International Journal of Computer Sciences and Engineering Open Access
Review Paper Vol.8, Issue.3, Mar 2020 E-ISSN: 2347-2693

The Role of Emerging IT Technologies in Agriculture

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DOI: https://doi.org/10.26438/ijcse/v8i3.4957 | Available online at: www.ijcseonline.org

Received: 05/Mar/2020, Accepted: 11/Mar/2020, Published: 30/Mar/2020

***Abstract*—** Agriculture sector in India is moving back day by day which affects the production capacity of ecosystem. Agriculture has usually been treated as an instinctive space with insight passed down from one generation to another. But today's problems like the climate change, reduction of feasible farmland, reduction of water resources, and the loss of productivity due to the occurrence of extreme weather events are more complex and vital in the present nature. The United Nations estimates that the global population will reach 9.8 billion by 2050 that is a 2.2 billion increase from now [1]. This means that there is a need to improve our crop production significantly to supply to the rising number of people. One of the important things that are associated with present agriculture is the capability to forecast the events that will produce a desired outcome. Farmers need proper information throughout the entire farming cycle to achieve the goals. The required information is sprinkled in various places which includes actual information such as market prices and current production level along with the existing primary crop knowledge. The world around agriculture requires automation by replacing manual procedures with the expansion of technology, because it is energy efficient and takes minimal man power. Some farmers simply cannot increase their land to cultivate more crops, in that situation there is a need for technology to make better use of the available space in an efficient manner. This situation leads for technological innovation, to face the challenges like extreme weather conditions, rising climate change, and farming's environmental impact. To meet these increasing needs, agriculture has to revolve to new technology. Now a day's there is rapid enhancement in technologies, different tools and techniques are available in agriculture sector. To improve efficiency, productivity, global market and to reduce human intervention, time and cost there is a need to divert towards new technologies named IoT, Big Data and AI – The Three Digital Pillars of every Industry. This paper emphasizes on the analysis of the agriculture data and finding optimal parameters to maximize the crop production using technologies, examines the challenges, applications and opportunities of these technologies and concludes that these technologies will lead to relevant analysis at every stage of the agricultural value chain that leads to smart agriculture.

Keywords— Internet of Things, Big Data, AI, Smart Farming.

I. INTRODUCTION

Now a day's Agriculture is the backbone of the Indian economy, but the industry currently needs more support and innovative ideas to increase the production rate. India is a country of over a billion people in population, out of which, over 70% of the population lives in the rural areas, with 40% of the people lives in agriculture as a major business. In India, usually the farmers, along with their family members; cultivate crops in their small area of land. The crop yield in this way is mainly the economical source to the farmer and his family with very little profits left for sale in the outside market. But the Agriculture in India faces demands as the population in India is increasing at a high rate. This agricultural sector has to provide food and employments to large sections of society. To achieve this goal we need more and more lands for producing high quality food, but now a day's the major hurdle that we are facing is majority of agricultural lands are converted into non agricultural usage. Further, the yield mainly depends upon monsoon, which is unreliable, uncertain and irregular.

In the world, the essential arena is always occupied by the agricultural industry. This situation is irrespective of time and lifestyle changes. In the past the existence of agricultural industry was very decisive, but now the situation is differing where new developments in the industry have been made with the help of technology. Areas like productivity, cost and labour have been highly improved and supported with the help of new technology. Agriculture is the broadest economic sector and plays a vital role in the overall socio economic foundation of India. Agriculture is a unique business crop production which is reliant on many climate and economy factors. Some of the factors on which agriculture is dependent are soil, climate, cultivation, irrigation, fertilizers, temperature, rainfall, harvesting, pesticide weeds Historical crop yield information and other factors. Based on the yield production estimates and different climatic changes fertilizer, agrochemical and agricultural machinery industries plan their production and marketing activities.

Efficiency is the main factor that everyone has to concentrate for the future of modern agriculture. A broad range of technologies will enable the conversion of modern agriculture in the field. Even though some technologies are already in use for agricultural sector, some other new

technologies like Internet of Things, artificial intelligence and machine learning are adopted to the smart agricultural domains. If modern agriculture is applied widely in the near future, millions of farmers will be able to benefit from the attainment of real-time farm information. Farmers can easily get information about their yield production, disaster warnings and weather information without spending much time. Due to advancement in technology modern agricultural activities includes sensors, devices, machines, and information technology.

