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An Extensive Survey on the Recent Applications of IoT in Rice Farming

Melanie M. Reynoso [1], El Jireh P. Bibangco[2], Cristina E. Dumdumaya[3]

[1]Carlos Hilado Memorial State University (Alijis Campus), Bacolod City, Philippines
melanie.reynoso@chmsu.edu.ph
[2]STI West Negros University, Bacolod City, Philippines
eljireh.bibangco@wnu.sti.edu.ph
[3]University of Southeastern Philippines, Davao City, Philippines
cedumdumaya@usep.edu.ph

Abstract

Recent studies reveal that adopting the Internet of Things (IoT) in agriculture improves efficiency and decreases costs, especially when partnered with big data and advanced analytics technologies. With the growing number of studies that utilized IoT-based technologies in rice farming, this study pursues two objectives: To perform a meta-analysis of developmental studies on IoT adoption in rice farming and identify the current applications of IoT in rice farming. As such, 49 papers were collected, examined, and synthesized. The findings revealed that most existing studies focused on the activities under the Growth Stage of rice farming, while limited studies were conducted for the Pre-Planting and Postproduction Stages. In addition, recent research on rice farming used IoT mainly in rice field management, smart irrigation, and disease detection. Furthermore, the technologies introduced in existing studies mostly used sensor/actuator networks or artificial intelligence models. However, there are several unexplored areas in this research domain: Firstly, six rice production activities remained unexplored, and secondly, seven enabling technologies are yet to be used in rice farming. Regardless, IoT-based solutions are undeniably helpful in rice farming, especially in achieving sustainability and food security.

Keywords: agriculture, applications, Internet of Things, meta-

analysis, rice farming

Introduction

Rice is a vital food product since it has been an essential sustenance for many people globally. From 1961 until 2010, rice production significantly increased worldwide, with a growth percentage of 2.24% annually [1]. However, ever since the global population growth surpassed the rice yield growth in the 90s, the gap between them has steadily increased. Eventually, this gap created a significant disparity between rice demand and supply. Even worse, the annual growth rates of rice yields are slowing due to numerous factors, including environmental problems, resource scarcity, and shrinking arable land [2]. In fact, between 2012 and 2020, global rice production's growth rate slowed by 0.96% annually [3]. As a result, the imbalance between rice supply and demand increased further and is forecasted to worsen in the next 25 years. According to the Food and Agricultural Policy Research Institute, to achieve food security, the world should increase rice production by at least 1.2% per year, stabilizing world market prices at reasonable rates for consumers [4]. One way to improve the global rice output is by adopting cross-industry technologies, especially those introduced during the fourth agricultural revolution [5].

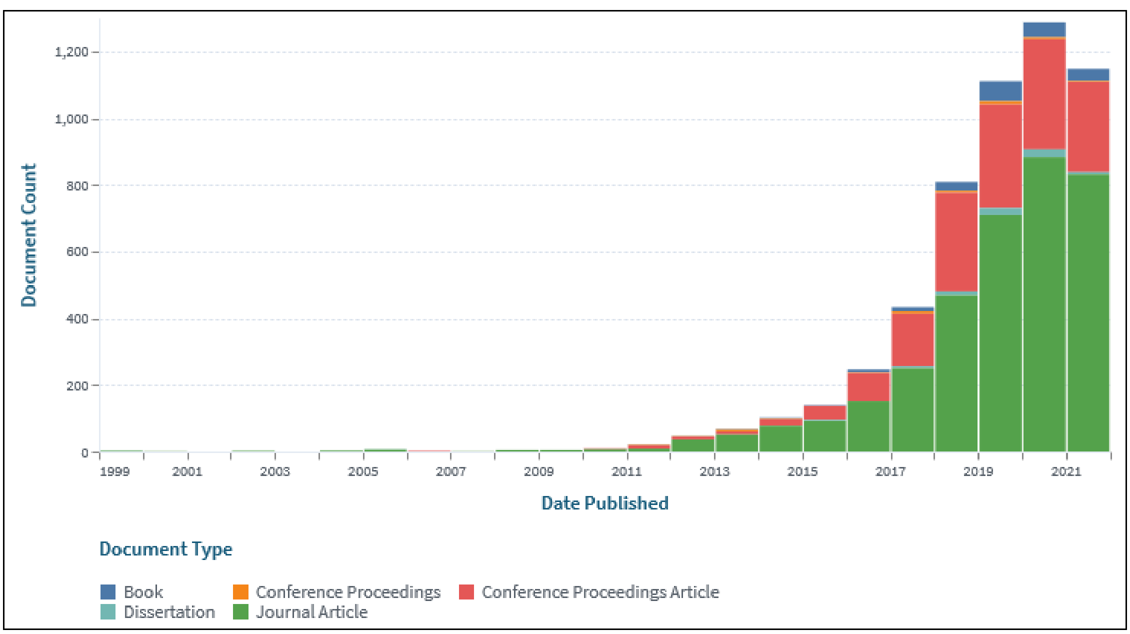

Figure 1. The trends of scholarly works on IoT in Agriculture over time.

