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Research Article

A Big Data Virtualization Role In Agriculture And Cloud Computing-Base Smart Agriculture

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ABSTRACT

Smart Farming is a development that emphasizes the use of information and communication technology in the cyber-physical farm management cycle. New technologies such as the Internet of Things and Cloud Computing are expected to leverage this development and introduce more robots and artificial intelligence in farming. This is encompassed by the phenomenon of Big Data, massive volumes of data with a wide variety that can be captured, analysed and used for decision-making. This review aims to gain insight into the state-of-the-art of Big Data applications in Smart Farming and identify the related socio-economic challenges to be addressed. Following a structured approach, a conceptual framework for analysis was developed that can also be used for future studies on this topic. The review shows that the scope of Big Data applications in Smart Farming goes beyond primary production; it is influencing the entire food supply chain. Big data are being used to provide predictive insights in farming operations, drive real-time operational decisions, and redesign business processes for game-changing business models. Several authors therefore suggest that Big Data will cause major shifts in roles and power relations among different players in current food supply chain networks. The landscape of stakeholders exhibits an interesting game between powerful tech companies, venture capitalists and often small startups and new entrants. At the same time there are several public institutions that publish open data, under the condition that the privacy of persons must be guaranteed. The future of Smart Farming may unravel in a continuum of two extreme scenarios: 1) closed, proprietary systems in which the farmer is part of a highly integrated food supply chain or 2) open, collaborative systems in which the farmer and every other stakeholder in the chain network is flexible in choosing business partners as well for the technology as for the food production side. The further development of data and application infrastructures (platforms and standards) and their institutional embedment will play a crucial role in the battle between these scenarios. From a socio-economic perspective, the authors propose to give research priority to organizational issues concerning governance issues and suitable business models for data sharing in different supply chain scenarios

I.INTRODUCTION

The data, of late, has been compared with the oil, one of the most important natural resources on the earth. Access to data provides a significant advantage to corporate giants like Alphabet, Amazon, Facebook and Microsoft. It fuels growth by introducing new products and services. Such accumulated data is increasing at a phenomenal rate and is expected to rise from 33 zettabytes (1 zettabyte = 1 trillion Gigabyte) in 2023 to 175 zettabyte (IDA, 2023) in 2025. The cost of data storage (per GB per month) is less than US $ 0.025 (in Amazon Cloud services). The availability of computing power is further making it possible to handle data explosion. Google had introduced Tensor Processing Unit (TPU) in 2023, which can perform up to 128000 operations per cycle as compared to Graphics Processing Unit (GPU, 10000 operations per cycle) and usual central processing unit (CPU, 10 operations per cycle). Thus, better processing, storage and availability of data for complex analytics reduces the cost of storage and high-performance computing. The industries which have embraced the new phenomena are significantly benefiting from these. The impact will be visible in every sector — be it business, research, governance and agriculture. It will transform the agri-food ecosystem, including research, education, extension, farming, and agri-business. To benefit from data science, the National Agricultural Research and Education System (NARES) of India needs to align its agenda with the emerging trends in it.

The agricultural industry has experienced tremendous changes over the years. Traditional farming practices have been replaced by *smart farming*, which uses technology to increase food production more effectively and efficiently. Along with advanced transportation technology, innovations in communication tools and software engineering started to be incorporated into food and agricultural industries. This new kind of farming, known as agriculture 4.0, has been revolutionizing the food and agricultural sectors, addressing some of the problems from the earlier generations. Historically, agriculture 1.0 and 2.0 required traditional and manual labors of human and domesticated animals. Since agriculture 3.0, farming practices and its capacity started to improve by utilizing technology. In agriculture 4.0, technology is completely changing how we do agriculture. For instance, researchers are working on automatic disease diagnosis using computer vision although it is still challenging and error-prone due to various non-infectious and infectious pathogenic agents that can cause similar symptoms in crops. Researchers showed how swarm intelligence can be used to deal with some of the challenges involved in smart farming. Others also looked at how blockchain technology can be used to create transparent smart contracts and to improve the food supply chain. Big data analytics, data science, machine learning (ML) and artificial intelligence (AI) are also being used to develop *precision agriculture* and other agricultural applications . This work reviews and investigates the latest developments and future directions of smart farming and agrotech. These include big data analytics, data science, ML and AI, deep learning (based on neural networks), internet-of-things (IoT), block chain technology, robotics, autonomous systems, and swarm intelligence.