Today's agriculture consistently uses sophisticated technologies such as robots, drones, temperature and moisture sensors, aerial images, and GPS technology. These advanced devices utilization in the agricultural businesses provides the results that are to be more profitable, efficient, safer, and more environmentally friendly. In the backdrop of these challenges, experts are advising farmers to adopt newer technologies in order to get good benefits and yield from their crops. So far a few farmers are applying these techniques and their efforts appear to be bearing fruits. This article is a guide of knowledge that can help the researchers and agriculture engineers implementing the new technologies to achieve the required smart agriculture.

The remaining part of this document is categorised as follows. Section II provides overview of major technologies like IoT, Big Data and AI in agriculture and what we can achieve by utilizing these technologies. Section III gives a deep insight concerning the role of IoT in advanced agriculture practices and its applications. Section IV highlights Big Data in the Indian Agriculture Industry. Section V covers application achievements and uses of AI in agriculture Section VI explains why there is a need for IOT, Big Data analytics and AI to be used together in agriculture to strive great outputs. Finally, Section VII concludes this article.

II. OVERVIEW OF TECHNOLOGIES

The Internet of Things (IoT), big data and machine learning are three of the most motivating new business technologies of the past 4 years. With these three classifications and systems, there are massive overlaps and they are somehow symbiotic with each other. The future of technology will actually be determined by these three elements in their own ways. Before we look into how this trio can benefit your business in the present and for the predictable future it is important to gain a basic understanding of what these three elements are.

IoT: The Internet of Things is an IT network of devices, ranging from the Smartphone to machinery and buildings, all the devices are connected making up The Internet of Things. Each device is fitted with sensors, which collect huge amounts of data each minute of the day [3].

Big Data: Big data is simply the information that these connected devices gather over time. It has become the sunshade term for the collection, analysis and storage of huge amounts of data. With the arrival of the internet and a society that naturally creates a significant amount of data, it has meant that organizations can collect data on almost anything in vast quantities. Big data is the act of collecting and storing this data [3].

AI: For data to be useful it must be analysed, which is exactly what AI is. The data that is collected by IOT can be analysed by AI using different algorithms with the help of machine learning. IOT with the help of AI and big data enable us to access data in real time. This real-time data has helped to improve key process within business, moving towards a elegant and more efficient society [3].

By using IOT the user can transfer the information from one place to another with the help of network devices and without human intervention. Hence, to gain high productivity, IoT works efficiently with agriculture to obtain smart farming. The Internet of Things (IoT) has continued to be a key development in the technical field, with many businesses looking to utilize IoT within their key processes and daily tasks. For example, IoT is already one of the key sources for real-time data for AI applications, and enables the decision of AI to be carried out. AI technology is also at the centre of prognostic analytics and maintenance for IoT. Machine learning is the technology to create algorithms themselves to find a particular pattern and then act upon it and then it can be analysed and acted in the lead, creating a cycle of learning and acting to create accurate and efficient processes.

At present the IoT is small in comparison how big it will eventually become, big data is a fairly well entrenched new business principal and AI is in a similar position to the IoT. Devices connected to the Internet of Things will create large amounts of data and then this data will be converted into useful formats and handled by big data. Machine learning will then use this large amount of data to improve processes and increase self adequacy of systems. The outputs of these systems are connected to the IOT devices and restart the process.

Each one has its own unique qualities that will be put to use outside of this particular cycle, the IoT in closed systems, big data in almost anything and machine learning in the automation and management of large systems. However, in order to get accurate and potential results, there needs to be collaboration and large amounts of growth in each of the segments.

III. IOT AND ITS APPLICATIONS

The Internet of Things (IoT) has the potential to transform the ways of our daily lives. The applications of IoT can produce target conventional, large farming operations, organic farming and enhance highly transparent farming. IoT-based smart farming can provide advantages like more

efficient water usage, optimization of inputs and treatments [4]. The following FIG-1 represents IOT applications.

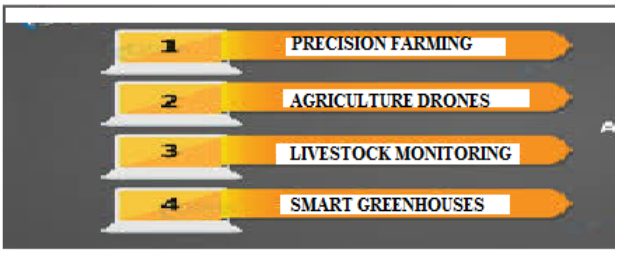

FIG-1. IOT APPLICATIONS

1. **Precision Farming**

Precision farming is a process that makes the farming procedure more accurate for increasing livestock and crop production. Precision agriculture educates formers about how to work better, not harder and how to improve production more efficiently**.** The key components in this technology are sensors, autonomous vehicles, automated hardware, control systems, robotics, etc.

