Turkish Journal of Agriculture - Food Science and Technology, 10(6): 1066-1071, 2022
DOI: https://doi.org/10.24925/turjaf.v10i6.1066-1071.4993

Turkish Journal of Agriculture - Food Science and Technology

Available online, ISSN: 2148-127X | www.agrifoodscience.com | Turkish Science and Technology Publishing (TURSTEP)

Cloud Systems Used in Smart Agriculture, the Internet of Things and Uses of Other Technologies and a Smart Agriculture Architectural Proposal

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ARTICLE INFO

Research Article

Received : 22/12/2021
Accepted : 31/05/2022

Keywords:
Decision support systems
Management information systems
Smart agriculture
Cloud computing
Internet of things

ABSTRACT

Agriculture has been important all over the world since the first days of humanity. The development of agriculture is proportional to the development of humanity. Today, people have reached the point they have reached in technology with agriculture. Today, the use of technology with different topics is effective in ensuring the development of agriculture. The concept of smart agriculture was born from here. The hardware and software used today provide convenience to manufacturers, production increases and businesses gain more profit. For this purpose, cloud systems, internet of things, artificial intelligence applications and many other technologies are used. In this study, it is focused on designing applications that can be used in smart agriculture in the light of current technologies, especially cloud systems and internet of things for producers. In addition, studies on smart agriculture in the literature were analysed by using the document analysis method. It has been determined that the studies on smart agriculture in the literature are similar. According to the research findings, applications related to smart agriculture aim to enable producers to obtain products with less cost. It can be suggested that manufacturers and experts working in the field of informatics work together to achieve this.

Türk Tarım – Gıda Bilim ve Teknoloji Dergisi, 10(6): 1066-1071, 2022

Akıllı Tarımda Kullanılan Bulut Sistemler, Nesnelerin İnterneti ve Diğer Teknolojilerin Kullanımları ve Bir Akıllı Tarım Mimari Önerisi

MAKALE BİLGİSİ

Araştırma Makalesi

Geliş : 22/12/2021
Kabul : 31/05/2022

Anahtar Kelimeler:
Karar Destek Sistemleri
Yönetim Bilişim Sistemleri
Akıllı Tarım
Bulut Bilişim
Nesnelerin İnterneti

ÖZ

İnsanlığın ilk günlerinden bu yana tarım tüm dünyada öneme sahiptir. İnsanlığın gelişimi ile birlikte tarımın gelişimi de orantılıdır. Bugün insanlar teknolojide geldikleri noktaya tarım ile birlikte gelmiştir. Tarımın gelişiminin sağlanmasında teknolojinin farklı konu başlıkları ile günümüzde kullanılması etkin olmaktadır. Akıllı tarım kavramı da buradan doğmuştur. Bugün kullanılan donanım ve yazılımlar beraberinde üreticilere kolaylıklar sağlamakta, üretim artmakta ve işletmeler daha çok kazanç elde etmektedir. Bu amaçla bulut sistemler, nesnelerin interneti, yapay zekâ uygulamaları ve daha birçok teknoloji kullanılmaktadır. Bu çalışmada üreticiler için bulut sistemler ve nesnelerin interneti başta olmak üzere, güncel teknolojiler ışığında akıllı tarımda kullanılabilir uygulamalar tasarlanması üzerinde durulmuştur. Ayrıca alanyazında akıllı tarımla ilgili yapılan çalışmalar doküman analizi yönteminden yararlanılarak analiz edilmiştir. Alanyazında yapılan akıllı tarımla ilgili çalışmaların benzerlik gösterdiği belirlenmiştir. Araştırma bulgularına göre akıllı tarımla ilgili uygulamalar üreticilerin daha az maliyet ile ürünler elde etmesini sağlamayı amaçlamaktadır. Bunu sağlamada üreticilerin ve bilişim alanında çalışan uzmanların birlikte çalışması önerilebilir.

