Research Article

Broadening the Research Pathways in Smart Agriculture: Predictive Analysis Using Semiautomatic Information Modeling

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Agriculture has become more industrialized and intensive due to the rising demand for food in quality and quantity. Agricultural modernization will be made possible by the Internet of Things (IoT), a technology with a great promise for revolutionizing the industry. Agricultural products will be in high demand by 2050 due to a 30% increase in the global population, so there is a need to devise new mechanisms for agriculture, and smart agriculture is one of those mechanisms; however, smart agriculture needs to be explored further to realize its potential fully. So, to explore the potential of this field, the researchers have used a corpus that is extracted from the Scopus database from the year 2008 to the year 2022 and applied the LDA technique. A corpus of 4309 articles was selected from the Scopus database to apply the latent Dirichlet analysis (LDA) model to predict research areas for smart agriculture. Using IoT technology, farmers and producers may better manage their resources, such as fertilizer consumption and the number of trips made by farm vehicles, while minimizing waste and maximizing productivity, including water, electricity, and other inputs. This data-driven experimental study identifies smart agriculture research trends by implementing a topic modeling technique previously used in smart agriculture. The authors have created seventeen research themes in smart agriculture based on the LDA topic modeling. This analysis suggests that the indicated areas are in the growth phase and require further research and exploration.

1. Introduction

Digital technologies like the Internet of Things (IoT) are reshaping agriculture. When it comes to farming, what is IoT? The IoT connects “dumb” devices. IoT is all about data [1]. Data is becoming a valuable resource for our world. Farmers may become more intelligent and safe by using data from gadgets to adapt to changing conditions more readily and farm more efficiently [2]. To free up resources, farmers can use the ability to monitor agricultural conditions and infrastructure from afar [3]. Many sectors and industries have adopted IoT to reduce errors and improve performance in manufacturing, energy, health care, and communication [1]. Farm devices can collect and deliver data remotely to their owners using IoT.

Farmers can save time and money using IoT to keep tabs on-farm operations and efficiency, make more informed decisions about boosting productivity, and respond more quickly to changing conditions. In this case, it is putting data ahead of the farmer’s intuition [2]. A trough’s water supply, the amount of fertilizer to use on a crop, and which ewe to check when lambing are all things a farmer could know about.

Smart agriculture is necessary since 70% of the farming time is spent monitoring and analyzing crop status rather than performing actual field labor [3]. Given the industry’s size, it needs various technology and precise solutions to ensure sustainability while reducing environmental damage. Sensors and communication technologies have provided farmers with a remote sight of their fields, allowing them to watch what is happening without leaving home. Wireless sensors make monitoring crops in real-time with greater precision and, more importantly, detecting the early stages of undesirable conditions easier [4]. This is why “smart agriculture uses innovative equipment and kits from seeding to
crop harvesting, storage, and transportation. The operation is smart and cost-effective due to its accurate monitoring capabilities and prompts reporting using a variety of sensors. Various autonomous tractors, harvesters, robotic weeder, drones, and satellites supplement agriculture equipment [5]. Sensors can be instantly deployed, started collecting data, and made available for further online study. By enabling precise data collection at each area, sensor technology allows crop and site-specific agriculture. IoT and its apps are only scratching the surface of what they can do and have yet to impact people’s lives significantly, and everyone can see this. However, given the recent rise in IoT technology in agricultural applications, we can expect it to play a significant role. Figure 1 summarizes the key factors driving agricultural technology.

There are reasonable efforts to emphasize the importance of IoT in agriculture; most published work [6] focuses solely on applications. However, in light of the most recent facts and data, most current publications either give little insight or place a limited emphasis on diverse IoT-based designs, prototypes, advanced approaches, IoT for food quality, and other future issues. The current state of IoT-based agriculture research is examined in this paper. Farmers are either delaying or refusing to change their traditional techniques, which might further depress India’s GDP. Recently skilled migrants from all across India who returned to their homelands during the COVID-19 pandemic selected farming as a profession and had no plans to return. These migrants may move closer to smart agricultural systems since it takes less time to persuade them to use them than traditional farmers.

(i) Remote monitoring of agricultural infrastructure and conditions can save farmers time and labor by reducing the frequency of on-site field inspections
(ii) Farmers benefit from data analysis
(iii) Gaining insights from real-time data throughout a value chain allows farmers to respond faster to market requests
(iv) The food manufacturing process should improve efficiency to lower food waste, speed up the time to market, and improve traceability. This will allow us to demonstrate to our consumers that our food is safe and sustainable
(v) Research, development, and adaptation to new technologies ensure continued productivity and innovation

The first objective of this study is to do a meta-analysis of the collected corpus. The second objective is to forecast the present research areas and trends as 2, 5, and 10 topics, as highlighted in Table 1. The third objective is to examine in-depth the current research trends to assist future researchers in determining the correct research directions in the field of smart agriculture.