Precision Farming in the recent years has become one of the most famous applications of IoT in agricultural sector and a vast number of organizations have started using this technique around the world. A key component of this farm management approach is the use of information technology and GPS guidance, control systems, sensors, robotics, drones, autonomous vehicles, variable rate technology, GPS-based soil sampling, automated hardware, telematics etc .

The services offered by IoT systems include VRI (Variable Rate Irrigation) optimization is a process that maximizes the profitability on irrigated crop fields with soil variability, thereby improving yields and increasing water use efficiency , soil moisture probes, and virtual optimizer PRO [4].

One example of a precision agriculture practice is to evaluate the natural soil variability of a field. If the soil in one area holds water better, crops can be planted more densely and irrigation can be sparing. Or, if the plot is used for grazing, more cattle can graze than a similar area of poorer quality soil.

By implementing the latest sensing and IoT technologies in agriculture practices, every aspect of traditional farming methods can be fundamentally changed. Smart farming through the use of IoT technologies will help farmers to reduce generated wastes and enhance productivity. So, smart farming is basically a hi-tech system of growing food that is clean and is sustainable for the masses. It is the induction as well as the application of modern ICT into agriculture [3].By studying these factors and using precision agriculture, farmers are able to produce more food at a fraction of the cost. Farmers also conserve soil for sustainable food production. Precision ag results in a stable food supply, which results in a strong community. The fallowing FIG:2 represents how smart farming is working using IOT.

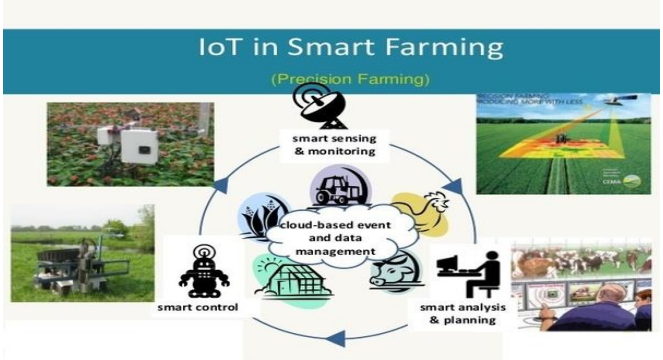

FIG-2 :IOT IN SMART FARMING [19]

2. **Agriculture Drones**

Agriculture industries today have become one of the major industries where drones can incorporate and it's a good example of IoT applications. Two types of drones, that is fixed wing drone and Multi-rotor drone (FIG-3) are being incorporated in agriculture in many ways such as, for crop health assessment, irrigation, planting, and soil & field analysis [4].

The benefits that the former can achieved from these drones include easy to use, time-saving, crop health imaging, integrated GIS mapping, and the ability to increase yields. Drone technology can make use of strategy and planning and based on real-time data collection and processing.

The farmers can enter the details of what they want to survey about fields through drones. Select an altitude or ground resolution related to data of the fields. From the data collected by the drone they can make a note of the various factors such as plant counting and yield prediction, plant health indices, plant height measurement, cover mapping, nitrogen content in wheat, drainage mapping, and so on. The drone collects data and images that are thermal, multispectral and visual during the flight and then lands at the same location it took off initially [4]

. Agricultural drones are a class of unmanned aerial vehicle (UAV). Agriculture monitoring is among the most mature use cases for drones. The use case's value proposition is rooted in the high labour cost of monitoring a wide, rural expanse of agricultural land using traditional ground-based vehicles.

The flight of agriculture drones may be controlled by an operator located in the surrounding area to fully self-directed flight coordinated by onboard computers. They are also useful in situations where issues related to bacteria fungus, or pests are difficult to manage and require regular monitoring. In addition to cropland, drones are also deployed to monitor aquaculture and forests, as well as poultry, cattle, and other livestock. Recently, the IoT has made remarkable progress in many industries, including

farming sectors but when we talk about agriculture, the communication facilities like base stations or Wi-Fi are very limited, which prevents the growth of the IoT in this sector. Such communication infrastructure and related facilities are even worst in developing countries and rural areas, which is one of the major hurdles. When introducing the IoT in the agriculture industry.

The data acquired through the wireless sensors cannot be transmitted in the absence of reliable communication infrastructure. In such a scenario, UAVs offer an alternative, as they visit and communicate with the wireless sensors spread over large areas in order to harvest data for further processing and analysis. UAVs, also known as drones, fitted with high-resolution cameras and clear-cut sensors, and covers thousands of hectares of farms. The role of surveillance in all agriculture applications is highly critical, especially in forestry and crop monitoring due to the need to cover large areas.

