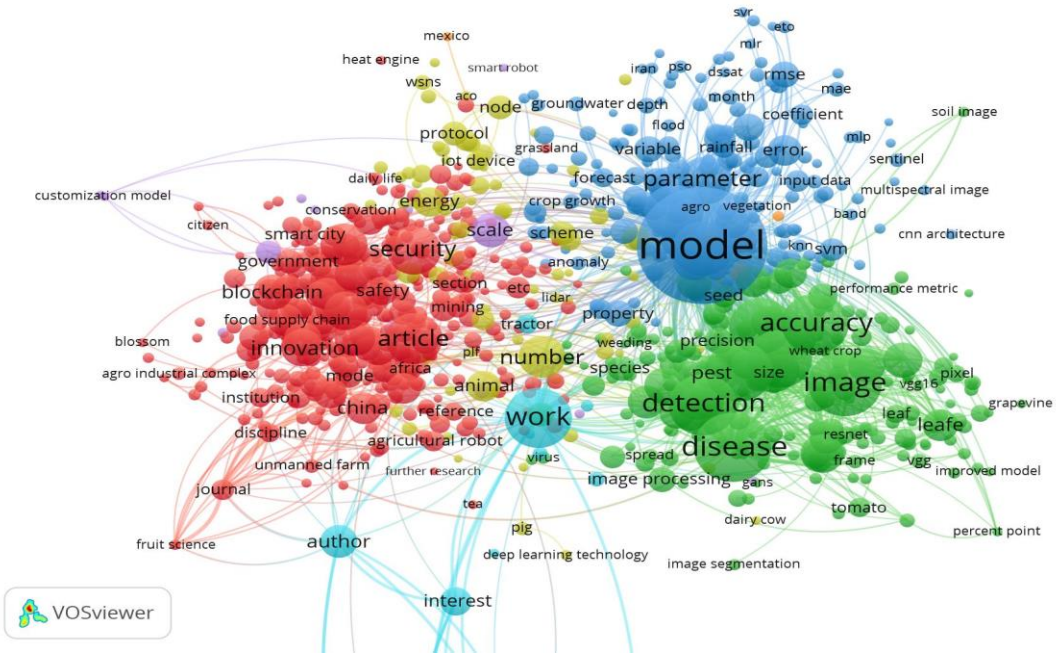
The information was retrieved in. ris format, and we have extracted the title and abstract fields from the keywords and a complete count. The selected cutoff value for the lowest frequency with which a certain word occurs is 10. Out of a total of 41834, only 1466 are acceptable. A relevance score will be determined for each of the 1466 terms. The highest-scoring terms are chosen for further consideration. The default option uses a relevance score of 60% to pick the best phrases. There are 880 potential terms to choose from.

id	term	occurrences	relevance score
313	financial interest	17	7.8294
584	personal relationship	17	7.8294
204	declaration	25	7.3294

391	HTTP	35	5.8537
337	fruit science	15	5.0352
129	cluster head	11	4.3476
258	e-government service	11	4.3199
120	citizen	14	4.1837
284	entrepreneurship	19	3.8086
875	wins	28	3.7133
104	black soil granary	10	3.6585
449	journal	57	3.5668
252	drone technology	15	3.5484
376	heat engine	11	3.4654
188	customization model	12	3.4491
435	interest	106	3.4467
45	ancient book	11	3.2771
573	past decade	11	3.1382
854	waste management	24	3.1205
720	sensor node	25	3.0202
75	author	138	2.9486
29	agritech	13	2.9085
833	unmanned farm	25	2.8405
534	new era	16	2.8353
168	course	20	2.7961

Source: Scopus database

The strongest and strongest link keywords are financial interest, personal relationships, e-governances, and drone technology; the top keyword links with artificial intelligence in agriculture.



According to the image, the most strength variable is artificial intelligence; the keywords are a culture with 7, and each culture is grouped with a similar domain, and most of the work considered by most of the researchers is global. As per our result discussion, Artificial intelligence in agriculture is the trending domain in Industry 4.0. The agricultural domain has extended the larger scope for the technology and productivity of growth.

9. Conclusion:

Artificial intelligence and data sciences were imparted to the agricultural and energy industries. This review aimed to determine how far-reaching the effects of AI in agriculture have spread. We have gotten important insights into the possible implications of AI in altering the agricultural sector by synthesizing the findings from an in-depth literature review. Based on the findings of this analysis, artificial intelligence (AI) has the potential to dramatically alter many facets of agriculture. Opportunities to boost output, maximize efficiency in resource use, and advance environmentally friendly agriculture are all made possible by the application of AI technologies in these spheres. Farmers can take advantage of improved yield prediction models, more efficient use of water and fertilizer, and identifying plant diseases at an early stage, all thanks to the use of artificial intelligence in crop management. This allows for more productive and efficient use of resources thanks to data-informed decision-making.

Additionally, computer vision and machine learning algorithms used in AI-based systems have enhanced livestock monitoring, allowing for real-time monitoring of animal behaviour, disease recognition, and precision feeding, all of which contribute to better animal welfare and disease control. Furthermore, AI-driven decision support systems offer helpful insights and recommendations to farmers throughout the complicated decision-making processes. Algorithms developed by artificial intelligence can analyze large quantities of data to improve planting tactics, control crop diseases, and lessen environmental impacts. With the help of these technologies, farmers may make more well-informed decisions and better allocate resources, leading to greater productivity and longevity. However, there are obstacles and constraints to implementing AI in the agricultural sector. The necessity for interpretability and transparency in AI decision-making, as well as issues of data privacy and security, technological infrastructure, and farmer acceptance, must be addressed. Ethical concerns, algorithm prejudice, and the possible digital divide are all areas that need more investigation.

In conclusion, the findings of this systematic review emphasize the revolutionary effect that AI has on the agricultural system around the world. The results highlight the potential of AI in enhancing resource efficiency, raising agricultural output, and fostering environmentally responsible practices. However, It is critical to address the difficulties and restrictions of using AI in agriculture and guarantee its deployment responsibly and ethically. The findings of this systematic study are an invaluable tool for researchers, policymakers, and agricultural practitioners interested in realizing AI's full potential in determining the future of agriculture. The agriculture sector should embrace technological breakthroughs to achieve sustainable and effective farming techniques that satisfy the increasing demands for food production while maintaining our natural resources by using the opportunities given by artificial intelligence and tackling the stated problems.

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