2. Review of Literature

IoT is revolutionizing agriculture by bringing together various approaches, such as accuracy and conservative farming, to help farmers overcome obstacles in the field. Jayaraman et al. [7] discussed using IoT, cloud computing, mobile computing, and smart agriculture to develop a “phononet” system, an open system of wireless sensors that share information and communicate. For many years, devices presently labeled as IoT have been deployed in agriculture. The Bosch technology corporation provides IoT-based data management strategies to monitor agricultural yield and diseases [8]. A platform based on IoT developed by Intel helps agricultural solutions operate more efficiently by improving the
<table>
<thead>
<tr>
<th>Topic ID</th>
<th>Key terms</th>
<th>Topic label</th>
<th>High loading paper</th>
<th>Count of studies</th>
<th>Contribution (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.1</td>
<td>Smart, application, network, agricultural, device, propose, information, provide, communication, security, model, energy, management, service, present, wireless, industry, cloud, design, challenge</td>
<td>Security and privacy in smart agriculture</td>
<td>[34]</td>
<td>2361</td>
<td>99.9</td>
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<td></td>
<td>Water, crop, soil, farmer, irrigation, monitor, control, plant, temperature, time, propose, smart, field, monitoring, farm, farming, agricultural, moisture, condition, production</td>
<td>Monitoring and control system in agriculture</td>
<td>[37]</td>
<td>1948</td>
<td>99.82</td>
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<tr>
<td></td>
<td>Machine, model, image, disease, crop, propose, detection, learn, learning, plant, result, time, prediction, deep, accuracy, method, technique, network, classification, neural</td>
<td>Intelligent disease detection models</td>
<td>[40]</td>
<td>464</td>
<td>99.86</td>
</tr>
<tr>
<td>5.1</td>
<td>Smart, application, device, security, cloud, network, service, provide, compute, propose, architecture, communication, present, challenge, environment, user, information, solution, platform, data</td>
<td>Data security challenges in smart agriculture</td>
<td>[43]</td>
<td>919</td>
<td>99.88</td>
</tr>
<tr>
<td>5.2</td>
<td>Water, soil, irrigation, crop, farmer, control, monitor, temperature, smart, moisture, field, plant, time, monitoring, humidity, farm, propose, parameter, condition, farming</td>
<td>Smart monitoring system in agriculture</td>
<td>[46]</td>
<td>1373</td>
<td>99.89</td>
</tr>
<tr>
<td></td>
<td>Agricultural, food, production, smart, information, farming, development, management, application, product, supply, farm, industry, research, chain, model, study, farmer, process, sector</td>
<td>Production and supply chain management in agriculture</td>
<td>[49]</td>
<td>978</td>
<td>99.87</td>
</tr>
<tr>
<td>5.3</td>
<td>Network, energy, wireless, node, low, power, application, propose, communication, result, consumption, design, cost, performance, device, monitoring, smart, transmission, range, area</td>
<td>Cost-effective communication system in smart agriculture</td>
<td>[52]</td>
<td>575</td>
<td>99.77</td>
</tr>
<tr>
<td>10.1</td>
<td>Monitor, temperature, monitoring, time, control, humidity, design, real, environmental, wireless, low, device, application, parameter, greenhouse, cost, develop, network, field, soil</td>
<td>Greenhouse monitoring system</td>
<td>[55]</td>
<td>453</td>
<td>99.89</td>
</tr>
<tr>
<td></td>
<td>Application, smart, architecture, platform, model, cloud, propose, service, network, information, provide, solution, device, process, management, present, compute, support, data, precision</td>
<td>Service-based industry for smart agriculture</td>
<td>[58]</td>
<td>440</td>
<td>99.86</td>
</tr>
<tr>
<td>10.2</td>
<td>Smart, application, device, city, network, challenge, provide, field, industry, make, communication, area, cloud, machine, connect, home, research, compute, present, human</td>
<td>Cloud-based smart applications in agriculture</td>
<td>[61]</td>
<td>442</td>
<td>99.86</td>
</tr>
<tr>
<td></td>
<td>Network, energy, wireless, node, power, low, propose, communication, application, consumption, result, device, performance, area, smart, transmission, range, cost, cluster, show</td>
<td>Energy-efficient smart transmission system</td>
<td>[64]</td>
<td>479</td>
<td>99.87</td>
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<tr>
<td>10.3</td>
<td>Agricultural, information, intelligent, production, management, product, application, development, improve, control, design, chain, supply, environment, platform, monitoring, problem, greenhouse, layer, modern</td>
<td>Smart solutions for modern farming</td>
<td>[67]</td>
<td>260</td>
<td>99.83</td>
</tr>
<tr>
<td>10.4</td>
<td>Water, irrigation, soil, moisture, control, crop, smart, plant, monitor, temperature, farmer, field, propose, level, farming, farm, time, humidity, parameter, agricultural</td>
<td>Smart irrigation system for agriculture</td>
<td>[47]</td>
<td>810</td>
<td>99.94</td>
</tr>
<tr>
<td>10.5</td>
<td>Security, device, blockchain, smart, attack, application, propose, network, secure, privacy, compute, edge, cloud, issue, provide, challenge, communication, authentication, computing, scheme</td>
<td>Blockchain-based security system for agriculture</td>
<td>[71]</td>
<td>218</td>
<td>99.29</td>
</tr>
<tr>
<td>10.6</td>
<td>Blockchain-based security system for agriculture</td>
<td>[72]</td>
<td>98.72</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10.7</td>
<td>Blockchain-based security system for agriculture</td>
<td>[73]</td>
<td>95.35</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
interoperability of services [9]. As part of the MIT Media Lab Open Agriculture Initiative, Google has shared its vision for a more sustainable food system [10]. For efficient seed planting, “sensors and vision-based technology” help determine the distance and depth. An autonomous robot named Agribot is being developed to sow seeds using sensors and a vision-based system [11]. Technology and economic sustainability go hand in hand. A study was conducted in Pakistan to determine the commercial viability of a proposed crop insurance plan and assess the demand for crop insurance in various flood-prone rural districts of Khyber Pakhtunkhwa Province [12]. Additional research revealed that farm households in the study area faced several barriers to adapting to climate variability, including a lack of labor, an insecure land tenure system, a lack of market access, poverty, a lack of governmental support, a lack of access to assets, a lack of water sources, a lack of credit sources, and a lack of knowledge and information [13]. One study found a link between poverty reduction and natural and social capital for sustainable livelihood. The research provides empirical and quantitative evidence on poverty alleviation, and the conclusions will improve agricultural households’ sustainability [14]. A study also uses natural and agricultural resources in Northwestern Pakistan to create a livelihood vulnerability index (LVI), LVI-IPCC, and livelihood effect index [15].

Further, several noncontact sensing methods for determining the seed flow rate are proposed in [16], “where the sensors were equipped with LEDs, infrared, visible light, laser-LED, and a radiation reception element”. The output voltage fluctuates depending on how the seeds move through the sensor and band of light rays and how the shades fall on the reception parts [17]. Therefore, the seed flow rate is calculated based on the signal information about the passing seeds. Researchers offer an expert system for evaluating the viability of agricultural land in a 2019 study by combining sensor networks with artificial intelligence systems such as neural networks and multilayer perceptron [18]. The proposed method is intended to assist farmers in categorizing agricultural land for cultivation into the most suitable, suitable, somewhat suitable, and unsuitable categories. In a recent study, researchers used citrus fruits data labeled by a domain expert with four severity levels (high, medium, low, and healthy) to train a deep neural network (DNN) model to detect disease by severity [19]. The model has a 98% likelihood of predicting low severity and a 98% chance of predicting high seriousness. In a subsequent study, the author takes advantage of blockchain’s potential benefits, combines it with SDN, and provides justification for worries about energy consumption and security [20]. In the most recent survey, authors applied the same blockchain technology integration technology to different platforms. LDA was used to anticipate blockchain research trends. The researchers have predicted 17 scientific trends that deserve more attention. According to the literature, LDA approaches anticipate smart agriculture research trends [21]. The researcher created a novel routing protocol for IoT networks with a cluster topology using a blockchain-based architecture for the SDN controller. The research concepts of the existing state of the art and its differentiation from the current state are represented in Table 2.

### 3. Topic Modeling

Data mining is an emerging field to extract data from unstructured formats. Topic modeling is a powerful technique in text mining in natural language processing to explore the relationship between the data and collected documents [22]. This technique is used by various researchers in their native fields, like medical, semantic analysis [23], and engineering [24], to conclude the relationship between the documents and topics. Techniques like latent Dirichlet allocation (LDA), nonnegative matrix factorization (NMF), latent semantic analysis (LSA), parallel latent Dirichlet allocation (PLDA), and Pachinko allocation model (PAM) were used in the topic modeling; among all, LDA is intensively used by researchers. The topic modeling technique is similar to the dimensionality reduction technique used for numerical data. A bag of words (BOW) is created from the dictionary of words, and topic modeling extracts the required features from this BOW. The words contained in the corpus are viewed as a significant feature in NLP.