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Introduction

With the development of humanity, agriculture developed together. In this sense, it can be said that the development of humanity is proportional to the development of agriculture. Today, the use of technology with different topics is effective in ensuring the development of agriculture. Technology reduces manpower and costs in agriculture and saves time. In this way, producers gain more profit. All these developments have given birth to the concept of smart agriculture.

Serious problems in agriculture are soil loss, global climate change, drought, etc. These are the predictions that the decreased production due to reasons will not be enough for the food needs of the increasing population. It is now a necessity to include smart agriculture, which includes the application of new technologies that penetrate all areas of life with industry 4.0, to agriculture (Kaya, 2019).

The hardware and software used in smart agriculture provide convenience to producers, increase production and businesses gain more. For this purpose, cloud systems, internet of things, artificial intelligence applications and many other technologies are used.

The efficient use of production factors in the agricultural sector will form the basis for the growth and development process of other sectors (Bayramoğlu and Bozdemir, 2018). In this sense, smart farming practices gain importance. Smart agriculture is the information technology applied with the internet of things. The progress of smart agriculture depends on the rapid progress of the internet of things and wireless devices. In addition, remote monitoring systems (RMS) and short message services (SMS) are among the smart agriculture technologies used in smart agriculture, which need internet and wireless environments. In this way, manufacturers and facilities can collect timely data about warnings, weather reports and products (Patil and Kale, 2016). The Internet of Things (IoT) is used in many areas and contributes to information systems (Baz and Uludağ, 2021). It is seen that these systems are included in many studies on smart agriculture (Gondchawar and Kawitkar, 2016; Lin and et al., 2018; Rao and Sridhar, 2018; Ayaz and et al., 2019; Kumar and et al., 2021).

It is important that all the information obtained from the manufacturers is collected and analyzed individually with the help of cloud systems. The collected data can be converted into meaningful information about that manufacturer. As a result, the information will be sent back to the manufacturer via mobile media offered by technology (Akın, Yıldırım and Çakan, 2014). Data and results, changes made in terminals can be viewed by manufacturers via special web applications. Manufacturers can also use these web applications with other manufacturers and professionals to access their own data and results (Gowda and et al., 2021).

It is thought that smart agricultural practices will provide great advantages in terms of both workplace safety and employee health and safety against climate change and the accompanying risky scenarios (Baran and Karaçuha, 2021).

In this study, it is focused on designing applications that can be used in smart agriculture in the light of current technologies, especially cloud systems and internet of things for producers. With the applications designed in the research, it is aimed to enable the manufacturers to obtain products with less cost. It can be suggested that manufacturers and experts working in the field of informatics work together to achieve this.

Method

In the research, document analysis method was used on smart agriculture. Document analysis takes place within a certain plan, it is necessary to reach documents suitable for the purpose, it is a method in which the reached documents are checked and analysed in appropriate methods (Sak and et al., 2021). If document analysis is to be used effectively as a research method, it can be said that understanding this analysis is vital for the credibility, impact, validity and reliability of the research. For this reason, if document analysis is to be used by researchers, its content should be known (Kıral, 2020). For all these reasons, the document analysis method was used in this study. In addition, the methods encountered in smart agriculture are given in the study by the researcher, as well as the deficiencies are determined and a smart agriculture architecture proposal is presented within the framework of management information systems.

Results

In this section, the architectural proposal to be used in smart agriculture within the framework of management information systems and the studies made in smart agriculture, the technologies used and the purposes of use are included.

Intelligent Agriculture Architecture Proposal in the Framework of Management Information Systems

In this study, a model to be used in smart agriculture is presented by making use of cloud systems and the internet of things and information systems to be used to support them. It is seen that cloud systems and mobile technologies are important in the use of producers in all parts of agriculture, especially in the field. Manufacturers should be informed about temperature, humidity, pests and similar issues.

Management information systems are planned systems for collecting, processing, storing and disseminating data as needed to perform the operations and functions of a farm. Various sensors (soil PH, temperature, humidity, light intensity, etc.) are placed in the product area to measure different parameters (Duman and Özsoy, 2019).