The quality of images taken through UAVs depends on the attached camera's resolution normally dozens of times better than satellite images and, most importantly, we can adjust according to application requirements. Due to the mentioned advantages, UAVs are considered the future of precision agriculture, and this is the reason they are generating the highest revenue amongst all agricultural robots developed for precision agriculture.

The results obtained from Agricultural drones are on-demand whenever and wherever needed, as the drone can be easily and quickly deployed. Most importantly, it is not all about their hardware but the convenience, quality, and utility they are offering, as the drone-enabled surveillance offers the real facility to have an idea of what is happening in the farm fields at that moment the UAVs, used for agricultural applications usually fall into two categories: fixed-wing and multi-rotor drones Although both are available in various ranges in terms of cost, payload capacity and mostly distinguished based on hardware differences. For example, when it is required to cover a large area, fixed-wing drones are suggested due to their long-range fight capacity. On the other hand, multi-rotor drones are more common due to their easy and faster set up as can take off and land vertically. Multi-rotors actually have many advantages over the fixed wings as they are easier to operate, require no advance wind planning and have the ability to fly more precisely. Moreover, in scenarios where low altitude flight is required in order to capture extremely detailed images, which is more common in agriculture applications then the multi-rotor are considered the better choice

Generally, drones collect information through the light over, either from soil or plants. For agricultural applications, specific cameras and sensors are used, depending on the grower's interest most commonly mentioned are thermal and hyper-spectral. Thermal sensors can help to recognize the water quantity, as leaves of plants with more water access appear cooler in an image

Hyper-spectral based sensors or cameras record the wavelengths of both visible and invisible lights, are able to identify the specific type of plant by measuring the colour of respected light. This respected light is used to distinguish various plant types, ultimately helping to detect the unwanted herbicide and weeds. Due to their nature and flexibility, UAVs are being used in a range of agricultural applications, including crop health monitoring, planting, plant counting, spraying, agriculture photography, and many other variable rate applications.

Considering the application of pesticide and UAV based irrigation where drone need to fly with heavy payloads then new procedures like tethering system can be helpful. In UAV tethering, a connection that provide power through the long cable, is provided so that it can fly as long as you have power backup on the ground, most importantly it doesn't require lifting heavy batteries. Currently, agriculture is being considered one of the most favourable fields where UAVs can offer solutions to resolve many dominant and long-lasting issues.

FIG-3a: Fixed Wing Drone **FIG-3b:**Multi-rotor Drone

3. **Livestock Monitoring**

IoT applications help farmers to collect data regarding the location, well-being, and health of their cattle. This information helps them in identifying the condition of their livestock. Such as, finding animals that are sick so, that they can separate from the herd, preventing the spread of the disease to the entire cattle. The feasibility of ranchers to locate their cattle with the help of IoT based sensors helps in bringing down labour costs by a substantial amount.

Out of the many solutions provided, one of the solutions is to help the cattle owners observe their cows that are pregnant and about to give birth. From them, a battery that is sensor powered is expelled when its water breaks. Information is then sent to the herd manager or the rancher. The sensor thus enables farmers will more focus [4].

Each year, farmers lose significant amounts of profit due to animal illnesses. There are many ways that IoT-enabled livestock management solutions allow farmers to promote better livestock health. Connected sensors in livestock wearable allow farmers to monitor heart rate, blood pressure, respiratory rate, temperature, digestion, and other vitals. Data streamed to the cloud directly from wearable allows farmers to identify and address issues like illness and feeding problems before they significantly impact the herd’s health.

By using IoT solutions the user has to monitor livestock reproductive cycles to promote safer and more successful outcomes. IoT sensors can be used to track an animal's location, which can be helpful in locating sick animals as well as establishing and optimizing grazing patterns [5]. The following FIG-4 shows the livestock monitoring demo.

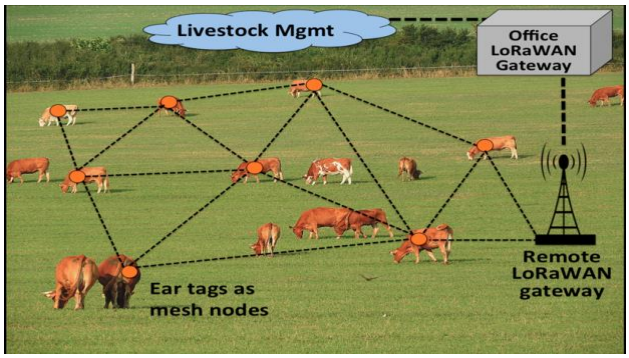

FIG-4: LIVE STOCK MONITORING DEMO [21]

4. **Smart Greenhouses**

Greenhouse farming is a technique that increases the yield of crops, vegetables, fruits etc. Environmental parameters can be controlled by Greenhouses in two ways, manual intervention or a proportional control mechanism. However, since manual intervention has disadvantages such as production loss, energy loss, and labour cost, these methods are less effective. For the benefit of eliminating human intervention we may use smart greenhouse through IoT embedded systems they not only monitors intelligently but also controls the climate. [4].

