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CLOUD COMPUTING FOR QUANTUM DEVELOPMENT IN AGRICULTURE

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Abstract- Information and communication technology has become an inevitable component in all matters of life, its appropriate use for agricultural has made remarkable impacts in the past. To integrate technology further into farming sector we need more intensive and agile network frameworks. It should be cost effective, user-friendly and affordable. However, due to high investment cost for installing and maintaining IT infrastructure many organisations are not in a position to use ICT. This is where cloud computing as a framework for harboring different ICT services plays its role. Through this technology all organisations can make use of ICT simply with the help of various devices like computers, smartphones and tablets. Cloud computing is primarily concerned with providing solutions for data storage, data processing and data dissemination services. This technology supports us to keep up with the changing trends and helps to achieve quantum development in Indian Agriculture.

Keywords- Cloud computing, Agricultural Cloud, Information and communication technology, Agricultural development

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Introduction

In legacy system, every institution have to keep separate IT infrastructure like its hardware, softwares, servers, databases etc. and its maintenance and updating is expensive. Corporates, Govt. Institutions and other such establishments can afford these facilities but farmers, SME's, cooperative societies and humble start-ups they are resource poor and have limited access to these technologies. Thus making a divide in consumption of technological services. If we are able to provide them with IT infrastructure they can focus on their core competencies and carry out their business efficiently. In this paper we are conceptualising a model based on cloud technology for accelerating use of ICT services. When cloud harbours the IT infrastructure, providing computing facility as a utility service rich and poor alike can use IT resources in an unlimited way. No firms need to buy any IT infrastructure they just need a device to access the services provided by cloud service providers through internet. Services can be made available to users across devices like computers, smartphones, tablets etc. As service is based on utility basis these users need only to pay for what they use and only when they use it. No investment from client's part is necessary for availing the benefits of cloud computing. These services are faster, reliable, user-friendly and most importantly affordable because cloud technology utilizes the economies of scale.

What is cloud computing?

According to National Institute of Standards and Technology (NIST) US, Cloud computing is a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction [1]. Cloud represents internet. The term "Cloud" literally used here as a veil to hide technicalities of the computing process. Cloud is a combination of servers, softwares, hardwares and databases that can be made available through internet to multiple devices. Cloud is based on a concept called utility computing, which means that computing power is made available to public as a utility service like electricity, water, Public transport etc. Cloud computing technology comes into use for such organizations, which doesn't have resources to develop IT infrastructure but have realized the impact of ICT.

Essential Characteristics of cloud computing:

1. On-demand self-service- Faster availability of services without human intervention.
2. Broad network access- Services available anywhere and everywhere across devices.
3. Resource pooling- Service provider pool resources *viz*. storage, processing, memory, and network bandwidth to serve multiple consumers using a multi-tenant model.
4. Rapid elasticity- Increase or decrease computing capabilities instantly.
5. Measured service- Pay-per- use basis like utility billing.

Service Models:

The NIST report on Cloud computing also describes three service models of cloud [1].

1. Software as a Service (SaaS) - It is service on demand, designed for end users and delivered over the web. Installation and Updating of software is not required for availing services by clients. Potential users may be NGO's, cooperative societies, farmers etc. E.g.: Gmail, Facebook etc.
2. Platform as a Service (PaaS) - offers the computing platform for designing and developing specific applications according to the requirement of users without the need to buy licenses or the products like Databases and Agri-softwares. E.g.: Microsoft azure, Google app engine etc.
3. Infrastructure as a Service (IaaS) - Physical infrastructure such as servers, hardware and networks are provided to users as a service. This is the most prominent benefit of cloud computing E.g.: Amazon EC2.

Deployment Models:

There are four types of cloud deployment models based on the location

or where the cloud is hosted and level of access [1]. They are, Private cloud, Community cloud, Public cloud and Hybrid cloud.