In applications developed for use in smart agriculture, it is essential to prepare certain modules. In addition to these basic modules, the designed application also needs some modules according to its advanced features. Suggested modules for a new smart agriculture application can be listed as follows:

- Determining the need for technology in agriculture
- Determining the path to be followed in smart agriculture, making the planning
- Determining the sensors and applications to be used in smart agriculture,
- Launching the application and collecting data,
- Analyzing the data collected from the production areas,
- Analyzing the collected data and transmitting it to the producers,
- Turning the analyzed data into meaningful information,
- Information to support producers in decision making

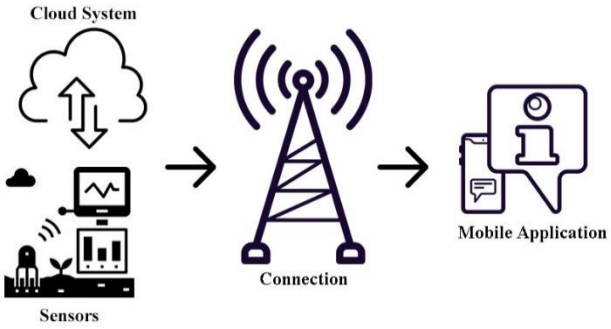

Figure 1. Smart Agriculture

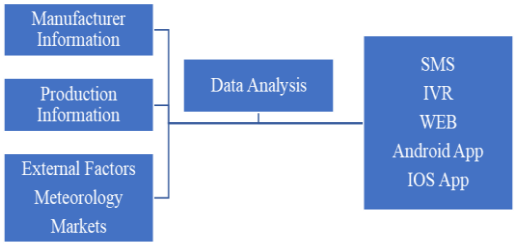

Figure 2. Data Analysis for Smart Agriculture in Information Based Decision Support Systems (Akın, Yıldırım and Çakan, 2014)

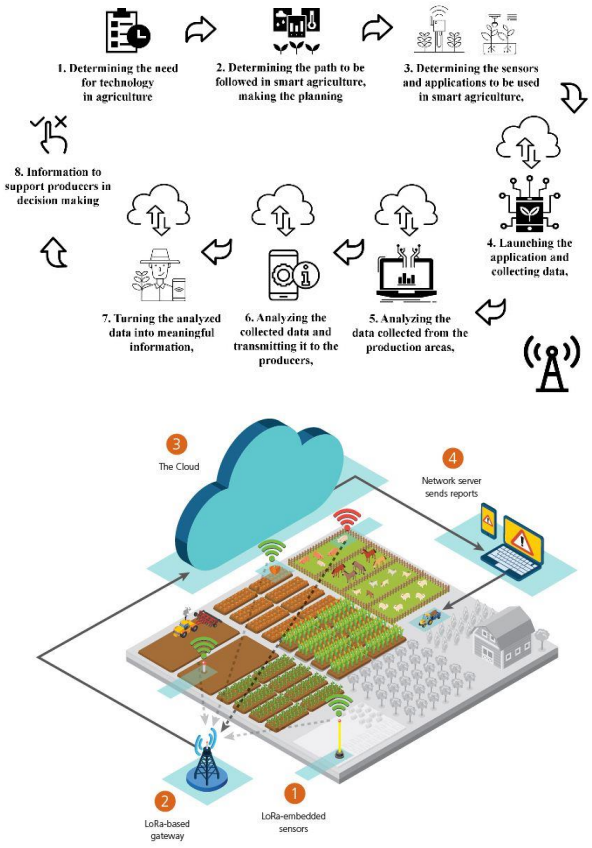

Figure 3. LoRaWAN - Based Precision Farming System Works (Semtech Corporation, 2017)

In this research, the smart agriculture architecture proposal within the framework of management information systems is designed as follows.

There is also a need for studies for long-distance fields in smart agriculture. The LoRa application developed by Semtech Corporation (2017) for this purpose is shown in Figure 3.