Technological adoption is common in agriculture; however, the utilization of emergent technologies in agriculture remains limited despite their proven capacity to improve operational efficiency and productivity [6]. One is the Internet of Things (IoT), an emerging paradigm between electronic devices and sensors that enables communication through the Internet to solve sector-specific problems [7]. The concept of IoT has attracted considerable attention from scholars and engineers, evidenced by the increasing related scholarly works, as shown in Figure 1 [8].

Pioneers in this area reported that the utilization of IoT in agriculture has significantly decreased the necessary resources and costs in farming. At the same time, data-driven operations through big data and advanced analytics have significantly improved decision-making. These benefits have attracted more agriculture experts to explore the potential of IoT in improving agricultural processes and assisting farmers in their labor-intensive tasks. At the end of 2021, the global research communities collectively published more than five thousand scholarly works on the adoption of IoT in agriculture, with 10% focusing on rice agriculture [2]. Some of these scholarly works used IoT to assist rice farmers in resource management [9-11] and rice plant development [12, 13], while others used IoT for real-time monitoring of rice plant health [14-16] and pest control activities [17, 18].

Inspired by the growing number of studies that utilized IoT in rice farming, this paper formulated two main objectives: To perform a meta-analysis of developmental studies that utilized IoT in rice farming and to identify the recent applications of IoT in rice farming, including the commonly used enabling technologies. Specifically, this study intends to address the following questions:

1. What are the current applications of IoT in rice farming?
2. What are the enabling technologies used in IoT solutions applied in rice farming?
3. What are the unexplored research areas on IoT utilization in rice farming?

Related Studies

Previously, it was mentioned that an upward trend was observed in terms of scholarly works on the application of IoT in agriculture.

With this increasing number of studies, it is necessary to synthesize existing in this research area, evidenced by the increasing number of review studies on IoT as applied in agriculture (see Figure 2). In fact, the global research communities have already published more than a thousand review studies in this research area since 1999 [9].