Quantum development in agriculture

Cloud computing is designed to integrate a perfect system with high strong computing power and with the help of SaaS, PaaS, IaaS and MSP to distribute the computing power to the end-users [2]. SAAS platform has immense potential in reaching out to farmers and making available to them required information from time to time. It can work as a user friendly interface, contents displayed in local language while hosting live and updated information gathered from various sources. Live video chats with local extension agent or experts etc. are some of the available services. Where as in PAAS, which provides platform for making applications which in turn can be made useful by various developmental agencies according to their need. IAAS, provides infrastructure services over internet. This service will come handy for institutions like agriculture universities, in creating a common platform for all the institution under them to get digitised and share research data, smooth administration, improving extension mechanism and bringing accountability in a holistic way.

How does an agricultural cloud function?

Agricultural Cloud functions in a four-step process, Acquiring, Processing, Reporting and Storage. Cloud system uses Internet of things (IOT) to collect field level data. IOT is a combination of radio frequency identification (RFID) tags, sensors, cameras which are embedded into plants, animals, machines and implements used in farms that in turn enables them to communicate through internet for exchange of data. Here the idea is to make input into computer without the aid of human intervention. Hence, cloud computing with IOT becomes a powerful tool for close monitoring and surveillance for diseases, pests and nutritional deficiencies of crops and farm animals.

1) **Acquiring**- It is the first step in the process and utilises sensors, cameras, drones, RFID tags are used to get live data from the field. These data can also be provided manually by farmer in the form of a query through a SAAS based application.
2) **Processing**- It is done in a PAAS layer. Data available from the field is analysed with processing tools available in this layer to yield instructions for the actual problem. Programs will be used for statistical, financial, agronomical and pathological analysis. It also maintains live field status based on these analyses for fault warning mechanism.
3) **Reporting**- Thus, generated instructions or solutions are passed on to the clients through cloud platform. This report is available on the device and it can be accessed from anywhere and across devices.
4) **Storage**- All the work done by the system is stored in a database. This contributes to the agricultural information management. These databases are also useful for research & development and refinement of technology.

Services available through Cloud system

A cloud system is expected to provide services in several areas of agricultural domain *viz.* agricultural education, research and extension.

- **Extension services** - Bridging the last mile connectivity problems by Implementing ICT tools efficiently. Present ICT tools are limited in scope when compared to cloud applications. Major problem faced by farmers in accessing ICT facilities are (a) either users doesn't have devices to access ICT tools or doesn't know how to access them in their device. (b) Users have appropriate device but ICT content is not available in local language for these devices. Hence, they have to always relay on a third person for getting information.
- **Farm management**- Maintaining and updating farm records, tracking of expenses and profits, live market information etc. Farmers being illiterate, they hesitate to keep proper farm records. With the help of user friendly applications and interface, cloud computing can be made useful to incorporate scientific farm management practices in farmer's field.
- **Crop protection-** Improving the pest and disease warning mechanisms and monitoring services. Monitoring mechanism in cloud computing gathers field images of pest /disease samples, infrared images of the entire field etc. which are subjected to analysis with the help of algorithms or field experts to arrive at the remedial measures and are reported back to the particular farmer. This reporting services hasten the broadcasting of pest and disease outbreak in any location. Pest and disease warning services helps farmers to take up timely prophylactic measures and reducing the impact of disease or pest outbreaks.
- **Crop improvement-** Biological research nowadays uses computers for analysis of the data, experiment planning and hypothesis development. Application of bioinformatics tools in biological research enables storage, retrieval, analysis, annotation and visualisation of results. Bio- informatics tools helps in providing information about the genes and their sequencing process. These tools can also help to search for genes within the genomes and elucidate their functions. These specific knowledge can then be used to improve tolerance of crops towards drought, insects, diseases etc.
- **Crop Production-** Real time advice on cultural practices and implementing Package of Practice. With the advent of cloud computing and internet of things various activities going on in farmers field can be monitored closely. Farmer's field practises are compared to standard practices for optimum output. GPS and different sensors attached to implements provides data related to land preparation, Irrigation schedule, crop spacing, weed growth and soil nutrient status. When these value fall out of the standard values farmers can be alerted through instant message service through a cloud based platform. Along with it suitable corrective measures can also be provided.
- **Meteorology-** Location specific weather details can be collected and stored through weather stations. These accumulated time series data can be used for accurate forecasting services. Day to day weather forecast can be made available in cloud servers which in turn can be communicated even to remote rural locations. Thus helping farmers in decision making and crop selection.
- **Agricultural database services-** Cloud computing also provides Agricultural database services [11]. Agri-Expert knowledge Database (AKDB) contains rules, inferences for decision making purposes. Image Knowledge Database (IKDB) to make decisions based on images received from farmers or consumers from farm lands. Statistical knowledge Database (SKDB) which allows to make decisions regarding amount of land to be cultivated, quantity of seed, fertilizers to be used etc. Business Knowledge Database (BKDB) contains data to make business related decisions for pricing or for comparisons of business at different locations on different agriculture products. Agri-Secure Data Service (ASDS) libraries for securing cloud data storage by encrypting it at storage and decrypting during its usage by various services. Thus, it can be used to gather information from field and systematically use it for scientific research or for gathering traditional farming practices or knowledge of farmers in the field of agriculture.