II.BIG DATA

Big data is a research field of analyzing large amounts of data, characterized by volume, velocity, variety, veracity, etc. Precision agriculture emphasizes the collection and utilization of data to make decisions for agricultural value creations. There are many different sources of big data, including ground sensors, historical data collected by governmental and non-governmental agencies, web services, and online repositories. Over the past decade, agricultural production has seen a lot of growth due to the increasing use of data from sensors and IoT devices . This data is used to analyze food production patterns, processing, and supply chains. Big data helps producers know what crops to plant and how to produce the most food possible. Sawant et al. designed platforms that connect supply chain actors with quality products and processes. Karmas et al. studied different methods of high-throughput to provide detailed information about interactions between plants and the environment. The study by Gutiérrez et al. looked at self-operating and data-intensive production systems such as indoor LED-illuminated aeroponics and greenhouses. Love et al. demonstrated how these systems can be used to control pests.

III.CLOUD-FOG-EDGE COMPUTING

Cloud computing virtually pulls many similar and/or different computer resources that may be closely or distantly located from each other, in order to provide on-demand computing services over the internet. Three different service models of cloud computing are software as a service (SaaS), infrastructure as a service (IaaS), and platform as service (PaaS). Fog nodes have the ability to communicate with other fog nodes and clouds as well as the computing power and storage to process data efficiently. Edge computing is a growing area of technology that enables efficient data processing without a need to upload data to the central node. During the past decades, cloud-fog-edge (CFE) computing have played an important role in transforming the agricultural sector. This allowed to store data remotely, capture data from different sources, automate land records, and make predictions about the weather to support more effective agricultural management and improve the crop production. Alonso et al. developed a new edge computing architecture for monitoring the activities of livestock on dairy farms. This system can improve the dairy industry by making the activities of the livestock more transparent, efficient, and environmentally friendly.

IV. LITERATURE SURVEY

There exist a lot of scientific papers related to smart farming. Many papers speak about Precision agriculture but, some of them also talk about precision livestock. Big Data improve crops productivity. The paper presents the importance of Big Data in the increase of the world food production by showing how technologies can help farmers and stakeholder in the agricultural sector. Even though technologies have

many advantages when being used in smart farming and precision agriculture, some issues remain, among others, such as the data protection and data ownership rules of the new GDPR (General Data Protection Regulation) convention in force in the EU, as well as IT security issues. “Big Data analysis in agriculture” with the purpose of presenting how Big Data can be applied in all the different fields of agriculture.The authors first presented Big Data then later on, they spoke about the different areas in which Big Data analysis is applied in agriculture. Furthermore,they have presented some agricultural sector where Big Data is not yet applied but will be welcome. Smart Sustainable Agriculture (SSA) platform coupled with IoT and AI technologies. Thus, showing how new (high) technologies (AI, IoT, CC, robotic, etc.) enhance agriculture in all (its various) domains i.e. Human resources, Crops, Weather, Soil, Livestock, Irrigation/Water, Fertilization, Pests, etc. The papers begins with a description of need, challenges and urgency. Moreover, other works closed to Smart Sustainable Agriculture (SSA) have been studied and a layered architecture divided in seven layers recovering all needs has been proposed.
A Smart Farming software called PLATEM. The authors have presented the existing Precision Agriculture system. This was done by presenting the Smart Farming data management cycle, architecture and the architectural view of the smart decision system. Regarding livestock farming, Sun He and al. has presented one of the major aspects of animal behavior analysis by image processing. The authors used specifically image acquisition, image processing, image analysis and classification algorithm to make decisions. That process is used to predict animal growth (in this case animals are pigs). Linear regression is used for prediction and real-time condition monitoring. Ivan Andonovic and al. has shown how new technologies can be used to control animal activities (in particular eating/ruminating), to enhance animal welfare, to ensure fertility, reproduction and control the pregnancy rate. Also to detect reproduction diseases and poor œstrus.