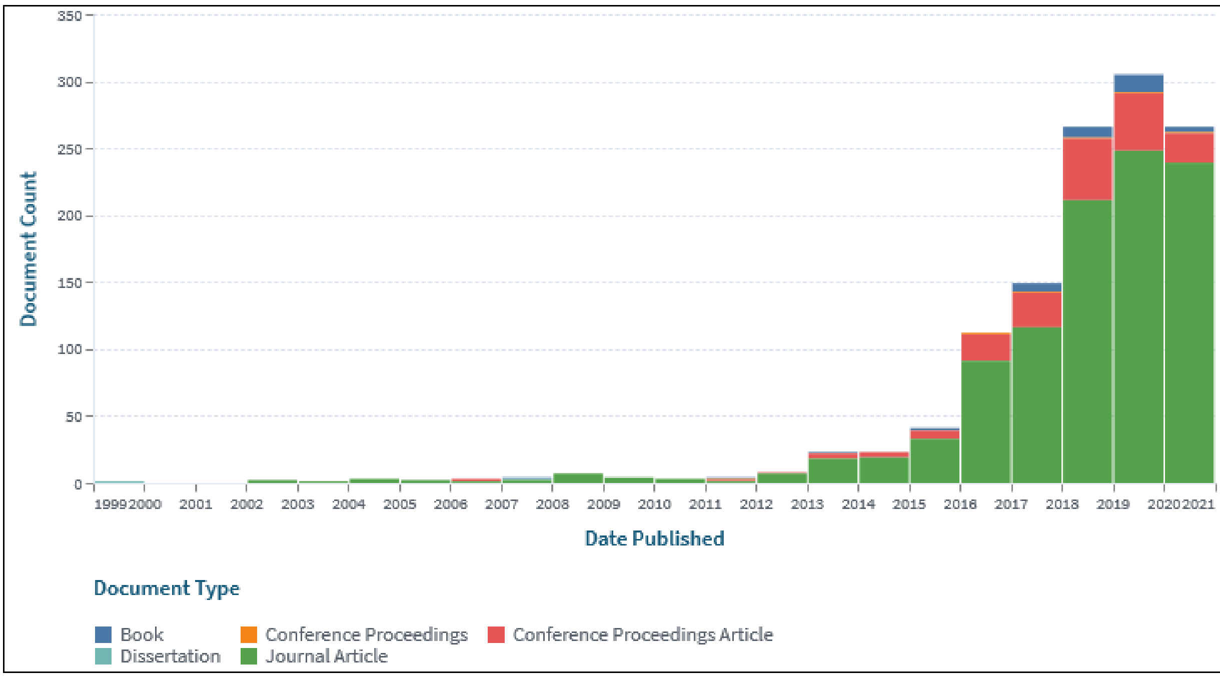

Figure 2. The inclinations of review studies over time relevant to IoT in agriculture.

However, only a few review studies focused on IoT adoption in rice farming. Specifically, only three review studies have been published since 1999 that synthesized the scholarly works that used IoT in rice farming (see Table 1).

Table 1: Summary of Related Studies

Study	Title	Objective
[19]	Towards Paddy Rice Smart Farming: A Review on Big Data, Machine Learning, and Rice Produce Tasks	This study reviews the recent studies on intelligent data-driven technology utilized in rice production and offers a framework that configures the activities demarcated in rice farming.
[20]	A Review of Detection of Pest Problem in Rice Farming by Using Blockchain and IoT Technologies	Reviews papers on pest detection systems that employ Blockchain and IoT technologies.

[21]	Rice Disease Prevention Using IoT – A Review	This presents the recent papers proposing IoT-based techniques for preventing rice disease, identifying well-known rice diseases and their solutions.

Alfred et al. [19] gauged the research on innovation in rice farming and found that efficient integration of big data, machine learning, and IoT is crucial in transforming rice cultivation practices; however, they focused mainly on big data and machine learning. Although they mentioned IoT, the only valuable related result is the list of sensors used in the study. In addition, this paper failed to present its review protocol. In contrast, Hidayat and Mahardiko [20] and Arun et al. [21] have clear review protocols; however, they covered only some activities in rice farming. Specifically, Hidayat and Mahadiko focused on pest detection studies in rice fields, while Arun et al. concentrated on rice disease prevention. Thus, a study with a well-defined review protocol is needed to summarize the IoT adoption in every stage of rice farming.

Rice Farming

As shown in Table 2, rice farming involves pre-planting, growth, and postproduction stages [22]. The pre-planting stage includes the selection of the appropriate variation, the development of a cropping chart, and the concoction of the rice field. The growth stage ruminates various factors relevant to management, such as planting systems, water, weeds, pests, and diseases. The postproduction stage includes harvesting, drying, storage, milling, and distribution [23].

Table 2: Activities for Each Rice Production Phase

Phase	Activity	Description/Specific Tasks
PRE-PLANTING	Rice Variety & Seed Selection	Includes selecting a locally adapted variety and choosing seeds to get a good crop with a high harvest potential and a firm market price.
	Planning & Scheduling	Includes the planning for input purchase and utilization. It also involves developing the cash flow budget needed for the year, identifying the need for credit and period prerequisites, labor requirements, planning for peak usage periods, and forming contractors for the preparation of land and harvesting.

	Rice Field Preparation	This includes plowing to "till" or digging up, mixing, overturning the soil, harrowing to break the soil clods into smaller masses, incorporating plant residue, and leveling the field.
GROWTH	Planting	The rice crops can either be direct-seeded or transplanted.
	Soil Health Management	Applying nutrients to the crop so the plants usually develop.
	Water Resource Management	Includes continuous flooding, which ensures sufficient water for the rice plants.
	Weeds, Pests, & Diseases Control	Controlling and solving crop problems related to weeds, pests, or diseases.
POSTPRODUCTION	Harvesting	This involves the collection of mature rice crops from the field.
	Drying & Storage	This involves a drying process that reduces the grain moisture content to a safe level for storage. The Storage facilities offer a safe storage environment for the grain to prevent grain loss.
	Milling & Distribution	This includes the removal of the husk and the bran layers, which produces a comestible, white rice kernel that is adequately milled and free of contaminations, and distributing milled rice to the consumers.

