

# Applications Of Cloud And IOT Technology For The Development Of Agricultural Sector

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**Abstract:** Cloud computing is a platform of multi-systems like software, Hardware, data base storages and IT system. Whereas the Internet of Things IoT is a technology which maps real-time objects with each other by using network. Cloud computing with Internet of thing is powerful combination of handling data and sharing the information to take decisions. Cloud and IoT technology adopted by many sectors but the main focus in these days is to use these technologies in the agriculture development. This paper focus on the importance of using cloud technology and IoT technology, their application and benefits regarding the agriculture sector, as agriculture is the main root of the success for the nation also for its economic conditions. This paper propose a model by brief study of cloud an IoT application, the purpose of this model is to highlight the how to take information of agriculture data from different sources and use the information and data regarding agriculture to reduce the man power and provide platform for the users to take the decision easily.

**Index Terms:** Pakistan Agriculture, Challenges in Agriculture, Cloud Computing, Application of cloud computing, Internet of things IoT, Application of IoT, Benefits of cloud services and IoT, Cloud-IoT model in Agriculture.

## 1. INTRODUCTION

In the past years, computing technologies plays a vital role in every sectors whether the sectors are of transportation, health services, smart online shopping, providing smart education or either warehousing. In every field and sector computing technologies makes the livelihood easier for man to adobe the information. The purpose of these technologies in every sector is to provide real-time, reliable, efficient, securable information when needed. Moreover, the computing technology also provides the user-friendly environment to use the technology easily for every person related to it. The main purpose of the technology on other hand is also to make communication better for different sectors because communication and Information is always been an important part of the human race as discussed in [7]. The application of information technology will not only provide good information but also provide the good communication to shorten the distance of the world. The purpose of this paper is to highlight another computing technology in the different sector that is also an important part and plays a vital role in the human societies. The two technologies discussed in this paper is Cloud computing technology and Internet of Things (IoT) in the sector and era of agriculture, since agriculture is the main part of the nation that defines the economic conditions of the country because to increase and to make better the economic condition of the nation there is need to improve the agriculture sectors [4] of them as discussed. Because agriculture is the backbone of the nation. This paper also highlights the use of

Application of cloud computing and applications of internet of things (IoT) in the agriculture development, because utilization of every resources on time is very important for the growth of the agriculture. Therefore, the importance of application of these two technologies for agriculture has been studied in this paper. Although the two technologies cloud computing and Internet of things (IoT) tends to connect the various objects in the world to the internet as in [9]. So, to handle and to avoid challenges faced by the production of food, there is need for the technology to communicate and to handle the information about resources of agriculture sectors properly as discussed in [15]. So the introduction to these two technologies is great breakthrough in modern agriculture era. The structure of this paper as follows: Section 3 describes the Overview of the cloud computing and significance of its applications in agriculture whereas, Section 4 describes the Overview of the IoT and significance of its applications, finally Section 5 provides the model of cloud computing with IoT in Agriculture.

## 2 AGRICULTURE IN PAKISTAN

Agriculture is an important part of Pakistan's economic sector and vital sector that effects the country alot as in [27]. No doubt Pakistan is very much rich and fast growing in its agriculture and responsible for growth of economic sector and is also known as the agricultural country. It accounts for 19% of the GDP and together with agro-based products fetches 80% of the country's total export earnings. More than 42.3% of the labor force is engaged in this sector. It accounts for 19% of the GDP and together with agro-based products fetches 80% of the country's total export earnings. More than 42.3% of the labor force is engaged in this sector [23] [26] as discussed.

### 2.1 Major Challenges in Agriculture of Pakistan:

No doubt that agriculture is an important part of Pakistan as discussed in section 2. By the research we come to conclude that the challenges faced by the Pakistan in agriculture are as follows:

#### 1. Lack of Modern Agricultural Technology:

One of the most challenge faced in Agriculture by Pakistan is the Lack of the Agricultural technology, because technology has great impact on the irrigation system of agriculture, crop production, disease information about the crops.

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## 2. Waterlogging and Salinity:

This is also the major issue that Pakistan faces because waterlogging and salinity effects the plants and as a result there is a great reduction in crop production.

## 3. Old method of Production:

This is also the main challenge towards Pakistan as the farmers in Pakistan uses old method and mechanism for production like sowing, harvesting and ploughing from the conventional tools.