V. METHODOLOGY

Big Data Value Chain Big Data Value Chain is described by the following steps:
Data Acquisition: This step contains all the processes which are use to collect, filter and clean data that are coming from any source and transmitted to a storage system, . Big Data improves acquirement to enhance high volume of various Data in higher speed build in a distributed system (environment). So, some required infrastructures are needed.
Data Analysis: Here, we are dealing with how data are treated. This process involves exploring, transforming, modeling and de-noising data for a future use and decision making. This step helps to enhance the accuracy of data and distinguish those which are usable, useful or important with respect to their needs or to their trustworthiness. It is also relevant for extracting information from data and gaining knowledge from information which are known to be very important from a business point of view .
Data Cu ration: stands for ”process used to clean, to purify and to enhance data before they are used”. The main goal of this process is to increase data quality .
Data Storage: refers to a process that aims to save data in a secure system for any future use and needs. Data storage system has evolved during the last years, and with the rising of the Big Data, it is becoming a challenge for the community . Storage systems are also related to the nature of data.Indeed, data are either structured or not and you can choose the relevant storage system.
Data Usage: This aim of this process is to provide data for all needs, specifically for user (customer), stakeholders, etc. This is the view side which is also called a Dashboard. It can be a web, mobile or desktop application.

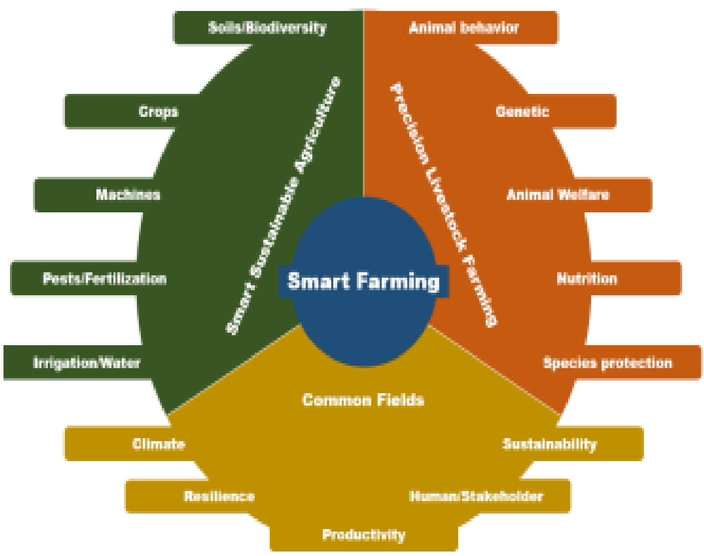

Fig.1.Smart farming general overview.

Apache Spark and data Bricks platform

The data used in the irrigation industry is divided and stored in the databricks file system (DBFS), a distributed and redundant parallel file system. Additionally, the support vector machine classifier uses machine learning to assess the present dataset. This section describes the planned research technique and describes the technical context of this effort, which is based mostly on the following technologies. A rapid engine for handling lots of data is Apache Spark. It is a unified framework and open-source tool for large data analytics. It makes it possible to use techniques like graph processing, machine learning, statistics, and structured query language (SQL) to acquire insightful information. Spark is renowned for its distributed parallel processing on affordable hardware25 . It allows rapid speeds due to in-memory caching and directed acyclic graph (DAG) processing engine. It comes to correct the constraints of Hadoop. For in-memory computations, Spark is in fact 100 times faster than MapReduce in Hadoop. Additionally, it may sort100 TB of data (1 trillion records) can be processed three times faster and with ten times fewer machines than Hadoop's MapReduce.26 Apache Spark established the big data processing platform called Databricks. It was developed as a MapReduce replacement for data scientists, engineers, and analysts and offers a just-in-time cloud-based platform for massive data processing. Automated cluster management was offered by the open-source distributed computing platform Databricks. Python, Scala, R, SQL, and other computer languages are supported, in addition to data science frameworks27 . In order to execute all forms of analytics workloads, it developed its own file format, the data bricks file system (DBFS), which is distributed and immediately mounted on the unified platform28 . Additionally, it enables the deployment of sophisticated big data analytics via its virtual analytics platform