NLP considers each word as a feature to train the model. This technique helps us find the right content instead of analyzing the accurate data. LDA is used to attain a relationship among the documents in the collected dataset, and results

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**Table 1: Continued.**

<table>
<thead>
<tr>
<th>Topic ID</th>
<th>Key terms</th>
<th>Topic label</th>
<th>High loading paper</th>
<th>Count of studies</th>
<th>Contribution (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>10.8</td>
<td>Crop, farmer, soil, farming, disease, plant, farm, agricultural, yield, production, field, increase, smart, propose, machine, pest, time, weather, make, growth</td>
<td>Production-based smart system for agriculture</td>
<td>[74]</td>
<td>461</td>
<td>99.90</td>
</tr>
<tr>
<td>10.9</td>
<td>Food, agricultural, study, research, production, industry, sector, development, supply, farmer, chain, smart, develop, management, farming, farm, sustainable, challenge, digital, business</td>
<td>Industry 4.0 in agriculture</td>
<td>[77]</td>
<td>489</td>
<td>99.94</td>
</tr>
<tr>
<td>10.10</td>
<td>Model, machine, image, learn, propose, result, detection, learning, method, deep, accuracy, prediction, time, classification, neural, network, technique, feature, algorithm, disease</td>
<td>Image-based classification techniques in intelligent agriculture</td>
<td>[79]</td>
<td>257</td>
<td>99.69</td>
</tr>
</tbody>
</table>

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are represented statistically and graphically. To develop LDA, variational exception maximization (VEM) algorithm [25] is used to estimate the similarities from the corpus. Usually, the top few words are picked up from the BOW as this approach lacks semantics in the sentence. LDA follows the concept of probabilistic distribution, so each document in the corpus portrays the probabilistic distribution of topics, and each extracted topic depicts the probabilistic distribution of words. It led to concluding a clear vision of the topic connection. LDA is applied to retrieve critical information or analysis from unstructured data. For example, research on social media makes users understandable reactions and conversations among the people connected in social media to conclude the patterns [26].

4. Methodology

The stepwise procedure of whatever tasks have been completed is affecting explained, which picture quality defines our research methodology to predict the research trends of IoT agriculture. The methods used to conduct this review are depicted in Figure 2, in which three phases are involved. The first phase of research is data collection; in the second phase, collected data is preprocessed; finally, in the third phase, data is analyzed, and results are depicted.

4.1. Corpus. The primary sources of data collection and formation of the research corpus were the various online digital libraries, journals, and conference proceedings available to users through Google Scholar. The search keywords for digital libraries have been selected based on topic selection. The research works of Sehra et al. [27] have influenced them to experiment. The search phrases identified were "IoT agriculture". Scopus is considered the most extensive database for published articles globally. The string is run on the Scopus platform, and 4803 articles were extracted from the Scopus database. The specific keywords in the publication's title, abstract, and keywords were collected by searching for them in various databases.

<table>
<thead>
<tr>
<th>Existing research Title of research study</th>
<th>Research concept</th>
<th>Current research</th>
</tr>
</thead>
<tbody>
<tr>
<td>&quot;Knowledge domain and emerging trends of climate-smart agriculture: a bibliometric study&quot;</td>
<td>A bibliometric study of the literature written on the topic of climate-smart agriculture between the years 2010 and 2021</td>
<td>In the current research, the LDA technique has been applied to Scopus dataset from 2008 to 2022</td>
</tr>
<tr>
<td>&quot;Privacy and security in smart and precision farming: a bibliometric analysis&quot;</td>
<td>All papers in the ISI Web of Science database totaled around 150 between 2008 and 2018 are considered. Through the use of bibliometric analysis, the number of publications and citations is discussed</td>
<td>The difference lies in the dataset and the technique used for the analysis</td>
</tr>
<tr>
<td>&quot;Wireless sensor networks in agriculture: insights from bibliometric analysis&quot;</td>
<td>The current dataset comprising 2444 documents after refining the dataset and subject area is based upon WSN</td>
<td>The final corpus comprises 4309 documents, whereas the subject area defined by the researchers is smart agriculture</td>
</tr>
<tr>
<td>&quot;Deep learning for smart agriculture: concepts, tools, applications, and opportunities&quot;</td>
<td>The researchers presented a systematic literature review of all the deep learning techniques used in agriculture</td>
<td>The researchers present a technical perspective of smart agriculture with current research trends</td>
</tr>
<tr>
<td>&quot;Latent DIRICHLET allocation (LDA) based information modeling on BLOCKCHAIN technology: a review of trends and research patterns used in the integration&quot;</td>
<td>LDA technique has been applied to blockchain dataset and predicted the current research trends</td>
<td>The researchers have applied the same technique but used a different dataset to predict the current research trends</td>
</tr>
<tr>
<td>&quot;Interpreting atomization of agricultural spray image patterns using latent Dirichlet allocation techniques&quot;</td>
<td>The researchers have applied latent Dirichlet allocation (LDA) to discover latent features of spray videos</td>
<td>The researchers have collected and examined 4309 research papers that were published during 2008-2022 using the same technique</td>
</tr>
</tbody>
</table>

Table 2: Existing and current research differentiation.

FIGURE 2: Proposed methodology.
Further processing required inclusion and exclusion criteria to finalize the corpus, so, for inclusion criteria, we considered the research papers published in English only. Then, the studies concerning IoT agriculture were only considered. Under the exclusion procedure, we excluded and removed those studies published in different native languages. In addition, studies having missing information like author, abstract, title, and year were excluded from the corpus. After applying the requirements, 4309 studies were considered for the current research. Figure 3 represents the year-wise growth in article publication in IoT agriculture. It is clear from Figure 3 that after 2015 there has been tremendous growth in publications. The leading publication is in 2021, 26.43% of the total corpus; in 2020, 21.95% of an article was published. In 2022 as per data, there is 0.07% publication, which can be increased by the end of the year.

This area of research is published in various reputed journals. Some top-rated journals or dominating journals in IoT agriculture are shown in Figure 4. Dominating journal analysis shows maximum participation from the Advances in Intelligent Systems and Computing, which has 134 articles having 0.031%, and this journal belongs to Springer, having H-Index 48 and 0.66 as its impact factor.

4.2. Preprocessing. It is a preliminary step that processes the dataset or the information collected. The objective of preprocessing is to discard the extraneous information inside the information. Preprocessing removes unwanted words and characters from the accumulated or collected corpus and improves the dataset’s quality. As a result, the profile of further processing becomes more accurate and acceptable. In the collected corpus, the author used four types of data for LDA modeling: title of the paper, year of publication, journal of published article, abstract, and keywords of the documents. Further, abstract and keywords are combined under the same column. A sample of the loading corpus is shown in Table 3.