## 4. Lack of knowledge towards farmers:

Most of the farmers have lack of knowledge towards the crop like unknown condition about weather, prevent the crop from insects and pests the lack of these skills also effects the agricultural production.

## 5. Diseases of crops from pests:

This is also one of the major issues in Pakistan because Pakistan suffer the problem by attacking of locusts on the crop that cause destruction.

## 3 CLOUD COMPUTING

Cloud computing refers to a cloud and that cloud refers to paradigm that consists of multiple things and technologies like data storages, interfaces, information technology, servers, applications and software. Cloud computing is to manipulating, accessing, configuring and distribution of these technologies and connecting these technology infrastructure with the Internet. It is also called the paradigm of technologies because it gives a lot of the benefits to every sectors. The charm of cloud computing is that the services may be availed whenever and wherever needed as in [4]. Basically it is a pool of systems and are connected to public or private networks. Cloud computing technology is an emerging hot technology appeared in recent years; it is very similar with utility computing and grid computing, and is considered as combined product with the computer technology such as grid computing, utility computing, distributed computing, network storage, load balancing, and network technology [10]. The Cloud Computing is making our business applications mobile and collaborative, also gives user-friendly environment and make ease to use the technology infrastructure. This technology also gains the attention of the Governments of different countries and territories such as United States, British, Japan and other developed countries, and all have begun to use national cloud computing infrastructure for the future development and betterment of their agriculture sector. [10].

### 3.1 Role of cloud computing in Agriculture:

Cloud based technology is an emerging solution to better managing the agricultural processes as in [6]. As discussed in previous section cloud computing refers to the sharing of the technologies through internet and provide ease for the farmers to manipulate and analyze the data because the cloud computing in agriculture it provides storage of data about relevant things such as data about weather conditions, waterlogging, disease of pest, data about production of crops, crop model database and decision-making database. Cloud computing platform requires less man work more to provide ease for development of agriculture. The cloud computing data can be accessed everywhere and can be accessed by different researchers, labor and farmers. This paper describes how cloud computing plays a vital role and elaborates the importance of the applications in development of Pakistan Agriculture. Using the cloud services in agriculture farmers

and labor did not have to learn the technical skills or any other technology for using it. It is basically the ease of services the service refers to provide ease of decision making, the ease of handling the information and knowing the information that is provided to the farmers. The type of cloud services can be provided whenever and wherever needed. Because the developed nations and developing nation are using the cloud computing services throughout in the agricultural fields. Briefing about the cloud services the cloud computing consists of different cloud models as these models are beneficial for the end-users and easy to be availed everywhere:

- **Software as a Service (SaaS) Model:**

This model comprises of providing the software service to the end-users on demand. The service can be provided from cloud through the internet by the multiple end-users. Another feature of this model is that it can be used as per user basis such as software, Google applications, LinkedIn and other web applications.

- **Platform as a Service (PaaS) Model:**

This model comprises of providing the computer platform to design and develop the particular software application. It also provides the tools for non-developers to build the web application, platform basically included as operating system, database and web servers.

- **Infrastructure as a Service (IaaS) Model:**

This model comprises of providing the component on which the cloud services can be availed and used. This model includes the components such as machines, virtual computer, database storage and servers.

Cloud computing models are explained in figure 1.

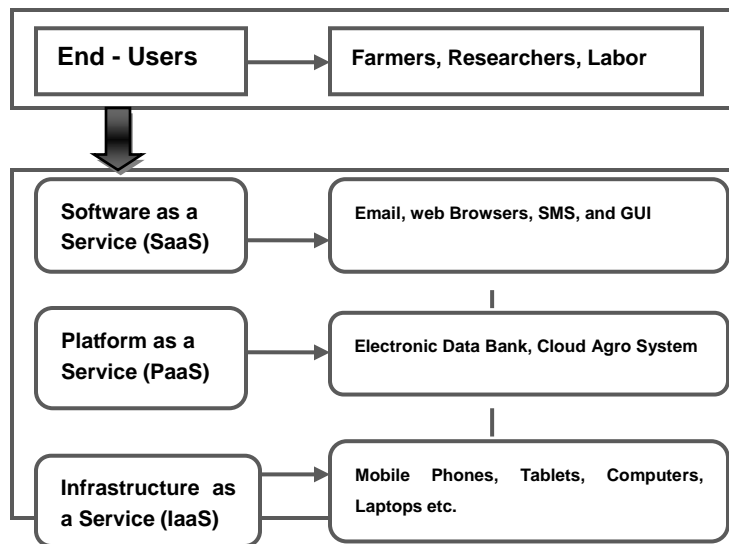


Fig 1: Cloud Computing Models Framework.