Data Science And Machine Learning Models

The platform's databricks will house the used dataset. For uploading data from files and databases, the latter offers a straightforward and userfriendly interface. Once the data have been stored, we will build a cluster and a databricks notebook that is connected to it, as shown in Figure 1. The machine learning technology is used as the study methodology to analyze this data and then reply to the use case for irrigation. Additionally, it is suggested that the neural network and support vector machines be used to represent the state of the pumping motor utilizing the Spark engine. Depending on the temperature and moisture levels, ON or OFF. Before presenting the results, we outline the dataset utilized and go over how a data science model was used in this section. As shown in Figure 2, big data analytics can be performed utilizing machine learning techniques by doing the following: Finding relevant data that can be kept in databases and comma separated values (CSV) files is known as data intake. To gather data, we can make use of big data solutions like Apache Flume and Apache Sqoop. After that, combine it into one table. Data transformation involves cleaning and preparing the data. This process is for getting the data ready for analysis. Tools like Apache Spark, Hive, or Pig are available. Prepare a dataset from which we can learn by using training data. Training is the procedure of reviewing the practice data and

creating a model. Prepare a data collection for testing to see if our model is accurate. The dataset for the experiment with 200 recordsin it. The NN and SVM classifiers are trained using 80% of the records, and 20% are employed in testing. The handled data is divided up and kept in the databricks file system (DBFS).

Data Science Model: A rational and sequential series of actions to address a specific issue is a data science model. Once we have a well-structured table, we may model a number of algorithms based on analytical methods and then select the algorithm that produces the best results for deployment based on a survey.

Prediction: Employing SVM and neural network techniques applied to the current dataset, we can first determine whether the soil is dry or not by using a function that predicts target values of the test data supplied in a parameter. A text report with the classification metrics of accuracy, precision, recall (sensitivity), and f1-score should then be used to assess the prediction. To anticipate the status of the pumping motor based on moisture and temperature, we will use support vector machines and neural network approaches in the demonstration. The notebook we have already built will be used to apply the suggested models.

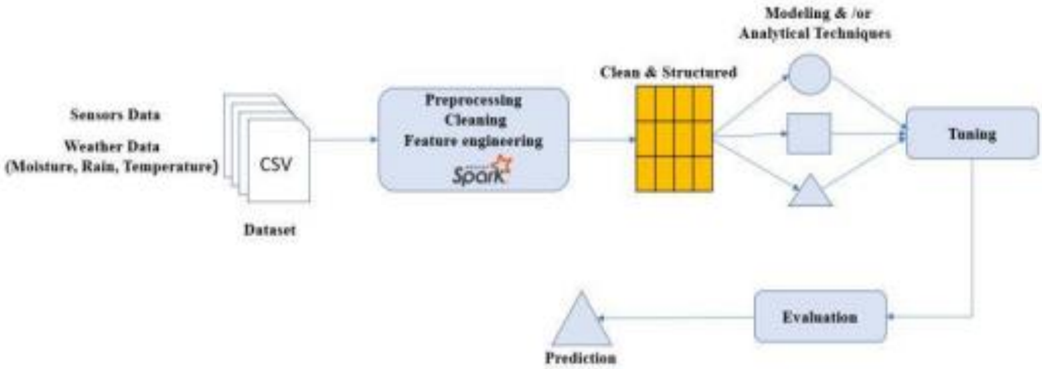

Fig.2. Data advanced processing using machine learning

Hybrid cloud service: A hybrid cloud is a computing environment that combines a public cloud and a private cloud by allowing data and applications to be shared between them. When computing and processing demand fluctuates, hybrid cloud computing gives businesses the ability to seamlessly scale their on-premises infrastructure up to the public cloud to handle any overflow—without giving third-party data centers access to the entirety of their data. Hybrid cloud computing is a "best of all possible worlds" platform, delivering all the benefits of cloud computing—flexibility, scalability, and cost efficiencies—with the lowest possible risk of data exposure.