The first step to performing on the uploaded corpus is to token the words so that all the abstracts per title are tokenized into tokens. The generated tokens are then transformed into lowercase letters for each document. In tokenization, the focus is on removing the punctuation marks, single characters, and other special characters like ’,’ ‘.”,’ ‘/’, ‘\’, ‘brackets’, ‘[]’. Further, any equation or formula used in the abstract was removed. Also, the numerical values were eradicated to get a full-fledged textual token [28]. Finally, after tokenization, the words which have no meaning are removed. The stop words are the commonly used words such as “the”, “if”, “but”, “a”, or “an”. These words take up space in our corpus and consume valuable processing time. Thus, it becomes crucial to remove these stop removals, and here in our experimentation, we have used Natural Language Toolkit (NLTK). This toolkit has stop words stored in more than sixteen languages. Here, the English-language stop words in the NLTK library and other phrases used to build the corpus were removed from the corpus [29].

Further, stemming is reducing a word to its word stem. Stemming is essential in natural language understanding and natural language processing, endeavoring to extract the root or core word that is usually appended with the English suffixes and prefixes. It erases all the extraneous parts in the word and sources out the accurate, meaningful word. For example, use is the core word that can be extracted by stemming the word useless, useful, and uses. To prepare an adequate corpus, words stem from their original form using the Snowball stemmer algorithm [30], and the resulting base keywords are stored in the cleansed corpus. Finally, the words which were previously stemmed need to be lemmatized. Lemmatization is when the context is considered, and stemmed words are converted into more meaningful base words or lemmas. This phase targets removing inflected words and outputs the dictionary form of a word [31].

5. Latent Dirichlet Allocation

Latent Dirichlet allocation (LDA) is the most popular technique in NLP, so data is fed to the LDA model after preprocessing. Before sending data, bigrams and trigrams are removed from the corpus. Two words that occur together are named bigrams, like human resources, and the three words frequently occurring together in the document are termed trigrams, like human resource management. The LDA model is implemented in python language, where the genism library has been used to remove such phrases. Genism’s phrases model can build and identify these bigrams, trigrams, quadrams, or even n-grams [32]; thus, we can remove and improve the data cleansing process. It is also part of preprocessing, so after completing this stage, data is sent to the LDA model for further analysis [49, 67]. LDA topic modeling is based on three input parameters, one of which is a list of topics, and the other is hyperparameters. Before the distribution of a document’s topic content is the magnitude of the Dirichlet. This parameter is regarded as several “pseudowords” equally distributed across the document’s topics, regardless of how the document’s other words are assigned to topics. $\beta$ is per-word-weight of Dirichlet prior over topic-word distributions. The $\alpha$ value for this experiment is taken as $1/T$, where $T$ is the desired number of topics [33], and the $\beta$ has been fixed as 0.01 for all topic solutions. For identifying two, five, and ten topic solutions, as suggested by [26], the number of iterations considered is 1000. Thus, initializing these parameters becomes a concern as the values can define the distribution of high-quality topic results. The bag of words (BOW) extracted is initially processed in LDA topic modeling, where the most frequently and least frequently occurring are removed so the corpus can become absolute. This study removes a word frequency of more than 5000 from BOW. The top 20 frequently occurring words from the corpus with their frequency are shown in Figure 5, as it is clear from the graph that the most occurring keyword is the system, use, sensors, internet, agriculture, and many more.

Hyperparameters are optimized using Python’s mallet library, a JAVA-based NLP package. Then, the mallet package extracts the desired topics by training the model using BOW. Unfortunately, no official or proven measure exists
to find the optimal number of solutions [27]. Still, some observational parameters are given by Cao and Arun, which helps the researcher decide the optimal number of keys [55, 68]. Furthermore, the choice of the topic solution has been influenced by the heuristics and findings of the studies [55, 61, 68, 69]. Finally, K-mean clustering algorithms are used to find the optimal number of topics from the BOW.

6. Topic Labeling

Once the topics have been extracted with the help of the LDA model, each topic is labeled manually based on the key terms of each topic. As a result, there are 4309 articles in the corpus, and out of all documents, the top five high-loading papers and their contribution to the topic are mentioned in Table 1.

7. Result Analysis

7.1. Parameters of Topic Solutions. The loadings for two, five, and ten topic solutions have been acquired by deploying the LDA model and are presented in Table 1. The selection of two, five, and ten topic solutions is based on a coherence score and is influenced by the previous studies. The
coherence score plays an essential role in finding the semantic similarity between the key terms in the topic, and ideally, a 0.3 to 0.6 coherence value is considered a good score [81]. In this study, coherence values achieved are good; for two topic solutions, 0.62; for five topics, 0.58; and for ten topic solutions, 0.52 coherence value is reached. Therefore, five topic solutions are considered optimal based on coherence value. The dominance of each topic solution is also supported by the corresponding count of articles it covers. Table 4 summarizes the count of year-wise publications corresponding to each topic solution.

The initial choice of two topics will broadly depict the core research areas that have been widely covered by the researchers in the compiled research literature. Further, in five topic solutions, the researchers have explored the research areas. Therefore, we have depicted in detail the research areas studied in five topic solutions. Further in the hierarchy, the five topic solutions have widened into ten topic solutions, with new areas emerging as the research trends in GHRM.

7.2. Topic Labeling. The core research zones explored and discovered based on the two topic solutions are depicted in topics T-2.1 and T-2.2. Let us discuss how this labeling has been performed. While implementing LDA on two topic solutions, the keywords and their loading has been extracted. The extraction results of LDA depict the high-loading articles per topic and the high-loading terms or keywords per topic. The labeling process is based on the high-loading keywords that have been collected. Thus, in the table, the labeling per topic solution corresponds to the terms extracted under the heads T-2.1, T-2.2, and so on; it goes for five and ten topic solutions.

7.2.1. Core Research Area. The two topic solutions present an abstract view of the literature dataset and divides it into "Security and Privacy in Smart Agriculture" (T-2.1) and "Monitoring and Control System in Agriculture" (T-2.2). These two significant labels depict the research areas the researchers have extensively explored.