IoT-Enabling Technologies

IoT enables technological advancements that sustain the specific networking functionality required in the system [24]. However, the scientific community needs an official list of IoT-enabling technologies; thus, the researchers reviewed the generalized open IoT research topics to identify the latest enabling technologies. As a result, 26 enabling technologies were identified, of which only 15 were judged relevant to IoT adoption in agriculture: 5G Networks; Adaptive Systems and Models at Runtime; Artificial Intelligence; Cloud Computing and Web Services; Data Management, Mining, and Analytics; Distributed Storage and Data Fusion; Edge and Fog Computing; Internet of Nano Things; Security and Trust; Machine-to-Machine Communications; Resource Management and Access Control; Sensors and Actuators Networks; Ultra-Low-Power Technology and Embedded Systems; Wearables and Smart Portable Devices; and Web of Things.

Materials and Methods

This study employed a meta-analysis of the scholarly works on IoT adoption in rice farming. Figure 3 illustrates the review protocol of this study, which is a modified version of the guidelines introduced by Kitchenham and Charters [25]. This modified review protocol comprises five phases: planning, searching, filtering, synthesis, and reporting.

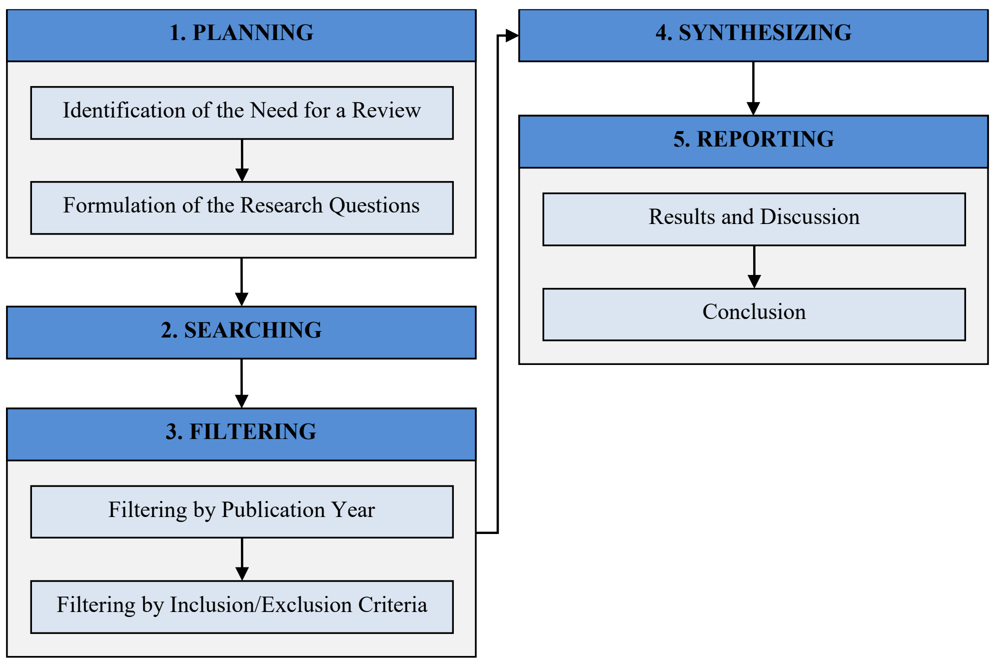

Figure 3. Review Protocol.

Planning

This phase has two main activities: identifying the need for a review and formulating the research questions, as shown in Figure 3. The researchers discussed the impetus for conducting the review stated in the introductory section, which is expanded in the related studies section. The initial analysis showed limited review studies on IoT adoption in rice farming. In addition, there is a need to identify the applications of IoT in every stage of rice farming and the most common IoT-enabling technologies. Thus, this study grounded its objectives on these necessities. On the other hand, the research questions were conveyed according to these objectives.

Searching

The search process aims to extract and accumulate relevant studies and literature. This study used Google Scholar and Lens.org as search tools. This stage involves the following undertakings: First, identify the terms reflected in the research questions. Second, list all the key terms substitutes. Third, combine search terms with Boolean AND/OR operators. As a result, the following search terms were formulated: (IoT OR Internet of Things) AND Rice AND (Farming OR Agriculture); Enabling Technology AND (IoT OR Internet of Things) AND in Rice (Farming OR Agriculture). After conducting the search process, the researchers collected 578 papers.

Filtering

The papers collected previously underwent a two-step filtering process to determine the final papers for analysis. This process is illustrated in Figure 4, including the number of papers retained and excluded during each step.