Fig.3. Cloud in farming

Smart agriculture using IoT makes use of several sensors for monitoring the climate conditions of the surroundings. the task of the sensor is to collect the data across the field send it to the cloud. The cloud is loaded with some basic measurements which will then be compared with the sensed data.Soil and land characteristics through centralized decision support systems, high integration & sharing of agricultural information ,It can be eliminate the farmer's limitations of technical knowledge & resources ,Providing agricultural technology service & science, Improvement of the agricultural products marketing, Efficient use of agricultural resources, Promote the circulation of agricultural product and service in wider level. The objective of this paper is define land potential and explicitly and dynamically for unique and constantly changing soil and climate conditions. cloud applications helping the farmers to increase their agricultural yield. The work will also facilitate more rapid and complete integration and dissemination of local and scientific knowledge about sustainable land management. The impact of doing it would cut the cost, time and makes the process much faster and easier. Cloud computing can be used to aggregate data from tools like soil sensors, satellite images, and weather stations to help farmers make better decisions about managing their crops. ... In recent years, agricultural companies have been harnessing the power of the cloud to create solutions.

RESULT AND DISCUSSIONS:

Application of agricultural information cloud: ☐ Cloud computing in planting management by using cloud computing database, information management of specific processes of plant production becomes possible and this allows cloud computing management of relevant records and storing of data related to production performance shown by individual plant and plant groups, analyze and compute, make production plans, etc. This include automatic analysis of key problems occur in specific process of production, like analysis of potential management defects, measurement and analysis of productivity and property based on productivity curve. ☐
Cloud computing in estimation of productivity effect and management measures Cloud computing estimates productivity effect of plants with production function constructed by using computer simulation and

mathematic modeling. For example, scientists use random model and computer simulation technologies to estimate the benefit of various management strategies adopted in different growing processes of key plants. ☐
Cloud computing in tracing and control of farm produce security By using information technology of computer network, cloud computing is able to build a tracing system for regional farm produce, thus enhances security monitoring of farm produce "from farm to dining table" and realize certification of pollution-free farm produce and place of origin. ☐Cloud computing in monitor of plant growing Cloud computing is able to identify the growing of plants by using pattern identification technology and perform dynamic monitor of plant growing with help of other sensing equipments