(1) T-2.1: Security and Privacy in Smart Agriculture. Agriculture has shaped human civilizations since ancient times. Rapid information and communication growth affects agriculture’s structure and operation (ICT) [82]. Despite advances, hazards may be significant, so smart farming must grasp security and privacy challenges before contemplating cyber attacks. Smart farming uses devices, protocols, and computer ideas to modernize agriculture. Digital farming changes everything and creates effective, efficient, sustainable, and open systems [83]. Mobile devices, precision agronomy, remote sensing, big data, cloud analytics, cyber security, and intelligent systems simplify agricultural technology integration. Incompatibility, heterogeneity, equipment constraints, processing, and data security may threaten smart farming, but recent years have increased usage of ICTs in agriculture [84]. Physical risks and concerns may impede agriculture’s deployment, but agriculture 4.0 will be the new agriculture standard [85]. Simultaneous research is also going on in the area to secure smart agriculture. Technology has added to environmental problems—list agriculture’s physical threats by category. Population increase, urbanization, aging, and technical developments in food production all affect agriculture and farmers. Agriculture’s most significant physical hazard is weather [86]. External factors continually threaten agriculture. In recent decades, technology has reduced its influence. Agriculture apps need stable connections, IoT networks, and cloud computing [87]. External factors continually threaten agriculture. In recent decades, technology has reduced its influence. Agriculture apps need stable connections, IoT networks, and cloud computing. The sensors can malfunction, causing erroneous readings and instructions that could cause a manufacturing failure. Temperature, humidity, obstructions, and human presence can impact Lora WAN, Zigbee, and other agri-wireless networks, causing data loss. Sensors and networking equipment are usually exposed [88].

(2) T-2.2 Monitoring and Control System in Agriculture. New techniques, technology, and approaches have also helped in agriculture. 35% of the world’s workforce works in this profession. Agriculture helps many economies to grow [89]. It boosts industrialized nations’ economies. India is the second largest country that deals in this profession. Every country has practiced agriculture since ancient times. Businesses and other areas must support agriculture’s tech transformation. The future population rise is frightening. Mid-20th century population may have surpassed nine billion counts, so agriculture needs to be strengthened to meet the flooding needs. Agricultural engineering challenges include drainage, irrigation, crop scheduling, and bio-system optimization. The lack of agricultural technology to monitor and manage
systems or machinery likely causes these problems. The report says control approaches increased seedling growth [90].

IoT helps in the process of modernizing the agriculture segment by gathering farming data. IoT-based agricultural monitoring system wirelessly communicates and disseminates the sensor data. Global agriculture uses 70% of available fresh water each year to irrigate 17% of the land [91]. Growing food requirements and global warming reduce irrigated land, a challenge in plague agriculture. FAO predicts global food production must rise by 70% to meet population and urbanization needs. Modern agriculture uses robotics, automation, and computer systems to replace challenging human jobs, so expanding agriculture needs new technologies to be included [92]. Future agricultural technology includes robotics and machine vision. In addition, population growth will increase the demand for resources and products. “Sustainability” is blended into social, economic, and technological problems to address environmental conservation and economic development, and information and control systems will be crucial [93].

7.2.2. Five Topic Solutions: Research Areas

(1) T-5.1: Intelligent Disease Detection Models. India’s economy is mainly based on agriculture. Agriculture accounts for 16% of India’s GDP and exports. More than 75% of India’s population depends on agriculture. Healthy, high-quality agriculture is essential for economic prosperity [94]. Detection of plant disease is critical at an early stage. Plants can become ill while growing. Early illness diagnosis is a challenge in agriculture. Researchers first demonstrated cutting-edge machine learning methods for identifying plant illnesses [95]. Training parameters are used in modern systems but require powerful computers or lengthy training and prediction durations to work. Convolutional auto encoder (CAE) network prediction features have been reduced while preserving accuracy in this research. Thanks to technological advancements, the world’s population of 7 billion people can be fed [96].

Changing climates, declining pollinators, and plant diseases threaten the ability to produce enough food. Plant diseases endanger the livelihoods of smallholder farmers who depend on healthy crops [97]. Despite declining yields, smallholder farmers in developing economies provide more than 80% agricultural output. Methods for preventing disease already exist [98]. Pesticides have been replaced with integrated pest management (IPM). Early diagnosis is essential for successful therapy. Agricultural extension organizations and local plant clinics have long supported disease detection thanks to their computer power, high-resolution displays, and broad accessory sets, such as HD cameras. Smartphone diagnostics are a first-of-its-kind technology. 5-6 billion mobile phones will be in use by 2020. More than two-thirds of the world’s people now have access to mobile broadband, a 12-fold increase since 2007 [99].

(2) T-5.2: Data Security Challenges in Smart Agriculture. Technology, equipment, protocols, and computer paradigms are all used to enhance agricultural operations in smart agriculture. Big data, artificial intelligence, the cloud, and edge computing all store and analyze the data in various forms of storage and archiving. As a relatively new field, smart agriculture lacks adequate data security measures [84]. Farming’s future relies heavily on the availability and quality of data, which necessitates the need for security. To maintain security in smart agriculture, managing data compatibility, resource constraints, and massive data processing [100].
Agricultural systems may not be well suited to traditional IoT security solutions, resulting in unique demands and possibilities. New agricultural projects have been developed to keep up with population increase and food production. The success of agriculture depends on productivity, era-specific restrictions, and the advancement of science and technology. A lot may go wrong regarding smart agriculture, which is still in its infancy. In the future, farmers will rely heavily on the availability and quality of data to help them; thus, developing secure and stable systems is critical [101]. The growth of the agriculture generation is depicted in Figure 6, in which agriculture 1.0 started in 1784. In the 20th century, agriculture 2.0 came into existence. In 1992 agriculture 3.0 was started, and in 2018 agriculture 4.0 if followed.

Smart agriculture uses IT to increase information perception, quantitative decision-making, intelligent control, suitable investment, and personal service [102]. In addition, current technology boosts agricultural yield and improves security and privacy [103]. There are both advantages and disadvantages to using automation in smart agriculture. Computer-aided farming uses contemporary technology and procedures, so in the future, “digital agriculture” will be more productive, efficient, sustainable, inclusive, transparent, and resilient agriculture. Many different types of agricultural technology may be used in conjunction with one another to increase efficiency and productivity [104].

(3) T-5.3: Smart Monitoring System in Agriculture. Rainfall and temperature fluctuations are very unpredictable. Climate-smart farming is becoming increasingly popular among Indian farmers. IoT enables smart agriculture. It saves water, fertilizer, and agricultural yields. IoT-enabled automated systems and wireless networks are expanding industries. Thus, research into integrated sensor technology and the usage of IoT networks in agriculture is reaching the level [105].