For controlling the environment in a smart greenhouse there are different sensors that measure the environmental parameters according to the plant requirement. Then, a cloud server creates for remotely accessing the system when it connects using IoT. Within the greenhouse, the cloud server processes the data and applies a control action**.** This design provides optimal and cost-effective solutions to the farmers with minimal and almost no manual intervention [4].

Greenhouse structure protects the plants from several weather conditions like wind, hailstorm, ultraviolet radiations, and insect and pest attacks. Due to equipped with modern sensor and communication technologies, smart greenhouses automatically capture and deliver information in a regular basis on the surroundings and crop. Collected data is fed into an IoT platform where analytical algorithms turn it into actionable intelligence to uncover bottlenecks and abnormalities. The following FIG-5 shows the working of green houses using IOT.

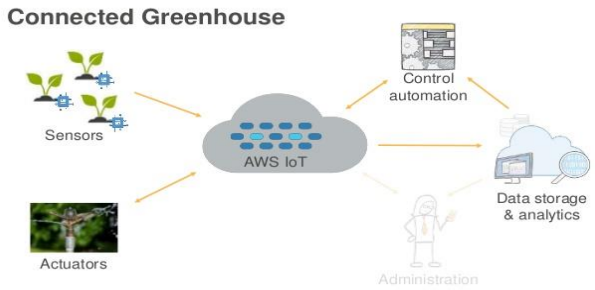

FIG-5: SMART GREEN HOUSE (Amazon web services and Intel smart green house demo [20])

IV. BIG DATA IN THE INDIAN AGRICULTURE INDUSTRY

Big Data in Agriculture – Saving the lives of farmers

Big data is expected to bring a enormous impact on farming in the coming years. In this article, we will be looking at some of the ways that agricultural businesses are using data to execute their operations. In agriculture, big data is often viewed as a combination of technology and analytics that can collect and compile original data and process it in a more useful and timely way to support decision making.

Big data provides formers to receive their crop information in an analytical way. In order to collect the data about the They can use smart phones to collect the growth of their crops or satellites, drones, and robots throughout the season. Then Analytical software can then estimate the yield potential according to the weather conditions, historical data, and information captured by farmers. And next farmers can create automatic calculations about their crop reports by using a big data-powered system. According to these resulted yield reports, farmers can take proper decisions and actions for the sake of improvement in the quality management of their crops and increase yield production. According to agriculture funders, the big data can able to capture the relevant data from different verity of sources and translating it into constructive information to improve business processes and solve problems at high extent and speed. Following are the few applications. Following FIG- 6 denotes few applications

FIG-6: BIG DATA APPLICATIONS

1. Big Data For Weather Prediction

In general all agricultural productions are contingent on natural conditions such as climate change, soil condition, pests, and relevant weather. With the help of big data and monitoring technologies, farmers can able to monitor the impact of extreme weather conditions and other impacts on their crops. But the more voluble thing is that the ability to predict and adjust to these unexpected changes .The raised areas motorized by big data can reflect changes in weather conditions in real time so farmers can respond promptly [9]. For example, data collected by using sensors in soil and images collected by drones can give accurate information to the formers to achieve estimated growth rates [9]. In case of any deviations are any observed anomalies the smart systems can automatically detect this information and warn the farmer to take necessary actions in proper time. The process of Predicting yields in this way can permit a farmer to take out insight on what to plant as well as where and when to plant it. The use of sensors for collecting data and utilization of drones to capture the images can reduce the amount of manual work that is required to handle abnormal conditions and instruction manual educates the former on how to produce the best return from their crops [8].

2. Risk assessment

The main bottleneck that is more influenced by connected devices and algorithms is risk management or risk assessment. It's now possible for farmers to be influenced by more about big data with a view to observing the chances of events like crop failure, and even improve feed efficiency within the production of livestock [10]. In common big data for risk assessment is applied in benchmarking, sensor deployment, analytics and predictive modelling. Big data can utilize these approaches to make predictions in the right time and in the right way and that can help farmers mock-up and manage risks related to raising livestock and growing crops.