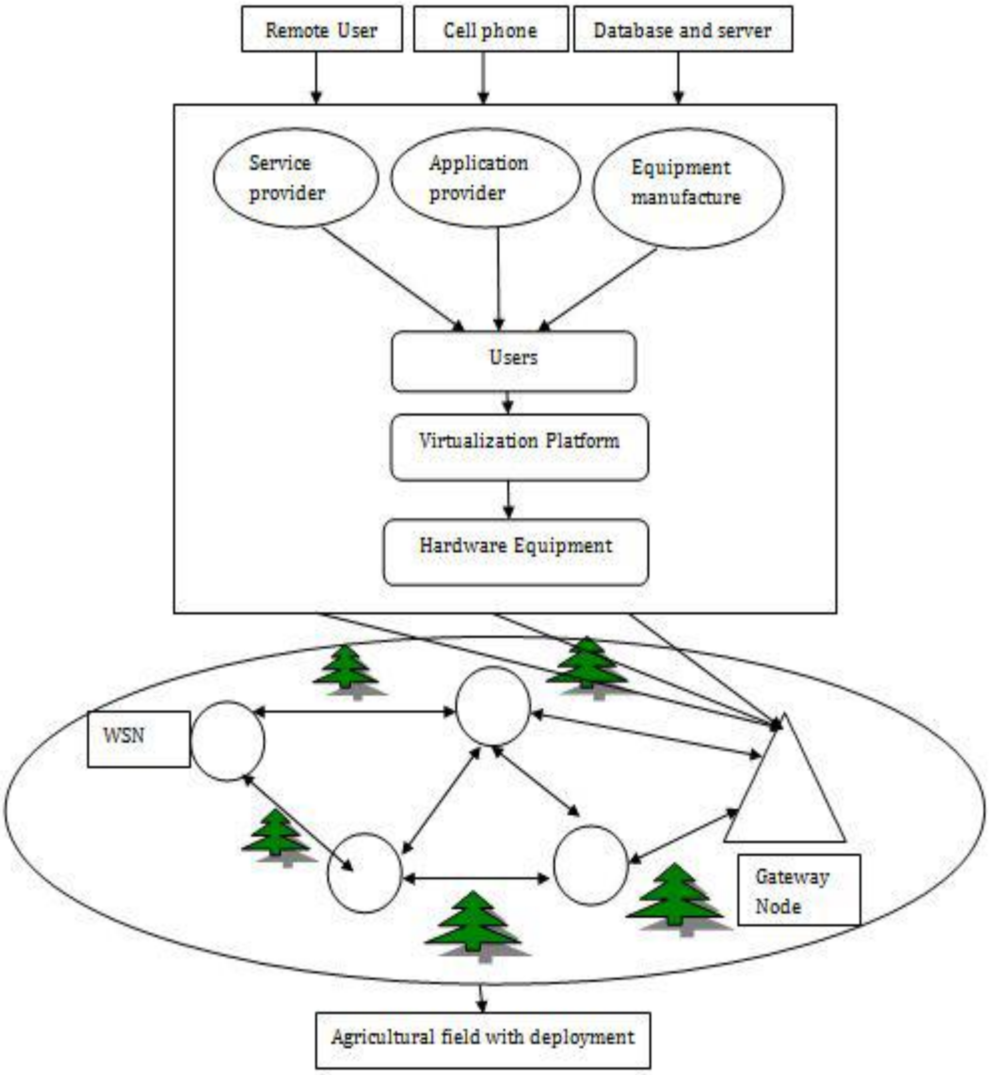

Fig.4. Virtualization in agriculture.

The nodes in the field sensor network transmit using Radio Frequency (RF), links of Industrial, Scientific and Medical (ISM) and radio bands. Then the gateway nodes provide both RF and GSM (global system for mobile communications). A remote user will monitor the agricultural field and power on the field sensor and actuator devices. For example, a user can switch on/off orpump/value the water level employed in the field to reach some threshold value. Users will move forward to a mobile phone to monitor and control the on-field sensors. It connects through GPRS and SMS (Short message service). Simultaneously information gets an update from the sensor and system to power both types of user. For saving time, resource optimization, reduce power system, installation of software quickly in the environment, and maintenance, utilization of the CPU increases from 15 to 80 % [16]