(4) T-5.4: Production and Supply Chain Management in Agriculture. The growth of the supply chain and the movement of information are driven by the gathering of materials, the transformation of products, and the delivery to end-users. Information-driven, “connected supply chains” enable organizations to reduce inventory and expenditures; increase product value; extend resources; expedite time to market; and retain consumers, among other benefits [106]. Supply chain performance determines how healthy activities are linked to maximizing customer value and profitability at each process stage—the end-user benefits from an efficient supply chain. Several agricultural supply chains in India are problematic owing to issues in the agriculture industry [107]. Many factors affect the agri-food supply chain, including small and marginal farmers, disjointed supply chains, a lack of economies of scale, subpar processing, value addition, and fewer marketing options. Supply chain management is expanding into logistics by creating new divisions integrating manufacturing, procurement, transportation, and distribution [108]. Information flow visibility has increased because of advancements in telecommunications, electronic data interfaces, and other technologies. Animals and plants are used in agriculture to produce products that benefit human health. For example, agribusiness produces textiles and paper. Throughout the supply chain, the needs of customers are met. Organizations in the agricultural supply chain, such as cooperatives, distribute produce, fruits, grains, pulses, and products derived from animals [109]—a network of businesses that make goods and services for the end-user. There are several benefits to establishing a supply chain network, such as shifting risk and profit from one company to another. Quality is ensured by openness and accountability in the process. Quality is dependent on transparent processes and responsibilities at each stage of the process. The price and performance of transfer payments are crucial to the success of process chains.

(5) T-5.5: Cost-Effective Communication System in Smart Agriculture. Low-cost solutions like crop rotation, green manuring, and mulching have cut cultivation expenses while saving soil and water. Legumes, weed control, and increased agricultural diversity are nonmonetary inputs [101]. Climate change, global warming, saltwater intrusion, desertification, and a lack of arable land have increased worldwide worries about food safety and security. Connectivity-of-Things applications require steady internet [110]. In the Mekong Delta and HCMC, climate change threatens food security. Drought and saltwater intrusion in the South and Central Highlands in early 2016 demonstrate the vulnerability and susceptibility of unsustainable agriculture. Agriculture may be more efficient and safer thanks to a new Farming system. Vietnam may become a smart and sustainable farm by modernizing, boosting productivity, and ensuring quality. Businesses in Vietnam have shared their know-how with companies in other countries. Another important factor to consider is the safety of the food being prepared. When deciding which meals are good for you and the environment, most people have no idea where to begin. Concerns about food safety have given rise to new ideas like “city farms” and “growing your veggies at home” [111]. However, the economic sustainability of these models must be thoroughly explored. Researchers are currently focusing on developing an IoT-enabled agriculture system. Increased productivity, quality, and safety may be achieved via this method [82].

7.2.3. Ten Topic Solutions: Research Trends

(1) T-10.1: Greenhouse Monitoring System. Most Indians work in agriculture, contributing to the country’s economy—agriculture benefits from technological advancements. However, pesticides are used to grow most fruits and vegetables since contemporary farming methods cannot keep up with demand. As a result, conventional farming practices contend with weather and disease. Although crop yields may be increased by altering agricultural practices [112] because of urbanization and land scarcity, farming must be done in greenhouses. Temperature, humidity, light, water content, pH, and wetness are all shown via LEDs in the greenhouse. The goal is to create an intelligent greenhouse.
Greenhouse temperature and humidity may be adjusted automatically using programmable modules and low-cost and high-efficiency options [113].

Soil water content, light intensity, temperature, and humidity may be adjusted. In greenhouse crop production, the appropriate growth conditions must be changed to achieve high yields, low costs, improved quality, and the lowest environmental impact. To attain these goals, proper heating and ventilation must be maintained. Using a greenhouse is more dependable, but it is also more difficult [114]. Temperature and timing controls had previously improved crop quality. Many control devices and systems lack automation and efficiency in today’s dynamic and competitive environment. A variety of complicated models depict the greenhouse effect. Costs increased, plans became more complex, and more control was required. The usage of computers in greenhouses has increased during the last decade. These components are necessary for a control system. Sophisticated microelectronic hybrid circuits boost sensor manufacturing. Advances in product quality and dependability enable commercial competitiveness. Each sensor’s performance is determined by its calibration and sensing processes. It will be impossible to automate some jobs even in the far future. Several American businesses have yet to automate fully, maybe due to cost concerns [115].

(2) **T-10.2: Service-Based Industry for Smart Agriculture.** Technical advancement has been driven by the widespread use of IT and its adaptability in satisfying various requirements. Service-based agriculture (SBA) is widely utilized in multiple industries. Farming systems that make it easier for farmers to do their work. A large-scale service smart agriculture systems link buses to a hotel, hospital, logistics center, restaurant, grocery store, or traditional market. With SBA, material sales partners may easily share information about their products with one other fast. As a result of SBA, Indonesia will see an increase in its economy, as quoted in one study. Over time, the importance of information technology has grown. The production of farms has increased thanks to the adoption of contemporary technology [116]. Many people are familiar with the predicament of Indonesian farmers. The significance of variables cannot be overstated. Farmers have a fear of technology. Farmers in Indonesia may be able to increase their abilities and produce food for the country’s population by utilizing new technologies.

Brokers are often used to resell the produce of Indonesian farmers. Small-scale farmers in Indonesia were hurt by brokers who gambled on the price of agricultural goods [117]. Prices for components are rising. Broker fraud inflated market values. Brokers save agricultural products, giving the impression that the market is oversupplied and driving up the price of food. When chili prices climb and there is a shortage, many brokers refuse to buy from growers. The growing cost of food in Indonesia might harm the country’s economy. Farmers must be able to sell their products directly to consumers. The direct distribution offers farmers an easy way to market their products. Wholesalers buy agricultural goods from farmers at inexpensive rates [118]. To get their goods to market, farmers must rent a vehicle. Commodities no longer impact farmers’ earnings with a long processing time. Indonesians rely heavily on their smartphones to get information. Technology can help farmers become food wholesalers. Local markets and restaurants might be fed using this method by farmers. The Internet of Things (IoT) and cloud computing support agriculture’s food supply and distribution systems [119]. Nowadays, nanotechnology is also used in agriculture to improve yields and reduce waste.

(3) **T-10.3: Cloud-Based Smart Applications in Agriculture.** Smart farming uses technology to increase production and improve product quality. For example, the Internet of Things-based smart agriculture automates crop inspections and watering. Database traffic and data cannot be handled
by a cloud-based IoT-based system. As a result, there is less lag, the battery lasts longer, and the money and information are better managed [120].

In many cases, the edge for IoT may provide significant advantages, such as removing the need for interval and geometric communications efficiency. High interface automation in IoT activities may achieve reduced latency and faster processing. This simulator replicates the sting, edge, and fog of IoT. IoT-based edge computing is more immediate, cost-effective, and efficient than traditional computer systems [121]. In cities, these strategies are ineffective. Rural locations are where they are most commonly used. Robots should be used in agriculture. The field is navigated using the GPS on the tractor. Agribusiness in the 21st century is anything but digital or computerized. Monitoring crops and animals with sensors, GPS-enabled tractors, image processing, and machine learning is possible. Edge computing reduces the amount of noise in the raw data it analyses which can be cleaned using data mining techniques [122].