Figure 3. LoRaWAN - Based Precision Farming System Works (Semtech Corporation, 2017)

An example of an application called LoRa for production in long-distance fields in smart agriculture is shown in Figure 3. According to the sample application, the data collected from the sensors is sent to the cloud system via a gateway. When the obtained data is analyzed, it becomes meaningful. For this, software used in smart agriculture is used. Thanks to this software, the processed data is transmitted to the manufacturers via mobile platforms. All these processes can be summarized with the following items.

- Sensors embedded with LORA Technology (Soil, weather and etc. data)
- Data from sensors is sent to gateway
- Gateway sends information to cloud server

Application sends data to manufacturer

Investigation of Studies in Smart Agriculture, Technologies Used and Purposes of Use

Recently, productive agricultural areas have been decreasing. Therefore, it seems that the air, soil and water are drying up and it is becoming increasingly difficult to produce food. Producers must take advantage of technologies that will help them reduce wasteland while improving their production activities (Gowda and et al., 2021). In addition, there are problems encountered in the field of occupational health and safety in agriculture for years. It is also aimed to minimize these problems with smart agriculture technology.

New technologies are being designed day by day in smart agriculture. The designed products bring together the current areas of information systems. In Table 1, the smart agricultural practices used today, the names of the studies carried out and the purpose they serve in smart agriculture are given.

In Table 1, some studies in the field of smart agricultural applications that are used today and the characteristics of these studies are given. The names of the studies carried out, what purpose they serve in smart agriculture and which technology infrastructure they use are given in Table 1. According to the research findings, it has been determined that the communication networks, which are called the Internet of Things (IoT), where physical objects connect with each other and with different systems, are mostly used in the smart agriculture applications examined. In the studies, it is seen that cloud computing systems are in current use as well as the internet of things. Thanks to cloud computing, manufacturers have the ability to use resources from anywhere, anytime, with computers and other devices. In this sense, cloud computing and internet-based information services can be offered to manufacturers. The important thing here is to provide uninterrupted internet service. It is seen that the Global Positioning System (GPS) is used in the researches. GPS is a satellite-based radio navigation system. Thanks to this system, manufacturers benefit from navigation systems at the maximum level thanks to geographical location and time information.

Table 1. Technology Applications and Features Used in Smart Agriculture

No	Name of the Study	Purpose of Use in Smart Agriculture	Used Technologies	Literature
1	"Multidisciplinary Model for Smart Agriculture using Internet-of-Things (IoT), Sensors, Cloud-Computing, Mobile-Computing & Big-Data Analysis"	It is aimed to minimize the cost in agriculture by developing suggestions for agricultural e-governance programs and existing smart agriculture practices.	IoT Cloud Computing Big-Data Analysis	Channe, Kothari and Kadam, 2015
2	"IoT based Smart Agriculture"	Intelligent decision-making system in agriculture with GPS using automation and IoT technologies.	IoT GPS	Gondchawar and Kawitkar, 2016
3	"A Model for Smart Agriculture Using IoT"	A Remote Monitoring System (RMS), a combined approach with the Internet and wireless communication, is recommended.	RMS IoT SMS	Patil and Kale, 2016
4	"A Survey: Smart Agriculture IoT with Cloud Computing"	Applications of Smart Agriculture IoT Sensor Monitoring Network technologies using cloud computing	Cloud Computing IoT	Mekela and Viswanathan, 2017
5	"Cloud of Things in Smart Agriculture: Intelligent Irrigation Monitoring by Thermal Imaging"	Use of smart irrigation and monitoring technology in smart agriculture using thermal imaging method	Cloud Computing Thermal Imaging	Roopaei, Rad and Choo, 2017
6	"IoT Based Smart Agriculture Monitoring System"	GPS-based remote monitoring, humidity and temperature sensing, scaring off intruders, security, leaf wetness and proper irrigation	IoT GPS	Suma and et al., 2017
7	"Blockchain and IoT based Food Traceability for Smart Agriculture"	Reliable, ecological food traceability system proposal with blockchain and internet of things.	Blockchain IoT	Lin and et al., 2018
8	"Energy-Efficient Edge-Fog-Cloud Architecture for IoT-Based Smart Agriculture Environment"	Making agricultural processes smarter and more cost-effective with the Internet of Things and cloud computing	IoT Cloud Computing	Alharbi and Aldossary, 2021
	"BIoT: Blockchain based Smart Agriculture with Internet of Thing"	Provide manufacturers with a secure and open process and approach to decision support.	Blockchain IoT AI	Biswas and et al., 2021
9	"Analysis of low power wide area network wireless technologies in smart agriculture for large-scale farm monitoring and tractor communications"	Enhancement of coverage and radio link quality of LPWAN-based WSNs for a large-scale farm area	LPWAN Cloud Computing	Klaina and et al., 2021
10	"LiveCare: An IoT based Healthcare Framework for Livestocks in Smart Agriculture"	Use of the Internet of Things as well as the use of LiveCare application for use in smart agriculture	IoT	Chatterjee and et al., 2021
11	"Smart Agriculture and Smart Farming using IoT Technology"	Supporting the agricultural process with the Internet of Things	IoT	Gowda and et al., 2021
12	"Agricultural business and product marketing effected by using big data analysis in smart agriculture"	Big data is used to expand agricultural businesses and increase product marketing.	Big-Data Analysis	Huang and Chen, 2021
13	"Smart Agriculture Cloud Using AI Based Techniques"	Creating a smart farming cloud using artificial intelligence	AI	Junaid and et al., 2021
14	"On Enabling Mobile Crowd Sensing for Data Collection in Smart Agriculture: A Vision"	To provide cost-effectiveness, scalability and mobility support in smart agriculture. In addition, data collection solutions are offered.	IoT MCS	Sun and et al., 2021