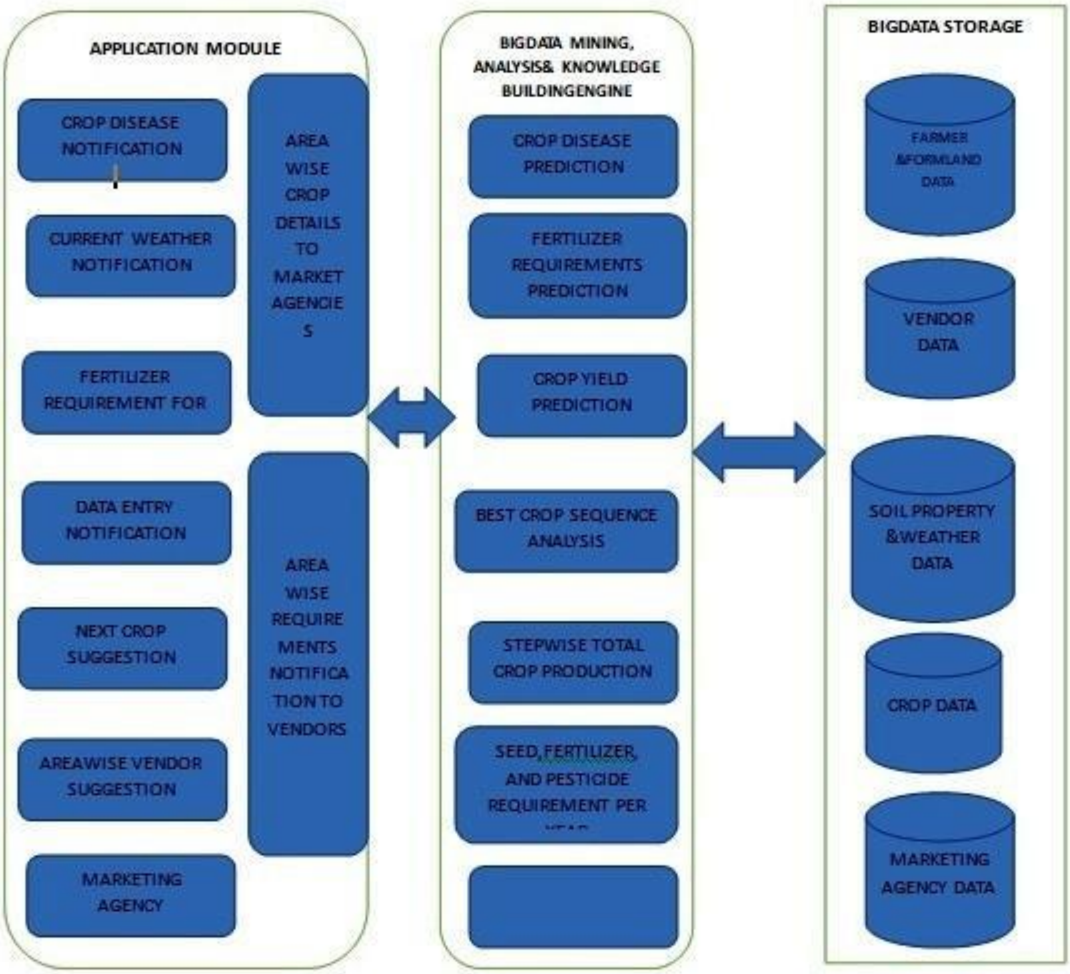

Fig. 5. Argo-Cloud Modules

The AgroCloud Component - All agricultural sector users must connect to AgroCloud via the MobileApp. AgroCloud storage, which includes Big-Data storage, will hold all landowner, agro advertisement, medication, and agro, vendor and service supplier details (fertilizer/pesticide/seed and agro machinery providers) specifics, as well as government programmes for the agricultural industry, such as bank loans for producers and concessions on seed and/or fertilisers. The module also saves data obtained on a regular basis through soil and environmental monitoring. As an increasing number of consumers connect to this assistance, the data amount expands significantly over time, leading up to Big-Data. The AgroCloud component, which includes Big-Data storage, Big-Data The mining industry, Evaluation, and Intellectual Construction Engine.

CONCLUSION AND FUTURE WORK

The topic of "smart agriculture" is expanding quickly and has the potential to completely change how we produce food. Farmers can maximise their resource utilisation, increase crop yields, and lessen waste and environmental effects by utilising cutting-edge technologies like sensors, IoT devices, and data analytics. Smart agriculture has several advantages, including enhanced food security for the world's expanding population, increased productivity and profitability for farmers, and less environmental impact. Future developments in smart agriculture technologies are anticipated to include the creation of more sophisticated sensor and data analytics algorithms, the application of artificial intelligence and machine learning to automate decision-making processes, and the integration of block chain technology to improve supply chain transparency and traceability. Additionally, there is a great deal of potential for smart agriculture to assist in addressing some of the major problems that the global food system is now confronting, including food security, population increase, and climate change. Farming operations can be managed more effectively, more food can be produced with less resource, and our food systems are more resilient to changing conditions because of the power of technology and data. Future developments in smart agriculture will concentrate on creating more integrated and all-encompassing systems that can handle the complex issues that farmers and the food system as a whole are experiencing. Collaboration between experts in a variety of fields, including agriculture, engineering, data science, and policy, will be necessary for this, as well as a dedication to innovation and ongoing development.

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