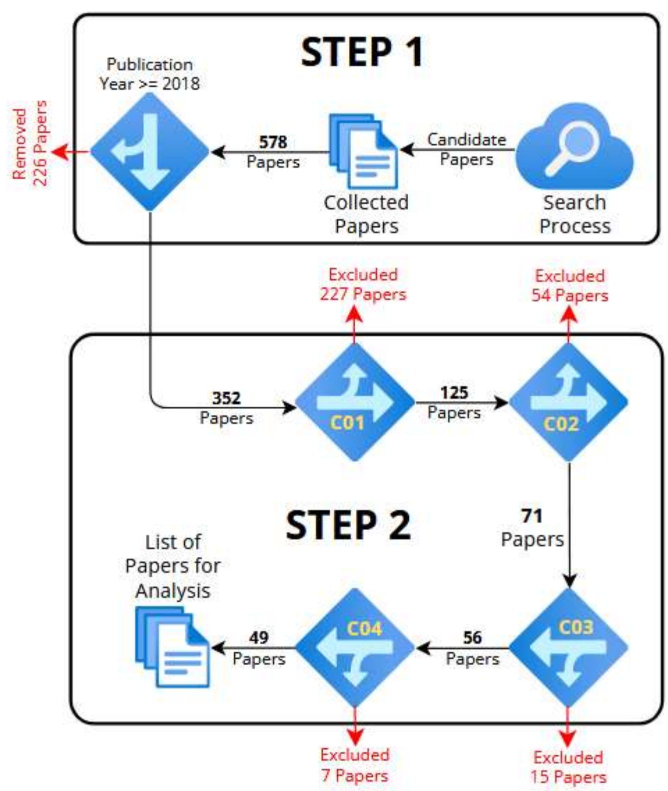

Figure 4. Two-Step Filtering Process.

In the first step, the researchers removed 226 papers published before 2018, reducing the list to 352. The second step filtered the remaining papers using the inclusion/exclusion criteria in Table 3. Using C01, the researchers removed 227 papers focusing on general crops besides rice. Using C02, the researchers removed 54 theoretical or non-developmental studies. Using C03 and C04, the researchers removed another 22 gray studies (e.g., nonpeer-reviewed studies, work in progress, or lacking bibliographic details) and non-English papers. As a result, 49 papers were retained for analysis, as described in [26].

Table 3: Inclusion and Exclusion Criteria.

ID	Inclusion Criteria	Exclusion Criteria
C01	Papers relevant to the questions based on their title, keywords, and abstract.	Papers that are not related to any of the defined research questions.
C02	Papers that proposed a technology, system, application, or at least a prototype of an IT product.	Papers that are not developmental and do not introduce an IT product, system, or application.
C03	Papers that are peer-reviewed.	Papers that are not peer-reviewed or published by questionable journals.
C04	Papers that are written in English.	Papers that are not written in English.

Among the selected 49 papers, five were published in 2018, 11 in 2019, 13 in 2020, 18 in 2021, and two in 2022 (see Table 4).

Table 4: Distribution of Primary Studies Per Year.

Year	Count (%)
2018	5 (10%)
2019	11 (22%)
2020	13 (27%)
2021	18 (37%)
2022	2 (4%)
TOTAL	47 (100%)

Synthesis

This stage includes extracting and classifying relevant data from quantified studies to achieve the main goal [27]. Using MS Excel, the researchers mapped each paper to rice farming activities. The result was used to address the first research question. In cases where a paper is mappable to two (or more) activities, encoding was made twice (or as needed). The researchers mapped each study to one of the pre-identified IoT-enabling technologies to address the second research question. When a study used two (or more) enabling technologies, only the core (or most crucial) technology was recorded to ensure a one-to-one mapping. To address the last research question, the researchers listed the rice farming activities and enabling technologies that were not mapped to any of the 49 papers.

Results and Discussions

Recent Applications of IoT in Rice Farming

The results show that most studies on IoT adoption in rice farming are applied during the Growth Phase, as shown in Table 5. Specifically, numerous studies focus on rice field monitoring, smart irrigation systems, and disease detection. None of the 49 studies were mapped to any Pre-Planting activities. On the other hand, only one study has been mapped to the postproduction stage, while 36 studies concentrated on the Growth Phase activities. Interestingly, some studies are not mappable to any rice farming activities; thus, to ensure that each study is mapped to at least one activity, the researchers added Farm Management, IoT Device Resource Management, and Data Security.

Planting. Three recent IoT adoptions assisted rice farmers in their planting activities. First is an intelligent system that raises rice seedlings inside a greenhouse. Feng et al. [12] verified that the intelligent system is feasible and effective in maintaining a greenhouse environment suitable for rice growth. Next is a germination system for rice plants, designed to help rice plants grow in cold regions [13]. Last is a monitoring system that uses a sensor network to gather environmental variables such as soil moisture, air humidity, light intensity, and temperature [28, 29].