### 3.2 Applications of cloud computing in Agriculture:

As discussed in the challenges regarding agriculture section. These challenges are due to lack of proper mechanism, lack of the information related to crops, lack of information regarding weather and crop diseases because of the farmer and the labor did not have proper knowledge about regarding agriculture. The application of cloud computing are helpful in solving these challenges. The cloud can offer a type of a bank which can store all the agriculture related information. This

information is available to the farmers and other users from agriculture sector at anywhere and anytime to make ease for them to collect the data [7]. Cloud computing technology provides a platform for the labors, farmers and researchers that they do not need to make any investment of software and hardware. For this calculation, the user does not need to know the calculation principle and process, simply according to the amount to pay. These farmers, labors and researchers can also adopt cropping techniques as well as pest control, disease control method, they can also monitor the problems related to animals and plants i.e. Agriculture era as in [10]. Fig 2 also explain the application of cloud computing in agriculture as a model. Some of the applications are given as:

- **Database for weather regarding information:**

It helps to know the information regarding the specific weather condition and weather environment for the seasonal crops by weather forecasting.

- **Database for disease related information:**

It helps to know the information regarding the pest disease that attack on crops and spoil the crops because Pakistan suffer from worst attack of locust on crop and destroy the crop.

- **Database for new technique of crop production:**

It helps to know the information regarding the new mechanism and new techniques of crop production form various tools. It also stores information regarding particular crop grown in specific region.

- **Sharing of information regarding agriculture:**

This is another application of cloud computing as cloud computing have powerful network access so it plays an important and easy role in providing and sharing of information regarding agriculture challenges to the users.

- **Monitoring of Agricultural product quality:**

The cloud computing technology has been providing the scientific research, accessing the raw materials, production of crops, storage and transportation, marketing, quality traceability and information services, inspection of the product quality etc. [10].

- **Real Time monitoring of crops:**

One of the application of cloud computing in Agriculture is that it provides real-time monitoring information and situation about the growth in the crop it monitors the leaf perimeter, stem height leaf diameter and height of the roots not only that it also monitors quantity of fertilizer and water in the soil.

- **Providing agricultural science and technology:**

As an important supporting technology of digital agriculture, cloud computing technology offers advanced information technology services, and realizes digitizing and visualizing expression, controlling, design and management of all the agriculture involving objects and the whole process. Agricultural extension, education and scientific research achieve trinity in the cloud computing environment. In addition, the cloud computing technology can be used to build precision agriculture technology and equipment systems, which make use of advanced agricultural production information and professional geographic information software to gain organic links among agricultural production and operating procedures.

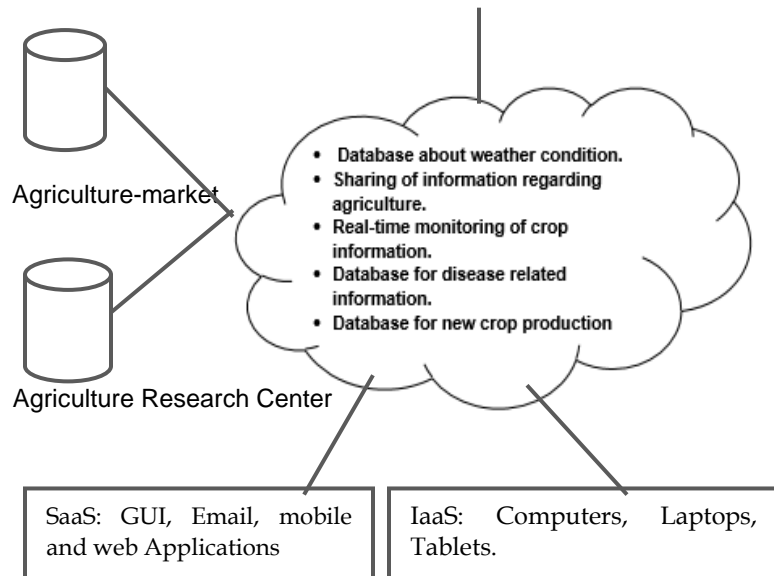


Fig 2: Cloud computing Model in Agricultur

### 3.3 Benefits of Applications of cloud computing in Agriculture:

Cloud computing based technology is an important factor of development of agriculture the benefits regarding these applications are given below:

- Enhanced the GDP and economic conditions of the nation.
- Remove the technical issues for the farmers.
- Data accessing at anytime and anywhere.
- Provide communication globally and locally.
- Reduction in man power more work technically and easily.
- No proper skills required to use the cloud services.
- Provide motivation to the farmers and researchers.
- Data can be available at any time at anywhere.