Block chain is another popular plot form in risk assessment for agriculture. In agricultural aspects, this approach comes close to converts the complex framework into faster and automated systems. Farmers want to make their economic models more durable, while insurers wish to be more assured as to the insured events. Big data can help both farmers and insurers. Smart insurance contracts deal with various risks, including natural phenomena, Insurers then calculate a premium based on the probability of a particular weather event and the impact it would have on livestock or crops at a specific point in time. Farmers get paid automatically when the number of occurrences exceeds a predefined threshold [9].

3. Food security

The measures that are offered by big data to the customers on food production can provide more confidence in food safety and security. In the concept of smart agriculture formers make use of devices like sensors, drones, and smart phones that captures data at specific locations. In smart agro businesses the data about humidity, temperature and chemicals will have more impact on health. In order to maintain better quality the former has to collect this information and based on this data they can take decision about how to get better production and transportation [9].

4. Optimizing farm equipment

We cannot underestimate the role of big data in aiding various aspects like optimized usage and make sure the long-term health of farm equipment. Some equipment manufacturers have already made a good start with their fitting of sensors around vehicles to collect the appropriate data. Farmers can reduce their equipment cost and utilization time by log into special portals and manage their fleet and maintenance of equipment in order to keep everything productive. Now more companies provide solutions to help areas of equipment management and supply chain optimization, so that one can expect a smoother delivery of crops to the market [8].

By deploying big data applications, Companies like John Deere have integrated sensors in their farming equipment that will help better manage their fleet. For large farms, this level of monitoring can be a useful to the former to know the details tractor availability, service due dates, and fuel refill alerts, so with this we expect optimize usage and also ensure the long-term health of farm equipment [10].

5. Supply chain tracking

Now a day's a overwhelming fact that the industry struggles is to bridge the gap between supply and demand. To tackle this, food delivery cycles from producer to the market need to be reduced. Big data can help accomplish supply chain efficiencies by tracking and optimizing delivery truck routes.

Precision agriculture is more about how crops are produced, while smart farming can cover all stages of the agricultural supply chain. There are many stakeholders in an agricultural supply chain, and big data has proven useful for all parties throughout all stages. Some reports stated that one third of food produced for human consumption is lost or wasted every year. During crop production at the production stage, automated systems handle data to show performance and reveal issues in critical equipment. Specifically if we deal with sensitive materials like seeds, plants, and food products, the main serious concern is on preventing spoilage. Big data helps farmers and suppliers optimize navy management to increase delivery reliability. On the other hand utilization of big data tracking solutions, like smart meters, and GPS-oriented analytics can produce routing information, cutting transportation costs and offering advanced mapping of the locations of animals and vehicles [9].

How big data can help agriculture [11]

Data collection is done through IOT devices, sensors plugged in tractors and trucks as well as in fields, soil, and plants aid in the collection of real-time data directly from the ground. Second, the large amount of data that is collected is integrated with the other data that is available

in cloud such as weather data and pricing models to determine patterns. Finally the collected patterns can be used to identify the situations like problems with soil quality, and operational inefficiencies. In order to solve these issues patterns are used to organize predictive algorithms that can recognize and solve the possible problems.

In agriculture, big data can be treated as a combination of technology and analytics that can collect and compile narrative data and executes it in a more well-organized way so that the former can take immediate and future decisions in a effective and efficient way to ensure profitability, efficiency, and sustainability.

Big data can collect huge amount of data from various sources and translated into more actionable information to improve business processes and solve problems at scale and speed and guide the former about how to utilize their inputs and what adaptations are required to take account of emerging weather events or diseases

Data chain: It is nothing but a flow of activities starting from data capture to Data marketing. Data chain consists of all activities that are needed to manage data for farm management. The following FIG-7 illustrates the main steps in this chain [12].

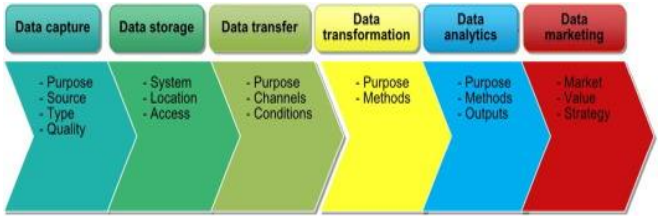

FIG-7: STEPS IN DATA CHAIN [12]

V AI IN AGRICULTURE

Artificial Intelligence (AI) is used in many different industries, One of the most interesting industries that AI is prominently applied is agriculture, Agriculture is a major industry and a vast part of the foundation of our economy, with respect to the changes in the climate & increase in the population, AI is becoming a technological innovation that is improving & protecting crop production.[14]

AI in agriculture improves formers efficiency in improving the yield production, and reduces the impacts of aggressive environmental changes. The agriculture industry strongly incorporates AI into their practice to change the overall production results, control and manage any uninvited natural condition. [13]

Today, most of the start ups in agriculture are adapting AI-enabled approach to increase the efficiency of agricultural production and with these approaches detect diseases or climate changes in prior and take necessary actions as soon as possible in order to reduce the impacts on the yields so that they can get better results.