On the other hand, Broadband networks are more cumbersome and difficult to standardize. After sensors are installed, data is automatically collected. We can identify if animals or birds are active, inactive, unwell, healthy, submissive, or dominant. We may alter their treatment, living circumstances, medicine, and food to suit their needs [123].

(4) T-10.4: Energy-Efficient Smart Transmission System. An intelligent electrical infrastructure that satisfies society’s sustainability and energy efficiency demands is called “smart infrastructure” Customers and utility providers will benefit from the smart grid’s ability to monitor their energy use better and link the power grid with micro-networks. As a result, there is a danger to data security and privacy. Economic growth depends on the availability of electricity, which boosts productivity and sustains quality of life. Global economic development and electricity usage are depleting the planet’s ability to monitor their energy use better and link the power grid with micro-networks [124]. The smart grid’s core assumption is to minimize resource depletion and promote economic growth through energy efficiency and management technologies. Demand management lowers transmission and distribution system stress and high-demand overhead lines. Several countries have used industrial and commercial demand response strategies to boost their economies. Direct load limiting often reduces peak demand [125]. Direct load management may result in a decrease in customer satisfaction—direct load management. Consumers and utility companies benefit from reduced peak demand when loads are shifted. However, the electrical system’s stability and dependability are compromised during periods of high energy demand. The smart grid and load modeling need to limit peak energy use.

Trouble ensues when demand exceeds supply. From 2019 to 2030, India’s population and development demands are expected to grow by 50 percent [126]. A transmission system that can endure interruptions and blackouts must meet these criteria. Grid operators must regularly monitor supply and demand to avoid power outages. To fix this problem, load shedding disconnects specific customers’ electricity. Generators must be turned down to prevent blackouts if supply and demand are out of sync. Smart grids can identify problems early on and immediately resolve them. Sensors monitor the grid and manage the flow of current. These are computerized to increase productivity [127].

(5) T-10.5: Smart Solutions for Modern Farming. Sustainable food production is in high demand as the world’s population expands and weather patterns shift. Agriculture and development go forward as time goes by. Agricultural technology is advancing rapidly. These new technologies are pretty effective, but they must be constantly improved. Using information and communications technology, planting, watering, and harvesting are all enhanced. Many fields, including agriculture, benefit from technological advancements. The Internet of Things (IoT) in agriculture is referred to as “smart farming” [128]. Produce and livestock will be healthier thanks to IoT-enabled smart farming. Real-time information is provided through wearables and sensors in the field.

Shelter, clothing, and food have been top priorities for humanity since the dawn of civilization. There is a lot of modernity in the house and clothing. According to the UN Food and Agriculture Organization (FAO), humanity’s food requirements will rise by 70% by 2050, according to the UN Food and Agriculture Organization (FAO) [129]. IoT can be used to solve problems in business and technology. Tractors are used to plant seeds and gather crops. You can use it for business or yourself. Farming is done with the help of tractors. Farmers can do other things when they use tractors that drive themselves. A Polish company called Agribot makes tractors that can work independently. When they pull weeds, their tractors have sensors that reduce the number of chemicals and pesticides exposed. Agro-IoT devices can meet the needs of farming in the future. Traditional agriculture must become more productive and less risky for the global economy to grow. IoT helps growth. Farmers can keep an eye on their land with the help of the Internet of Things. IoT applications include keeping an eye on climate change, managing water, keeping an eye on land, improving productivity, keeping an eye on farming, and keeping track of pesticides and herbicides [130].

(6) T-10.6: Smart Irrigation System for Agriculture. The most difficult chore in agriculture is watering fields. Water systems consist of drips, nozzles, tubes, and sprinklers, among other things. As a whole, agriculture has a positive impact on economic activity. Watering by hand is required. Gardening and soil deterioration are both covered in rainfall. Agriculture’s key objectives are the production of food and livestock. IoT is a network of interconnected devices that can exchange data [131]. When water supplies are limited, automatic irrigation may be necessary.

According on the weather, irrigation might be done continuously or intermittently. As a result, there is less spillage. Almost all of the water comes from drip irrigation or sprinklers. With a wireless gadget, soil moisture and humidity
Automated irrigation systems can be used to address the difficulties. Farming may benefit from drip irrigation, which saves on water. Automatic irrigation systems for crop management have become widespread during rainstorms, landscaping, and soil erosion. Wi-fi sensors are used to gauge the humidity and moisture content of the soil. In agriculture, controllers keep an eye on the electricity, keep an eye out for intruders, and manage the pumps. Saturating the soil is accomplished with the use of pumps. Using drippers saves water, therefore reducing the amount of water used. Floation irrigation commonly utilizes electricity, sensors, pumps, and controls [132].

(7) T-10.7: Blockchain-Based Security System for Agriculture. There are nodes in a blockchain, and each node has its own distributed ledger, allowing several nodes to read and amend a single ledger while preserving shared control. Each blockchain node contains a distributed ledger that is safe and accessible to all participants. There are no middlemen to authenticate, track, store or synchronize transactions using blockchain technology. According to several research studies, blockchain has altered technology from centralized to decentralized and distributed networks, a shift that has been well documented. The blockchain is used to help business networks [133]. Business networks are composed of companies or individuals trading assets. Products, materials, and equipment are examples of physical assets. A distributed ledger may be used to move assets across the network by anybody who is a member. The most recent ledger is available to all members. Consensus-based distributed ledgers and smart contracts foster network confidence. Assets and transactions are recorded in the distributed ledger. Transactions are possible with a distributed ledger. You cannot remove a transaction after it has been added. An encrypted ledger prevents tampering with transactions. With blockchain, the distributed ledger is transformed into a reliable data source for the network [134]. A distributed ledger of digital commerce is known as a blockchain.

Each node of the network modifies distributed ledgers through cryptography. Components of a blockchain include its block header, timestamp, nonce, and Merkle root hash. Smart apps are being developed for rural agriculture. Agricultural modernization relies on ICT to automate processes and protect personal data. Data from many IoT devices may be sent to a central hub to analyze and manage autonomous farm activities. However, centralized intermediaries are inherent in a single point of failure, data loss risk, and man-in-the-middle attacks. Thanks to smart contracts on the blockchain, decentralized and safe agricultural automations are now possible [135].