In the researches made with the use of this technology, the subject of smart agriculture has been beneficial. It has also been seen that Thermal Imaging, LPWAN and Blockchain technologies are also used in the research. All these information systems infrastructures are used in smart agriculture to increase ease of production, reduce costs, minimize time loss and reduce the need for manpower.

Conclusion

In the research, the technologies used in smart agriculture and the purposes of use of the technologies used are included by using the document analysis method. In addition, smart agricultural architecture proposals are also included in the research. In the literature, similar studies have been found on smart agriculture. Similar aspects of the studies carried out are the similarity of the devices used

and the smart agriculture architecture. In the literature, it can be stated that decision support systems are more needed in terms of management information systems. It can also be stated that business activities in smart agriculture will be supported thanks to decision support systems and that information systems will provide more support to producers by making decisions among the situations encountered.

In the research, a model is presented to be used in smart agriculture by making use of cloud systems and the internet of things and information systems to be used to support them. It is seen that cloud systems and mobile technologies are important in the use of producers in all parts of agriculture, especially in the field. Manufacturers should be informed about temperature, humidity, pests and similar issues.

Producers should receive training in the digital field on smart agriculture. These trainings can be carried out through distance education platforms. It may be recommended to work together with experts in the field of management information systems in the field of smart agriculture. In the studies to be carried out, the content of distance education should be prepared by experts in the field. These experts; should consist of those working in the field of agriculture, information systems and education.

There are no studies on the level of knowledge of producers in the field of information systems in smart agriculture practices. It is thought that the producers have more knowledge about agriculture. In this sense, it is imperative that manufacturers be trained on information systems, at least at a basic level. It can be suggested that these trainings are aimed specifically at the devices they use, computer software and basic technical problems.

Technical issues such as the installation of sensors in smart agriculture applications and the development of applications to be used are carried out by the relevant companies. Companies support the producers in technical matters, and even consultancy services are provided on agriculture. In addition to these, there are institutions that work and support the producers in accordance with the agricultural policies of the states. It is very important that these institutions and manufacturers cooperate. It is important to ensure that the activities regarding the smart agricultural practices to be carried out are carried out under the coordination of these institutions.

In future studies, it may be suggested to address the current issues of technology. The field of information systems is a field that is updated every day. Researchers should follow the advances in technology in the field of internet of things and agriculture and make new studies with current topics.

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