In general agricultural activities like planting, maintaining, and harvesting crops need money, energy, labour and resources. At this time if we can use AI technology, by replacing some of the human activities definitely we can improve the efficiency in the results. Practically a team of researchers uses various techniques like transfer learning which can be able to identify several crop diseases and pest damages, with this they can able to recognize the disease with more accuracy, Abundant Robotics of an apple picking robot, AI and machine learning for plants, image recognition used in potatoes, AgVoice natural language toolkit for field notes [15].

APPLICATIONS OF AI [13]: The following FIG-8 represents the applications of AI

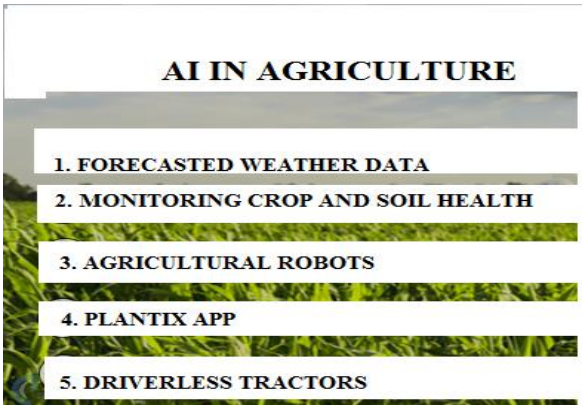

FIG-8: APPLICATIONS OF AI

1. Forecasted Weather data [13]

AI in an sophisticated way provides updated weather forecast data to the former The forecasted predicted data help farmers to take the precaution by understanding and learning concepts of AI as a result increase yields and profits without risking the crop and implementing such practice helps to make a smart decision on time [13].Based on the weather precautions the former has to decide the correct time to plantation, fertilize, spray, irrigation and harvest crops, with these timely decisions almost 30 percent of the weather related crop losses will be prevented. Weather forecasting doesn't just help grow crops but also with their immediate shipping. Many rural roads around the world are dirt, and knowing when these roads are dry enough to use is important for farmers [16].

2. Monitoring Crop and Soil Health [13]

AI in a more prominent way quickly identifies possible defects and nutrient deficiencies in the soil, through images captured by the camera.AI-enabled applications are supportive in understanding soil defects, plant pests, and diseases. To predict various environmental impacts on crop Machine learning models, deep learning algorithms to capture data that is captured by drones, and software technologies to monitor crop and soil health[17].

3. Agricultural robots [14]

AI-enabled agriculture robots help farmers to find more efficient ways to protect their crops from weeds and AI can harvest crops at a higher volume and faster rate than human and helping to overcome the labour challenge [13]. Agricultural Robots are used to handle essential agricultural tasks such as harvesting crops at a higher volume & faster pace than human labourers, Robots are designed to assist in picking & packing crops while combating other challenges within the agricultural labour force, Agricultural robots can protect crops from harmful weeds that may be resistant to herbicide chemicals that are meant to eliminate them[14].A robot called See & Spray reportedly leverages computer vision to monitor & precisely spray weeds on cotton plants, Precision spraying can help prevent herbicide resistance, Automation eliminates 80% of the volume of chemicals normally sprayed on crops and can reduce herbicide expenditures by 90%. Due to insufficient number of labourers millions of dollars of revenue losses in key farming regions at that time utilizing a robot can help farmers pick and pack their crops with greater efficiency. Utilization of agricultural robots can harvest8 acres in a single day by replacing more than 30 human labour work [14].