Table 5. Recent Applications of IoT in Rice Farming.

Stage	Activity	Recent Applications
Pre-Planting	Rice Variety & Seed Selection	None
	Planning & Scheduling	None
	Rice Field Preparation	None
Growth	Planting	**Intelligent Raising System for Rice Seedlings** [12] **Rice Germination System** [13], and **Rice Plant Development Monitoring System** [28], [29]

	Soil Health Management	**Soil Condition Monitoring System** [30], [31], [32] **Soil Fertility Monitoring System** [33]
	Water Resource Management	**Smart Irrigation Systems**: Intelligent controlled water pump [33], technology adaption [34], prototype [35], [36], irrigation control system [37], [38], [39], and AI-based system [40], [41] **Alternate Wetting and Drying Irrigation System** [42] **Water-level Monitoring System** [30], [43] **Automatic Pumping System** [44] **Water-Saving Irrigation System** [58]
	Weeds Management	None
	Pests & Diseases Control	**Rice Disease Diagnosis and Detection** [15], [16], [45], [49]: rice blast detection [14], [48], bacterial leaf blight detection [46], [50], brown spot detection [46], [47], [48], [50], rice false smut detection [46], early and real-time disease detection system using UAVs [49], [51], [66] **Rice Disease Prediction** [32], [45], [49], [52] **Rice Disease Classification** [46] **Pest Detection**: pest detection using UAVs [11], rice hispa detection [48] **Pest Trap:** Rice Black Bug Trapping System [18]
Postproductio n	Harvesting	None
	Drying & Storage	None
	Milling & Distribution	**Rice Logistic Monitoring System** [53]
Others	Rice Farm Management	**Rice Management Expansion** [9] **Monitoring & Controlling**: resource monitoring [10], [44], [55], mobile-based monitoring application [54], rice field management [17], productivity monitoring [56], AI-based monitoring system [57], real-time monitoring system [29], [58], [59] Farm Advisory System [56] **Weather Condition Monitoring** [31], [32], [36] **Greenhouse Gasses Detection** [60], [61]
	IoT Device Resource Management	**Low Delay Data Gathering Method** [62] **Low Power Consumption Communication Method** [63] **Low-Cost Aggregated Data Communication Method** [64]
	Data Security	**Blockchain Authentication** [65]

Soil Health Management. IoT has two recent applications in soil health management for rice farming. The first application is a soil condition monitoring system using sensors [30, 31] or chemical tests [32]. The second application is a soil fertility monitoring system using sensors [33].

Water Resource Management. Fourteen studies were mapped to this activity, grouped into five applications. The most common application of IoT is smart irrigation. Some studies designed mechanisms to control irrigation [37-39], while others proposed intelligent systems using AI [40, 41]. Also, IoT has been applied to substitute wetting and drying, a water-saving innovation that is applied to rice fields without decreasing their yields [42]. Moreover, IoT has been used to monitor water levels [30, 43], implement an automatic water pumping system [44], and design a water-saving irrigation system [58].

Pests & Diseases Control. A wide range of studies has focused on rice disease control, including diagnosis [15], detection [16], prediction [32], and classification [46] of diseases. Table 6 shows the most selected rice diseases in the selected papers. Furthermore, some studies used drones for real-time disease detection of diseases [49, 51, 66]. In the case of pest control, IoT has been used in pest detection [11] and pest trapping systems [18].

Table 6. Commonly Selected Rice Diseases in Scholarly Works.

Rice Disease	Description	Study
Rice Blast	This is instigated by a fungus that causes lesions on a rice plant's leaves, stems, peduncles, seeds, or roots.	[14], [48]
Bacterial Blight	This is deadly bacteria that causes disease; This is also among the most dangerous diseases in cultivated rice.	[46], [50]
Brown Spots	Caused by the fungus Cochliobolus miyabeanus; infects the coleoptile, leaves, lead sheath, glumes, etc.	[46], [47], [48], [50]
False Smut	Caused by a fungus that colonizes rice grains and converts them into a ball of fungal growth on the outer layer.	[46]

Milling & Distribution. Only one recent application of IoT was mapped to this activity: the rice logistic monitoring system [53]. This system monitors rice logistics, controls rice availability and distribution, and provides relevant information to the stakeholders.

