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Cloud Computing in Agriculture-An Affordable Way to Achieve Smart Farming

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Abstract–India is an agriculture based country. Agriculture is considered as the fortune teller of Indian economy as it contributes major portion of Indian economy. Over half of country's population are working in agriculture.Agriculture is a Primary activity, which produces major portion of the food that we consume. This not only concerns with India but also all developing nations having agriculture as their major source of food and income. The standard approaches of agriculture being adapted, has numerous challenges in terms of production, marketing, profit etc. In today's changing world, the growing technology is being applied in all most every sector. It is really important to apply these technologies in agricultural sector as well, to upgrade it and let the future generations see it as a profitable career. The world's population is increasing day by day creating a need to improve the production is the growing concern in today's agricultural sector. So the purpose of this study is to investigate and find an economic and efficient way to achieve smart farming in terms of production, profit and nutrient content. Analysing the challenges in traditional agriculture sector, this study thus proposes an ICT tool i.e., cloud computing model in agriculture that can address these challenges and provide feasible solutions. The important finding of agricultural researchers is knowledge is the key in agriculture. Using this analysis, our study is attempting to develop a model that can create such knowledge from collected information. Cloud computing is a trending technology that manages everything over the internet without the end users worrying about how to implement and manage it. The cloud computing model proposed here enables collecting a lot of information and storing it to analyse and create a knowledge out of it to arrive at better solutions.

Keywords– Agricultural Development , Cloud Computing , Data driven Agriculture , Smart Farming, Cloud Agro system , e-data bank.

1.INTRODUCTION

In recent years we are experiencing problems like loss of farm land and biodiversity around the world. Adding to given, adverse weather conditions induced by climatic changes and a rise in the world population struggling for scarce resources are indicating a clear picture of future. There is a need to incorporate technology to understand the trend of problems encountering in agricultural sector and that is introducing ICT which leads to smart agriculture.Ithelps in empowering the farmers by providing knowledge about the nature of their farm land, their climatic conditions ,providing better access to natural resources, improved agricultural technologies, effective production strategies, markets, banking and financial services etc. But the huge investment cost for ICT infrastructure and maintenance of it is primary drawback as we need to procure , process the data and store the results from that data to gain knowledge about nature of farm land, its nutrient content , suitable crops etc., As a result, the important

concern for the information technicians is to find a reliable, faster, efficient as well as cheaper ICT tool for this field.

Our paper is thus about the concept of implementing such an ICT tool which will maintain a huge but well customized, updated and secured data base with instantaneous connectivity but with reasonable investment cost. That is Cloud Computing. It allows users to make use of services such as real-time computation, data access, and storage to end-users without knowing the physical location and configuration of the system that delivers the those services.

2. OBJECTIVE

The objective of this paper is about how effective implementation of cloud computing helps agricultural sector grow and how it is a suitable ICT tool that is reliable, cost effective and capable of enhancing Indian economy through developing the agricultural sector.

3. WHAT IS CLOUD COMPUTING

Cloud computing is a tool to make IT related services available in an easy manner hiding the difficult implementations of those services, without really knowing and getting involved in the technicalities of how and what to do in providing the required services. It is named as "cloud computing" because the users using services do not really need to know who is providing those services and users consider that the services are provided and maintained by the cloud – an unknown to them. The charm of cloud computing is that the services may be available whenever and wherever needed. It also reduces the cost of availing those services significantly. It requires very less manpower and maintenance of those services. It also makes users do not need to buy software, maintaining them up to date, maintenance of data etc. All these issues are taken care by Cloud providers. Cloud computing offers range of models based on user requirements.

To put it simply ,as we said for smart farming farmers need to aware of details like soil type, its moisture , nutrient content and availability of resources etc., For this we are making use of cloud computing technology to provide farmers a knowledge those details by giving them access to the collected and processed data over the internet.

Three of the basic cloud computing models are

• **Software as a Service (SAAS):** It consists of ICT working environment tools such as software, web applications etc., It helps you avoid the expense and complexity of purchasing and maintaining your own software. Another characteristic of this model is it will let the users pay for exactly what they have used against the standard way of buying and paying for the entire application.

• **Platform as a Service (PAAS):** It provides users the computing platform for designing and developing required applications with minimum redundancy. It also takes care of hosting of those developed applications without concerning about hardware and data storage requirement. It also promises providing the latest platforms and their security.

• **Infrastructure as a Service (IAAS):** It is an readily available computing infrastructure provisioned and managed over the internet. This model usually includes components used in providing ICT services, such as virtual computers, traffic monitoring and re-directing, basic network components etc. This is the

most important benefit of cloud computing as the organizations invest most of capital in establishing infrastructure.