4. Plantix app a2

Plantix app uses images to detect plant diseases, and identifies potential defects, pest damages and nutrient deficiencies affecting crops, and offers corresponding treatment measures by providing formers with soil restoration techniques. The image recognition app can identify possible defects through images captured by the user's smart phone camera. The farmers can participate in the online discussion with a group of other farmers to discuss plant health issues and access their local weather reports. Analysis is conducted by software algorithms which correlate particular foliage patterns with certain soil defects, plant pests & diseases

5. Driverless tractors[14]

A driverless tractor is an autonomous farm vehicle that will be utilized for the purpose of tillage and other agricultural tasks that delivers a high potential effort at slow speeds. This vehicle can operate without the presence of a human inside the tractor so by utilizing these Self-driving tractors the formers gain the ability to optimize on-farm operations and offer a safer, less stressful working environment. Driverless tractors are programmed to observe their position, decide the speed and avoid obstacles such as animals, human beings or objects in the field performing their task. They operate with the aid of a supervisor monitoring the progress at a control station or with remote control from a distance [14].

Advantage of implementing AI in Agriculture [13]

Formers can apply Artificial intelligence in agriculture to understand the data insights such as temperature, precipitation, wind speed, and solar radiation, and they can compare this data analysis with the historic values, so as a result they can achieve desired results. Implementing AI does not mean that it eliminates the human intervention rather it will improve their processes with less time, less cost and more speed so that they can achieve their desired results.

AI is used in applications such as automated machine adjustments for weather forecasting, disease or pest identification, climate variation, an infestation of pests and weeds that reduces yields.AI has improved agro based businesses by implementing crop management practices in an efficient way. AI solutions have the capacity to solve the challenges that farmers face such as monitoring the information, rectifying the problems, recommending specific action that is required to overcome the problem and find solutions quickly.

VI THE CONVERGENCE OF THE TRIO

There has been an immense amount of news about these three technologies which must be considered, as the combination of IoT, big data and AI could mean great things for agricultural in the future. These three processes provide formers with the data that they need to make key decisions, working towards increasing the efficiency of crops. To fulfil the increased needs of food demand and climate changes, industry leaders are seeking assistance from technology forces such as IoT, big data, analytics, and AI. IoT technology refers to the Universe of devices with in-built sensors that provide data for further transmission in a much more convenient way. Internet of things has unique needs in different market segments, including agriculture, automotive, manufacturing, power or healthcare. There are five basic steps in IoT Measuring, sending, storing, analysis, acting. The most important step here is acting, which tells the need of IOT in improving the crop production. Whenever data is to high and not in a structured manner there is need to analyse the data because if we understand any problem or situation in a clear way then there is a chance to take better decisions so at this time we seek the help from Big Data.

Big data can able to analyse the data in three different perspectives like Adaptive Analytics, Predictive Analytics and Prescriptive Analytics. To improve the speed and accuracy this Data Analysis is combined with the quantitative methodology of AI, one noticeable fact is that the potential of Big Data can only be realized when it is coupled with AI. To extract meaning full data big data may use AI. Big data is a significant knowledge provider for AI.

The ability to make real-time decisions regarding climate changes, soil monitoring, pest's identification we must capture streaming data and add value to attributes and this is achieved when you apply AI and Big Data Analytics together. Definitely there is a need for big data analytics and AI to be used together in agricultural industry to drive more profitable results or outcomes. After collecting the data from various in-built sensor devices, it is put under

Artificial Intelligence and machine learning, for the computer to identify what the collected data represents ,what patterns and algorithms it follow, without human intervention it analyses s much more reliably and take timely actions to produce good results[18]. Use of these technologies named AI, IOT, Big Data, drones, robots in agricultural industry provides simulations that can be use full to extract environmental impact before practical implementation in the society.

VII. CONCLUSIONS

In today's fast growing needs technology is a major burning concept in any industry, and we are still struggling to integrate technologies with human effort. In everyday life gigabytes of data have been developed by humans and businesses but to extract useful information we need to deal with the operational challenges and implement a digital strategy. The trio of IoT, Big Data and AI brings high revolution in the agriculture industry. IoT in combination with data analytics, agribusinesses retrieve accurate predictions for crops and market conditions, so that the former can achieve favourable outcomes and helps to gain smart farming. Among other positive impacts, this trio will contribute to increased yields and profits, increased adaptation to a changing climate, increased sustainability of agricultural systems, and increased sustainability outside of the field, reducing nutrient transport and contributing to global sustainability. Therefore, the paper suggests a thought of contributing the most recent innovations into the agriculture field by introducing new techniques and some degree of mechanization for observing the field and product conditions up to some extents by utilizing cloud administrations. Contributing new practices in the real world will reduce the time and cost and that gives better environmental outcomes. This paper considered all these aspects and highlighted the role of various technologies, based on all this, it can be concluded that every creep of farmland is essential to maximize crop production. However, to deal with every inch of farmland in a most prominent way, the uses of sustainable emergent technologies are not optional it is necessary.

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