Rice Farm or Rice Field Management. The recent applications of IoT in this activity are rice management expansion, monitoring and controlling, farm advisory system, weather condition monitoring, and greenhouse gas detection. Regarding rice management expansion, IoT has been recently used to develop scales for rice management, including manpower resources, water, and cultivated land [9]. On the other hand, IoT has many applications in monitoring and controlling, such as resource monitoring [10, 44, 55] and rice field management [17]. More advanced applications include AI-based monitoring systems [57] and real-time monitoring systems using sensor networks [29] and drones [58, 59]. In addition, the advisory system mentioned above was developed to assist in paddy productivity monitoring [56]. In contrast, weather condition monitoring systems use either a sensor network or a web service to determine the current state or predict the future state of the weather [31, 32, 36]. Finally, the greenhouse gas detection systems assist in detecting nitrous oxide [60] and methane [61] emitted from paddy rice.

IoT Device Resource Management. Three studies belong to this added category. The first study [62] introduced a fast data-gathering method to improve the communication capability of the sensor network in rice fields. The second study [63] worked on a low-power consumption communication method to address the battery problems of sensor nodes. Finally, the third study [64] proposed a low-cost aggregated data communication method to ensure rice farmers afford the proposed system.

Data Security. Only one study focused on data security for IoT-based applications in rice farming. In this study [65], the researchers proposed a blockchain-based authentication to address the issue of non-repudiation attacks in IoT and prevent fake nodes in the sensor network.

Most Common Enabling Technologies

The results show that only eight of 15 identified IoT-enabling technologies were used in the selected studies, as shown in Table 7. Specifically, sensor/actuator networks ranked first in study count, followed by artificial intelligence. This result implies that IoT-based solutions in rice farming commonly used sensor networks or AI models.

Table 7. Commonly Selected Rice Diseases in Scholarly Works

Enabling Technology	Study Count	Percentage
5G Networks	0	0%
Adaptive Systems and Models at Runtime	1	2%
Artificial Intelligence	16	33%
Cloud Computing and Web Services	3	6%
Data Management, Data Mining, and Analytics	5	10%
Distributed Storage and Data Fusion	0	0%
Edge and Fog Computing	1	2%
Internet of Nano Things	0	0%
Security and Trust	2	4%
Machine-to-Machine Communications	0	0%
Personal Data Protection	0	0%
Sensor/Actuator Networks	19	39%
Ultra-Low-Power Technology and Embedded Systems	2	4%
Wearables and Smart Portable Devices	0	0%
Web of Things and Web of Everything	0	0%
Total	**49**	**100%**

Adaptive Systems and Models at Runtime. The performance of these systems is modified at runtime, which eventually reacts to changes within the execution environment. In the papers gathered in this study, only the study developed by Le and He [58] substantiated the category, such as the remote and actual-time monitoring and management system developed with an automated irrigation component. The irrigation component responds to the environment, particularly to the water level and the inception established by the water level sensor.

Artificial Intelligence. An AI-enabled IoT generally produces intelligent machines with similar intelligent behavior and supports automated decision-making. In this study, 16 of the selected papers employed AI, and most focused on image processing, such as in rice plant disease detection [49] and classification [46]. Some of the selected studies used deep learning algorithms [57], neural networks [59], and Fuzzy Logic [40, 60], while few of them introduced a new model or architecture [15, 49].

Cloud Computing and Web Services. Since cloud computing enables the completion of computing tasks using web services, it became a powerful IoT partner, which allows the processing of sensory data streams and new monitoring services. Only three of the selected papers employed this enabling technology. For instance, Donzia et al. [9] present a construction for IoT agrarian services grounded on cloud sensor structure, presenting potentialities in Central Africa. Meanwhile, Mya et al. [36] innovated a structure that collects data from IoT devices and stores data from cloud servers, showing its importance in the overall design. Indeed, as reported by Charoenporn [55], web service is the best way to implement an IoT rice system because it supports the relationship between communication protocols over the network.

Data Management, Data Mining, and Analytics. Big data is often coupled with IoT, especially when devices collect a substantial expanse of data that usual spreadsheets could no longer process. In this case, knowledge of data management is critical, while data mining techniques and analytics are necessary to process big data and extract knowledge or insight from them. Only five of the selected papers used this enabling technology. For instance, Xeng et al. [12] used advanced analytics techniques to predict actuators' operation duration. Similarly, Maneesha et al. [32] used advanced analytics techniques on soil and weather data to predict rice plant diseases. Interestingly, most of the analytics techniques used in the selected papers are predictive, while descriptive and prescriptive techniques were only partially utilized.

Edge and Fog Computing. Edge computing is a distributed computing framework that processes data close to the edge. On the other hand, fog computing places data processing between the data source and the cloud. Only [48] used this enabling technology through an IoT-based system with edge intelligence to detect rice plant diseases.