## 4 INTERNET OF THINGS (IOT)

Internet of Things (IoT) plays an important role of mapping real world objects with each other through the network. IoT is a world-wide network of intercommunicating devices. Internet of things is a platform where all the objects like transportation, Grocery, health care, furniture and appliances can be seen, readable and recognizable. IoT refers to "a world-wide network of interconnected objects uniquely addressable, based on standard communication protocols" whose point of convergence is the Internet. The basic idea behind it is the pervasive presence around people of things, able to measure, infer, understand, and even modify the environment [17]. IoT is becoming the major part of the technologies now-a-days. Everyone is adopting the IoT as Problem solving technology in every sector. In the past many researchers work on the different ICT technologies to solve the problem but they are suitable for short run but not helpful in the long run. But now IoT is becoming an important part of every sectors. The technology of IoT used in agricultural sector enables the farmers and labors and gain access form the GPS to send the information everywhere. IoT aims to integrate the physical world with the virtual world by using the Internet as [19] the medium to communicate and exchange information.

### 4.1 Role of Internet of Things (IoT) in Agriculture:

Now-a-days most of the research area of IoT in a sector is agriculture. As discussed in section 1 that agriculture is an

Data from other state

End-Users: Farmers, Labors, Researchers.

important sector in economic growth of the nation. The future of the IoT in agriculture is adopted by many of the developed and developing countries. Advancements also bring productivity. So, with the help of IoT, farmers will be able to manage Livestock like cow, sheep and other animals [1] as well with their health. The information of agriculture solution can be implemented as data collected from the farm is stored in cloud system and by network can be stored and tracked by the farmer to know the condition of crop. Internet of Things in term of agriculture is also known as power of data about the different information regarding agriculture things information are shared and analyzed by the data given through the network anywhere. It enables the farmers and labors to decrease their costs same time by improving their decision making with appropriate and real time data. IoT based improves the entire Agriculture system by monitoring the field by real-time data. With the help of sensors and intercommunication and connectivity, it has not only saved the time of the farmers but has also reduced the extra use of resources such as Water and Electricity. It monitors and tracks the various factors like humidity, temperature, soil erosion, pest control, disease related to crops and animals etc. under check and gives a crystal clear real-time observation. As we discussed in section 3.2 that cloud computing in agricultural have three cloud services that are used in every sectors, similarly IoT also have three layers used in agriculture sector is given as:

- **Data Acquisition Layer:**

Data Acquisition is a type of layer in IoT where data is collected from the various sources also in this layer object can also be identified major sources like GPS, Camera and Sensors etc.

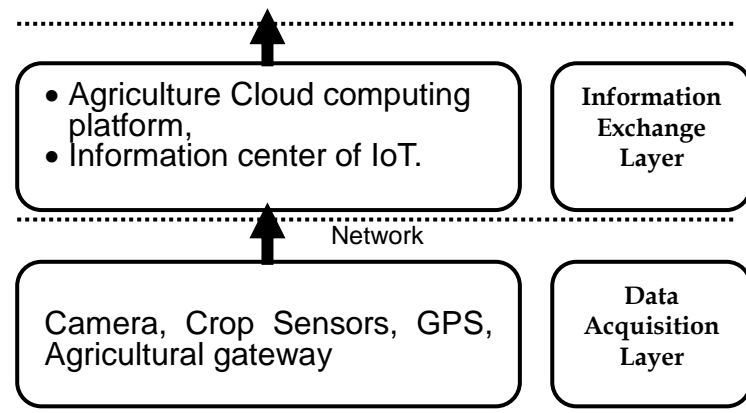
- **Information exchange Layer:**

This layer deals with exchanging or communicating the information by the network and internet with the IoT technology regarding the referred sector. This layer includes cloud computing and Information center of IoT.