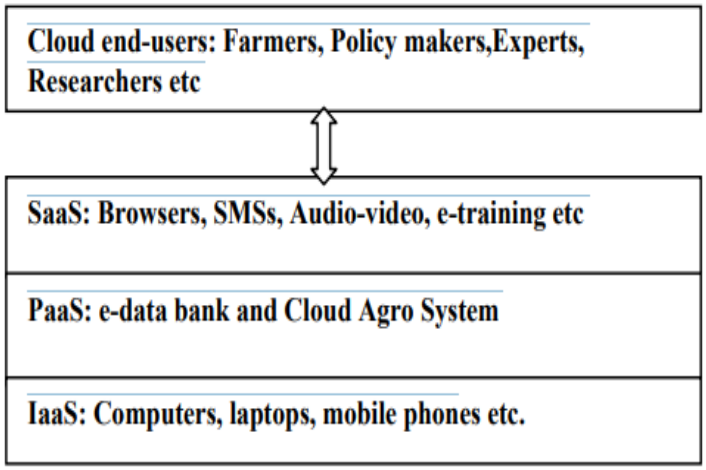


Figure-1: Basic Cloud computing structure

4. IMPLEMENTATION IN AGRICULTURAL SECTOR

We need to increase our food production up to 70% to feed the growing population of the world and 40% for India by 2050. If we talk about its nutritious content that is even more difficult to handle. According to the agricultural researchers a suitable solution is data-driven agriculture. It Is the ability to map every farm in the world and relate with a lots of data.

Farmers require various data and services about farming land, crop, climatic conditions, finance availability, irrigation facilities etc. that can help in increasing the crop production.

For example what is my soil moisture content at 5 inches below the soil throughout the farm? What is my soil moisture content throughout my farm? Which crop is best suitable for it? Etc., Using this approach

- Improves yield
- Reduces costs(as we are using fertilizers, nutrients only where they are needed)
- Ensures sustainability
- Promises nutrient level in the crop

So it is the data that plays a vital role in achieving our objectives in farming. According to the researchers high cost of data collection is preventing farmers from using data-driven agriculture particularly small holder farmers. There is no way for them to get their soil tested or knowing the availability of resources or about current market demand or other strategies to increase production etc., It is where cloud computing seems to be the practical solution to these problems.

There are real time applications for the use of cloud computing that create a entire ecosystem, from sensors and monitoring tools that collect soil data to agricultural field images and observations from human actors on the ground accurately feeding data repositories along with their GPS coordinates. As an

example, sensors are now able to detect the location of a bale of hay in a field, as well as the amount of moisture it contains.

5. ENHANCEMENT OF AGRICULTURAL SECTOR OF INDIA USING CLOUD

HOW EXACTLY CLOUD COMPUTING CAN BE USED IN AGRICULTURE

This paper introduces the implementation of cloud computing in the Indian farming sector. It basically introduces cloud computing model with two main parts in it. The first part is cloud agricultural system which provide user required services in faster approach , and the other one to store all collected relevant data in a centralized location referred as cloud.

5.1 Cloud Agricultural System: This part of the system can be used to observe the all functionalities of the system and deliver the required services. The system will have online service facilities accessible to all the users through out the country and 24 hours. To deliver these services, the Agricultural system may have the following services:

• **Demand-supply:** It can provide latest picture of the demand and supply information of agricultural products in different areas of the country. It helps the farmers in choosing the crops. It also enable them to go for a comparative analysis of the demand and supply chain.

• **Communication:** Literacy rate of India is little more than 75%. The system will provide services in their local language. The system will also have audio-visual facilities to perfectly demonstrate information.

• **Communication Devices**: The mobile services are available almost through our India and almost every family has at least one. Though most of the local farmers do not know ICT, they know how to use mobile services. Thus, the system includes mobile services and helps the farmers in knowing information from e-data bank from anywhere, at any time, through mobiles.

• **e-Knowledge sharing:** The system also provides chance to have online conversation with the experts or consultants and chance to appear for online training programs using the Community Service Centres (CSC) as the local information bases. The system not only contains local information but also worldwide as cloud agricultural is a global ICT approach. The system, therefore, will collect and provide agriculture related global information to the local farmers.

• **Conducting Research:** It will help the researchers around the world to use Indian agricultural data directly from the e-data bank and analyse them in order to contribute to the Indian agricultural sector. The research findings will be again kept in the e-data bank and will be made available to all its stake holders.