Security and Trust. IoT systems are vulnerable to malicious attacks, especially since they follow a distributed architecture where nodes can be removed or added dynamically. In this study, two of the selected papers used this enabling technology. The first study [65] implemented authenticated blockchain nodes using machine learning techniques. On the other hand, the second study [69] used security-enabled UAVs for rice field monitoring using the FIBOR architecture. Although there are only two studies under this category, numerous quality studies on IoT security apply to agriculture, specifically rice farming.

Sensors and Actuators Networks. Generally, sensors detect and respond to environmental changes, while actuators are mechanisms for turning energy into motion. A sensor/actuator network is a group of sensors that gather information about their environment and actuators that interact with them. In this study, 19 of the selected studies employed this IoT-enabling technology, most of which were used in a smart irrigation system [37, 38], resource monitoring [30], and weather condition monitoring [31, 32].

Ultra-Low-Power Technology. Since most IoT devices need a battery, it is essential to consider a connection between the embedded system’s power requirements and the energy generated by the systems. Therefore, it is significant to develop methods that decrease power consumption without compromising the entire performance of the system. Two selected papers introduced methods for a more efficient consumption supply of IoT schemes in this study. For instance, [62] proposed a low-delay data-gathering method for outdoor communication, which lowers power consumption. Similarly, [63] proposed a method of IoT communication that collects data in the shortest period to achieve the network's total capacity and provides data at the user’s desired time.

Unexplored Research Areas in the Application of IoT in Rice Farming

There are two perspectives in viewing the unexplored research area in this subject matter: Rice Production Activities and IoT Enabling Technologies. Based on the results in Table 5, there are six activities without a corresponding study: rice variety and seed selection, planning and scheduling, rice field preparation, weeds management, harvesting, and drying & storage. These six activities are blue oceans for researchers who wish to contribute to this research area. On the other hand, the number of studies in planting, soil health management, and milling & distribution is few; thus, additional work is needed to explore IoT's potential in rice farming.

Based on the results in Table 7, seven enabling technologies are yet to be used in rice farming: 5G technology, distributed storage & data fusion, Internet of nano things, machine-to-machine communications, wearable & smart portable devices, personal data protection, and web of things. This result points to two directions: Creating a new technology or improving the existing ones. Either way, these technologies are helpful to rice farmers. In addition, the number of studies on other technologies besides AI and sensor/actuator networks still needs to be increased.

Conclusions

This study pursues two objectives: to perform a meta-analysis of developmental studies on IoT applications in rice farming and identify the advancements in rice farming using IoT, including the commonly used enabling technologies. The following are the key findings of the study: First, most scholarly works on IoT applications in rice farming are focused on the activities of the Growth Phase. In contrast, limited studies were published focusing on the Pre-Planting and Postproduction Phases. Second, IoT is mainly used in rice field management, smart irrigation, and disease detection. Third, sensor/actuator networks and artificial intelligence are the most used enabling technologies in this research area. However, there are several unexplored areas that scholars should consider. Specifically, six rice production activities are yet to adopt IoT, and seven enabling technologies are yet to be used in rice farming.

This study has two main limitations: First, it should include the issues and challenges scholars and farmers face in employing IoT in rice farming. Second, the results should discuss each selected scholarly work to provide readers with clearer information about them. However, despite these limitations, the knowledge presented in this paper is valuable, especially when considered as a basis for other researchers who wish to explore this research area. Nevertheless, the researchers will expand this work in the future by adequately addressing the two limitations mentioned above.

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Melanie M. Reynoso completed her Bachelor of Science in Computer Science and Master in Information Technology from the University of Negros Occidental - Recoletos. She is a candidate for a Doctor in Information Technology from the University of Southeastern Philippines. She currently teaches undergraduate classes in the College of Computer Studies at Carlos Hilado Memorial State University (Alijis Campus), Philippines, where she is also the Program Chairperson and one of the Internal Auditors.

El Jireh P. Bibangco received his B.S. and M.S. degrees in computer science from the University of Negros Occidental-Recoletos in 2009 and 2014, respectively. He also earned 21 master's units in information technology from the University of the Philippines Los Baños. From 2009 to 2020, he was a Lecturer at the University of Negros Occidental-Recoletos, Bacolod City, Philippines. He is currently the Computer Science Program Head and Research Associate at STI West Negros University. His research focused on artificial intelligence, machine learning, emergent technologies, systems development, and user experience.

He serves as research reviewer for the Future Convergence Technology Research Society in South Korea.

Cristina E. Dumdumaya