Views of social researchers on Cloud computing in Agricultural and Rural development

There are nearly Six billion mobile phone subscriptions in the world today, four out of every five new connections taking place in developing countries, it makes sense to harness the power of mobile telephony to overcome barriers to agricultural information and extension services and reach as many smallholder farmers as possible [3]. India increased the number of mobile cellular subscriptions by 18.8 per cent and is ranked 2nd out of 195 countries surveyed. The number of subscriptions account for 72 per cent of the population, India's ITU- ICT Development Index (IDI) for 2013 is 2.21 (out of 10) resulting in a rank of 121st out of 161 economies [4]. ICT applications and services can enable farmers to obtain information on input and output prices, the weather and so forth[5]. In Global

Cloud Computing Scorecard, India ranks 17th out of 24 countries, its position in the 2013 Scorecard improved by two spots from 19th to 17th based on its updated intellectual property laws and enhancements to its infrastructure [7]. Projected public cloud service market value for five-year compound annual growth rate (CAGR) to 2016 to be 32.5 per cent; this ranks India 1st out of 20 countries for growth in the value of the market for public cloud services to 2016 [8]. In Japan the use of cloud computing is getting more and more popular in agriculture also, The GPS (Global Positioning System) and the 3G (Third Generation Network) are also use-able in this case[9]. Duncan Waga and Kefa Rabah (2013) [10] opined that cloud computing can become a powerful tool for scientists and researchers sharing massive amounts of environmental data. By adding a real-time component to these research projects, scientists hope to have major impact on people's lives. Venkataramana and Padmavathamma (2012) [11] observed that cloud computing applications would be more suitable as large data is to be processed and stored at cheaper prices which is essential in developing countries. Zhang (2009) [12] stated that cloud computing provides equality in resources management and exploitability to small budget farms against the big ones. Sam P. (2015) [13] noticed all digital India efforts which we have been doing for 25 years now requires restructuring because it is based on old silos. Today we need cloud computing, open source software through low-cost models.

Advantages and Disadvantages

Reduction in IT (installing and maintenance) costs, simplicity in deployment of cloud-based solutions, on demand unlimited provisioning of computing resources, pay per use policy, rapid scalability, User friendly interface, faster exchange of data, data swapping across devices, increasing productivity of services are some of the advantages of cloud computing. While, internet dependency, storage of sensitive data, difficulties with unsubscribing or changing cloud computing service provider, uncertainty about the location of stored data, risk of security breach, legal disputes and insufficient knowledge about cloud computing services are the disadvantages which is to be mitigated.

Conclusion

Cloud is capable of bringing quantum development in agriculture. Espousing it will reduce the complexity in accessing data as well as information. Information will be made available to each and everyone over a fair and easily accessible platform. With the virtualisation of IT infrastructure cloud provides equality to all organisation to take part in the digital revolution. Rural societies are responding positively to technology, this has led to numerous opportunities for studying and understanding newly emerging popular communication channels, information gathering and dissemination systems. This may also yield fruitful models which may replace old as well as time-consuming channels. Hence, cloud is a promising technology with infinite possible outcomes but its concerns also need to be weighing up before adoption.

Conflict of Interest: None declared

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