- **Application Layer**

This layer deals with the variety of servers and its main functions include the collection, transformation and analysis of the gathered data as well as the adaptation and triggers of things for users such as Cloud services (IaaS, PaaS, SaaS), End users and back-end servers.

IoT Application Layers in term of agriculture can be explained by Fig 3.



*Fig 3: IoT Layers in the Agriculture Model*

#### 4.2 Applications of Internet of Things (IoT) in Agriculture:

IoT is much suitable for solving the problem regarding the agriculture as discussed section 3.1. The use of IoT is not popular in the Pakistan but still it has the abilities to solve the challenges regarding agriculture in Pakistan, similar applications regarding IoT in agriculture is given as.

- **Monitoring of the weather conditions:**

Weather is the main factor that needs to be focused in the agriculture. The technology used by IoT is sensors that sense the data of the climate and send it to the cloud where cloud technology consists of various solution for the climate and weather condition the data send by the sensors to the cloud is compared with the data stored about weather conditions and then decision for suitable crop is taken by the farmers.

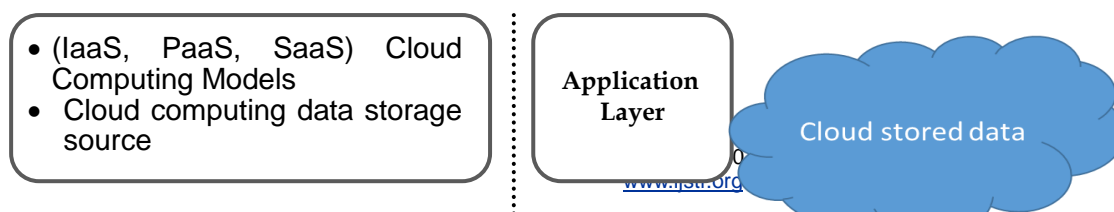
- **Water Management:**

Water is an important and essential part for the agriculture. The IoT technology used in this is map services and sensors system to provide appropriate water to the crops hence results in less waterlogging and salinity and reduces wastage of water.

- **Cattle Monitoring**

Cattle or live stocks are the important part of agriculture IoT provides sensors technology to measure the health and diseases of the cattle.

Applications of IoT in terms of Agriculture is explained by Fig 4.





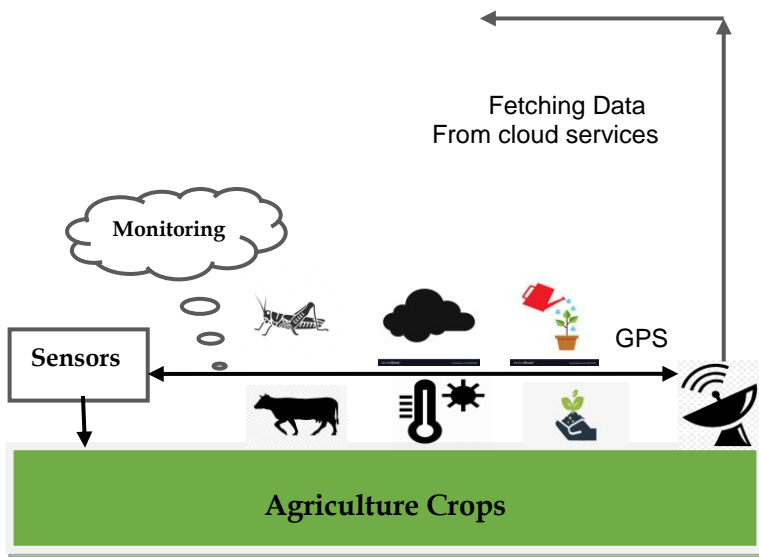


Fig 4: IoT model in Agriculture

**4.3 Benefits of Application of IoT in Agriculture:**

As it is already elaborated that IoT is of much importance in Agriculture. So some of the benefits of Application of IoT is highlighted as:

- For the farmers it is easy to utilize the information and take necessary decision on it.
- Data can be easily collected and managed using sensors and cloud services.
- By using IoT technology the quality of the crops would be better.
- Improvement in the efficient usage of inputs like soil, water, fertilizers, pesticides, etc.
- Reduced the cost.
- Decisions can be made in real-time and from anywhere.