(8) T-10.8: Production-Based Smart System for Agriculture. It is possible to increase productivity and quality by using IoT-based agricultural convergence technologies. Predicting demand, managing supply, and ensuring quality are benefits of precision agriculture. The expansion of the economy is mainly fueled by agriculture. The government is responsible for protecting the land [136]. Nothing has changed despite advances in science and technology. There is no shortage of green technologies. Farmers need to reduce the time they spend working and increase the precision they use their resources. Complex statistical methodologies are used by agriculturalists when analyzing historical data and making economic predictions. Farm yields are improved via GPS, sensors, and big data. Real-time data from ICT-based decision support systems can take the role of farmers’ knowledge and intuition [137]. Improved decision-making reduces the amount of waste and increases efficiency. Images, GPS, science-based solutions, climate forecasts, technology, and environmental controls play a role in agriculture. As with the terms “smart meters” and “smart cities,” “smart farming” refers to any M2M application. Technology advances to aid in harvest forecasting. However, predictions based on statistics are not always accurate. Harvest data and the agricultural environment should be correlated. IoT will provide agricultural data. Complex statistical methodologies are used by agriculturalists when analyzing historical data and making economic predictions. Predicting crop yields is aided by the use of smart systems. In the end, statistical forecasts are not perfect; they are only a starting point. Make a connection between the agricultural environment and harvest data. Crop pattern data will be provided through IoT-based decision support. On IoT, agribusiness utilizes data mining, statistical forecasting, and IoT services [138].

(9) T-10.9: Industry 4.0 in Agriculture. Global agriculture must undergo a paradigm shift in light of evolving environmental conditions, dietary preferences, and a scarcity of critical inputs. It is all about the latest advancements in agriculture. As a result of the adoption of Industry 4.0, businesses may expect to see advances in output, efficiency, and creativity. First, agriculture provides food for the world’s population. Second, agriculture 4.0 decreases labor and environmental effects to increase agricultural profitability by reducing greenhouse gas emissions and water use. Third, agriculture is the primary source of income for half of India’s population, India’s veins and arteries [139]. The fourth stage of industrial development is large-scale agriculture. Among the essential ICTs is the IoT. Flexibility is improved in “smart factories.” People, equipment, and software work together to satisfy production demands, which are met through cutting-edge technology such as CPS/IoT/iOS and real-time interaction. The industry benefits from consolidation. However, future manufacturing and commerce will be harmed. This shift is made possible due to the Internet and information technology [140]. Quality control encompasses all aspects of engineering, management, manufacturing, operations, and logistics. Costs, availability, use of resources, and market demand may all be automated. The implementation of Industry 4.0 will profoundly impact the agriculture and industrial sectors. All technologies like Big Data, AI, and IoT are part of Industry 4.0. IoT allows agricultural systems
and equipment to connect with one another, making Industry 4.0 a game changer in agriculture [141]. The fourth industrial revolution created networked tractors, farms, and manufacturing equipment [142]. "Industry Revolutions 4.0" refers to three factors:

1. Digitalization and its integration into simple economical and technical networks
2. Digitalization of services and products
3. Market models that have been updated

As economic, economic and business models develop, humans become more distant from the center of production and surveillance of crops. Industry 4.0 is being used by both developed and developing countries. India has a lot of untapped potential for agricultural growth. Robotics, IoT, and e-business are the three pillars of this revolution, aiming to deliver technology to every corner of the globe.

(10) T-10.10: Image-Based Classification Techniques in Intelligent Agriculture. Agriculture originated thirteen thousand years ago between the Tigris and Euphrates rivers north of Iraq. Gathered vegetation included wild wheat and others. Few people needed food. UN estimates that the world’s population will reach 10 billion by 2050, impacting farmers. Desertification and urbanization wreak havoc on farmland. COVID-19 is a threat to food security and the nation’s economy. To solve this problem, we need to use fewer people to generate more food [143]. In certain parts of India, rainfall is the only irrigation water supply. However, crop destruction can occur in some places due to unpredictability in rainfall, which is a problem. Management of watersheds is critical. Many-variable hydrological modeling is required to predict rainfall and runoff in different basins accurately. Estimates of imperviousness necessitate a terrain categorization, which ultimately categorizes land use and cover [144]. The image classification curve number is used in modeling. Satellite pictures are difficult to classify because of their high resolution and wide range of applications.

Nevertheless, images are a common practice in agriculture and water management. There are a plethora of tools and methods for classifying images. ANN and SVM are used for image classification [145]. Techniques used to organize pictures traditionally are time-consuming and prone to human error. With pattern recognition, alternate ways can reduce time and enhance accuracy. Unlike Bayes’ discriminant criteria, SVM multiclassification outperforms.

8. Threats to Validity

This analysis is based on LDA topic modeling and has bounded to the limitations of this topic modeling technique. A sufficient article count has been achieved, yet the risk of missing out is a concern. The bibliographic material has also been inferred. The search string insufficiency has been eradicated appropriately due to the limitations of selected search terms, synonyms, string formulation, and search engines’ variedness resulting in imperfect retrieval of literature corpus. Labeling topics is a significant concern due to subjectivity and bias. According to the author, a deep discussion has been conducted to determine the label best to overcome this limitation. Then, based on critical terms, labels have been formulated to draw the best topic labels for researchers and practitioners.

9. Conclusion

Using IoT technology, farmers and producers may better manage their resources, such as fertilizer consumption and the number of trips made by farm vehicles, while minimizing waste and maximizing productivity, including water, electricity, and other inputs. In IoT smart farming systems, sensors monitor the agricultural field and automate the irrigation system. Farmers can monitor their fields from anywhere. This paper concluded the research direction in smart agriculture and farming. Technology has shaped agriculture’s history. Historians have identified several agricultural revolutions that changed practice and output. Technological advances have fueled these revolutions. The Industrial Revolution mechanized agriculture, improving farm labor productivity.

Modern mechanized agriculture has replaced numerous farm activities by hand or by oxen, horses, and mules. Weather forecasting and barbed wire were 19th-century advances. Portable engines and threshing machines became popular after improvements. In the 20th-century, synthetic fertilizers and insecticides, mass-produced tractors, and agricultural aircraft for aerial pesticide application were developed. Precision farming, disease monitoring, agricultural drones, satellite imagery, and sensors are just ways technology makes farming easier for farmers. Intelligent software analysis for pest and disease prediction and soil management are only a few of the many analytical activities that IoT-based sensor networks may do. New issues in smart farming include the security of the farming data, technical failures, and technical incompetence.

10. Future Work

The LDA model works like a recommender system. The current research is based on extracting keywords from the documents and recommends current and trending research areas based on the correlation of the keywords in the specified field. So, in the real-time scenario, any corpus of any size can be passed to the model to get the relevant keywords, and based on these keywords, suggestions for topics can be depicted. The authors have used this model on smart agriculture in the current research. In contrast, this model can also be implemented in other research fields like smart cities, blockchain, and Wireless Sensor Networks. In this study, the authors analyzed data retrieved from the Scopus database instead of Web of Science, Education Resources Information Center, ScienceDirect, or the Directory of Open Access Journals. However, the authors chose the Scopus database over these other databases because Scopus has more excellent
coverage of publications, demonstrating that it is a comprehensive and dependable data source and so justifying its eligibility for this review.

Data Availability

Data are available upon request from the corresponding author.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

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