5.2. e-Data Bank:

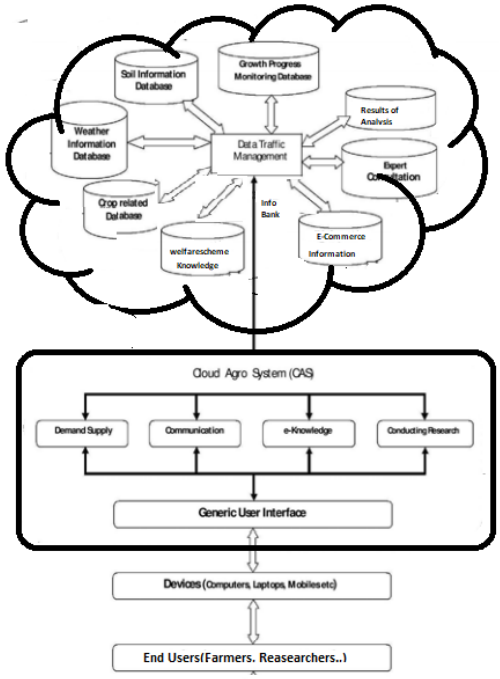
It is a data bank and it can be used to store all information collected and analysed related to agriculture in a centralized cloud, which will be available to all the clients at anytime, anywhere. The main reason in having an e-data bank is to provide crucial information to the local farmers in decision making. In order to do that ,the e-data bank includes the following databases:

- **Weather information**: It can be used to store the region specific weather information and also the weather forecast for a specific duration. It will helpful to the farmers in deciding things related to selection of crops.
- **Soil Information:** Soil information plays a very important role in crop related decision making. So, this provides information on character of soil of different parts of the

country. It can also provide the nature of soil in past and will help in estimating the future nature of soil.

- **Growth progress monitoring:** It monitors and stores data on growth of the crop in various regions on a regular interval. This will be really useful in comparing the crop growth region wise and also comparing it with past data will bring a clearer picture.
- **Results of analysis:** It is used to store the results of the analysis of collected data. For example given the growth progress of a plant and the level moisture content of soil can reveal its nutritional needs.
- **Expert Consultation:** It helps the farmers to overcome frequently experiencing problems through experts suggestions. It can also have a provision to post unattended problems asking for solutions from experts. It will also consists a bundle of frequently asked questions (FAQs) and their solutions to make the response reach the users faster.
- **E Commerce:** Provides information about market availability to that particular crop and a chance to directly sell the crop to the retailers. Otherwise middlemen pop up leading to former exploitation. It also guarantees the price of the crop must be great or equal to MSP(minimum support price).
- **Welfare schemes knowledge:** It helps the farmers to learn about available welfare schemes provided by the government to farmers along with eligibility constraints and a chance to apply them directly through a website.

THE SUGGESTED CLOUD AGRO SYSTEM



6. CLOUD IN PRECISION AGRICULTURE-FUTURE OF FARMING:

Precision agriculture is now a trending agricultural practice acknowledged as future of farming by agricultural researchers all around the world as it offers wide range of benefits. Precision agriculture is all about having precise knowledge on what inputs are needed , where and in what amount. To be able to create such knowledge this requires collecting a lot of information from different sources and in differentparts of the field on things like soil nutrients, the presence of pests and weeds, the level of greenness of the plants, weather information etc., Once the information is collected it need to be analysed to provide agricultural recommendations. For example given the developmental stage of a plant and its level of greenness may tell its nutritional needs. This information combined with the type of the soil where the plant is located and forecast of the weather for a specific duration can be used to determine how much of a certain fertilizer should be applied to that farm. Delivering these agronomic recommendations on time to the farmers and ensuring that they're able to apply these recommendations is the key in precision farming. If farmers are able to convert these recommendations into actions then they can solve many problems and achieve agricultural sustainability.

Big farmers use advanced machinery that collects geo-referenced information on soil nature yields and greenness of the plants. These machines are often connected to the internet and send the information automatically to AG big data firms to analyse the collected information and send agronomic instructions back to the machines which can automatically apply those recommendations in the field. It would be expecting too much from medium and small scale farmers. These farmers cannot afford that sophisticated machinery, lack the knowledge to operate the non automatic parts of the machines and lack the resources to hire a person who can handle it.

However our suggested cloud model can be expected to provide solutions to these problems that medium and small-scale farmers face when trying to implement precision agriculture of technologies. After all the suggested model also deals with collecting data, analysing it and getting the results of the analysis back to the farmers in an well customized and economical way. Easy to operate and economical sensors that tests soil moisture level, nutrient content, salinity level and portable networks to transmit the data
collected by field sensors to a central location called cloud and the collected data can now be analysed to assess the health status of soil or plants in an economic way . It does not even require the producers to know how to interpret complex data to get recommendations. What is even more exciting is the new sharing economy is creating opportunities for making the suggested mode to be more economic by just paying for the services we need, whenever we need them. That means we do not need to built our very own software, infrastructures to analyse the collected data. So cloud computing plays a vital role in making precision agriculture a real option for medium and small-scale producers.