**5 CLOUD COMPUTING WITH IOT IN AGRICULTURE**

Cloud computing with IoT is very beneficial and ease of communication and information in agricultural sector. Both of these technologies are important now-a-days to improve the quality of the products produced by the agriculture. Here IoT is used to collect the data by using different sensors and cloud computing deals with managing the data gathered by IoT sensors. Internet of Things will connect the world's objects in both a sensory and intelligent manner through combining technological developments in item identification. In this section we provide a Cloud-IoT model of agriculture. The main purpose of this model is to elaborate that how data is collected and managed in Agriculture to highlight the importance of Cloud and IoT. The Cloud-IoT model is given as in Fig 5:

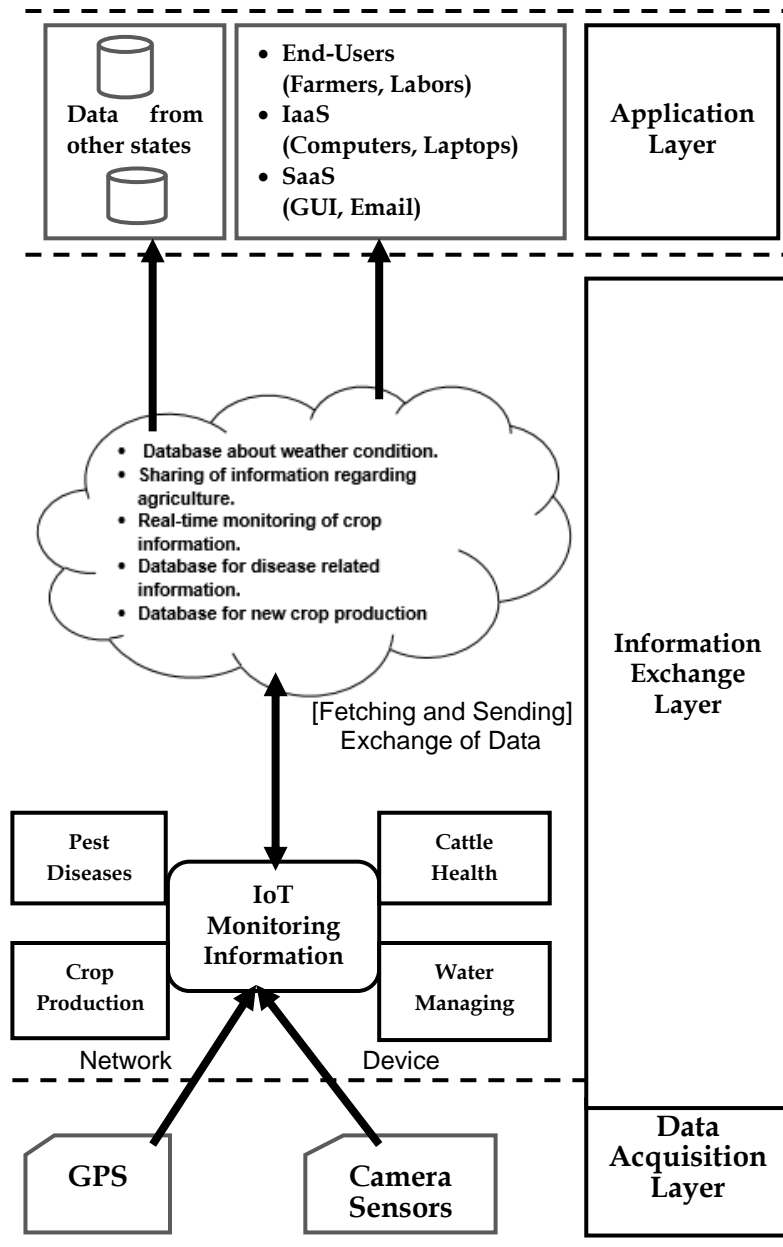


Fig 5: Cloud-IoT Model for the Agriculture

**6 CONCLUSION**

In this paper we make a deep study about the concept of cloud computing and Internet of Things IoT. We also take a brief concept about Application of these two technologies in the agriculture sector. Then we discuss the agriculture importance and some challenges in Pakistan. Several concepts of these two technologies also studied. Some cloud and IoT-based architecture and models are also provided. Further we give a Cloud-IoT model for agriculture that how these two technologies work in maintaining and taking decision in agriculture. The focus of this paper is basically upon how different methodologies effect the crop production, also how different factors affect the agricultural sector. It is also been focused that by adopting the Cloud and IoT methods how can we developed our nation and change the nation towards digital world and to become a developed nation.

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