7. Tanzania farmers already made efforts to apply cloud based digital farming and got succeeded in showing that it is worth considering:

All we said above about how cloud computing model will benefit small scale farmers may seem less practical to anyone. However it is already implemented but in small scale and managed to achieve its objectives. In Africa, where farmers struggle in a difficult environment to grow crops. Water is the most important requirement for irrigation. Imagine a state like Tanzania where there is already a scarcity of water , farmers have to use those few water resources for irrigation. Since agriculture is

their major source of income they have no choice but to do the irrigation. They could not afford to have borewells in their farmlands which made it even more difficult. But unexpectedly a small digital device which identifies the moisture content in the soil made them use those water at right amount at right place instead of applying water throughout the farm which resulted in saving a lot of water. They realised how beneficial it is to incorporate technology in traditional farming. Almost all farmers in Tanzania got their lands inspected by few people employed and the results are uploaded in a cloud where every farmer can know the details like their farmland moisture content , nutrient content and other information through mobile phones. They started using the resources even more efficiently thanks to the information in the cloud. The farmers even thought of expanding their irrigation scheme since they are now using the resources effectively than ever. They showed the rural bank that they deserve to get the loan and are able to repay it since now their farming is making profits. This is how technology turned agriculture into a blessing.

8. AI, IOT ALONG WITH CLOUD BROUGHT INTELLIGENT FARMING IN JAPAN:

Cloud computing can be used along with AI, IOT to make the farming even more smarter. For instancethere are concerns about agricultural sustainability, including forecasted water scarcity by 2030. So as to handle this issue, a digital farming technology has been developed in Japan. Experienced farmers know how to use water and fertilizers more efficiently, thanks to their experiences, knowledge. By utilizing the IoT and AI to gather and analyse data from their farming practices and repositing this data into a cloud and make it accessible to every farmer this technology enables even inexperienced growers to implement such techniques. It improved agricultural productivity even in areas with limited availability of water.

- Water, fertilizer, experience and knowledge are essential to farming. But farming that depends on large amounts of water and fertilizer suffers sustainability issues.

- In 2030, water supplies are forecast to be 39% short of required.

- Inexperienced growers have a large tendency to use more water and fertilizer, and this result in more wasted fertilizer flow into groundwater.

- Cultivators with knowledge and experience can judge the correct amount of water and fertilizer to use.
  Doing this lets them control yields and quality. That's where cloud provided a solution by providing this knowledge to all farmers.

- They used IoT and AI to turn that info into data so it could be used more wisely. It will take us from farming depending on experience and intuition, to sustainable farming with data.

- used IoT and AI to make an upgrade in fertigation.

- collected data from soil and light sensors. AI analyses the data from skilled cultivators to determine the right amount of water and fertilizer.

- Minimized the amount required to keep the soil in proper condition.

- With this technology, agricultural productivity throughout the region is drastically improved.
- Implemented this simple digital farming method in an inexpensive and highly efficient manner.
- Japan is followed by USA and China in introducing cloud along with AI, IOT in their agricultural sectors to achieve great results.

9. Advantages of proposed model in agriculture:

As discussed above cloud can also be implemented along with technologies like AI, IOT. But all in all the below are the exclusive benefits of the given model in agriculture.

- It facilitates large amount of data collection over the sensors and thus providing a better control on the internal processes and, as a result, production risks decreases.
- We can store every information related to agriculture in a centralized location called cloud, which will be accessible to all the clients at any time, anywhere without delay.
- Data related to location, weather, soil, water, fertilizers, pesticides, etc. can be managed and used to derive meaningful conclusions through centralized decision support systems.
- Results of analysis stored back in the cloud which helps the farmers in decision making like choosing a certain crop depending on weather forecast, soil moisture content, market demand etc.,
- Easy communication through a mobile device.
- Real-time monitoring and quick guidance in agricultural production
- Cloud makes communication between local and international users much faster, easier, cheaper, and secure as.
- Improved productivity, profitability, sustainability, and security.
- Allocation of resources on-demand without limit.
- Maintenance of the software taken care by the cloud provider.
- Farmers are able to do technology based agriculture and motivates the them and researchers to get involved more and more into agriculture.
- Can be used to upscale agricultural products supply chain.

10. CONCLUSION

This model will make farming more efficient and will ease the works of the farmers. India will benefit significantly if the model is implemented properly. The model bridges information gap within and outside the nation. In Indian agricultural sector, the suggested model can be considered as a pilot project. An effective implementation of this model will encourage other sectors also, which will lead to optimal benefit of shifting towards cloud. Using IOT,AI along with cloud will be a crucial step in leading Indian agriculture toward digital farming. This will definitely have a positive impact in the overall economic development of the nation. Above all, cloud computing is a newly introduced concept and most of the developing nations are not readily willing to accept and implement it. Therefore, it needs a mass awareness and promotion among the prime stakeholders to acquire the full potential of it and have a well established information base for the nation. This will in return lead to a well-connected.

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