Smart Agriculture through Artificial Intelligence

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**ABSTRACT**

 ***“The future is not something we enter, But the something we revolutionary create"*** Agriculture in India is livelihood for a majority of the population and the profession of 70% population can never be undervalued. Though the contribution of other sectors increased at a faster rate compare to agriculture in our ‘Gross Domestic Product’, India is one of the prime countries which is self sufficient rather exporter of food and allied products in mass quantity. In-spite of this prosperous scenario; Indian Council for Agricultural Research (ICAR) has estimated that, demand for food grain would increase to 345 million tones by 2030. Increasing population, increasing average income and globalization effects in India, will increase demand for quantity, quality and nutritious food and variety of food. Therefore, pressure on decreasing available cultivable land to produce more quantity, variety and quality of food will keep on increasing. Technology is transforming nearly every aspect of our modern lives and farming is no exception. The produce on your table tonight will have gotten there faster, fresher and more cost-effectively, thanks to recent leading-edge technology in agriculture. Venture capitalists invested bulk of billion in computerized agriculture technology startups now-a-days. That trend is expected to continue in coming years too, because the demand for innovative farm technology is high, and when inventors show results, modern farmers have demonstrated a willingness to embrace those inventions and new techniques. Artificial Intelligence (AI) is based on the principle that human intelligence can be defined in a way that a machine can easily mimic it and execute tasks, from the simplest to those that are even more complex. The goals of artificial intelligence include learning, reasoning, perception and precise execution too. Artificial Intelligence in agriculture not only helping farmers to automate their farming but also shifts to precise cultivation for higher crop yield and better quality while using fewer resources. AI solutions have the potential to solve the challenges facing by farmers such as climate variation, production of quality food, an infestation of pests and weeds that reduces yields. AI is being used in applications such as automated machine adjustments for weather forecasting, compatible cropping pattern and disease or pest identification.

***KeyWords – Future Agriculture, Artificial Intelligence***

**INTRODUCTION**

Artificial Intelligence (AI) is mutely but increasingly entering Indian agriculture and modifying our aboriginal farming culture at large. AI is an area of computer science that emphasizes the creation of substantial or indefinable systems which not only behave intelligently but also display behavior to the same level as human beings think and act and might be in outlook better than them, achieving human-like performance in all cognitive tasks using purely logical reasoning. Thus while the ‘artificial’ in AI can be understood as ‘non-biological’, the ‘intelligence’ can be taken as ‘ability to accomplish complex goals or tasks’ which has potential to furnish biological means. Even NITI Aayog also recently released a dialogue paper wherein it envisions AI solutions for emerging sectors including agriculture.

**Areas of Potentiality for AI in IA (Indian Agriculture) –**

 Agriculture will for sure immensely benefit from AI applications. AI can be used to create intelligent systems which are embedded in machines that can work with higher accuracy and speed than humans and at the same time be responsive like humans. AI together with Internet of Things (IoT) and Sensor Technology can be the great enabler of precision agriculture. AI can also play a critical role along with remote sensing technology in wide scale implementation of Climate Smart Agriculture.

 Some of the potential areas are - Automated Data Analytics, Robotics, Machine Learning (ML), Natural Language Processing (NLP), Automated Knowledge Representation, Expertise in Encoding & Decoding, Genetic Algorithms, Reasoning, Expert Systems in Database, Computer Vision, Speech Recognition, Virtual Reality, Predicting Consumer Behavior, Augmented Reality, Remote Sensing technology, Color Marking Sensatory, Internet of Things (IoT), Cloud Computing, Statistical Computing, Deep Learning etc. are some major sub-areas of AI having huge potential in solving complex problems of current agriculture.

 AI-driven technologies are emerging to help in improving the efficiency with respect to crop and soil monitoring, weather forecasting, predictive agricultural analytics, demand and supply chain efficiency. The cloud computing infrastructures with the use of data ecosystems, Internet of Things (IoT) and AI enables the development of digital agriculture and strengthen the farmers in practicing smart irrigation, smart farming, smart fertilizer application, and disease/ pest diagnosis/ detection, smart spraying and harvesting. Machine learning and soft computing methods with pattern recognition through image and video (drone cameras, satellite imagery) data processing are being widely used world-wide in monitoring and managing various farm operations and predicting the incidence of disease/ pests, weather forecasts, time of application and optimum dose of chemical sprays, time of harvest, life of produce etc.

 Using artificial intelligence we can develop smart farming practices to minimize loss of farmers and provide them with high yield. Using artificial intelligence platforms, one can gather large amount of data from government and public websites or real time monitoring of various data is also possible by using IoT (Internet of Things) and then can be analyzed with accuracy to enable the farmers for addressing all the uncertain issues faced by farmers in the agriculture sector. AI technology is rapidly remedying the problems while recommending specific action that is required to overcome the problem. AI is a smart monitor system to find solutions quickly. AI promises to drive an agricultural revolution at a time when the world must produce more food using fewer resources. This chapter briefly discusses key applications of AI in agriculture along different stages of the cropping cycle that have the potential to pay dividends to farmers in efficiency gains and higher incomes.

**Given below are top five areas where the use of cognitive solutions can benefit agriculture –**

 **1.** Growth driven by IOT

 **2.** Image-based insight generation

 **3.** Identification of optimal mix for agronomic products

 **4.** Health monitoring of crops

 **5.** Automation techniques in irrigation and enabling farmers

 **6.** Drone Based Technology

**1. Growth driven by IOT -**

 Huge volumes of data get generated every day in both structured and unstructured format. These relate to data on historical weather pattern, soil reports, new research, rainfall, pest infestation, images from Drones and cameras and so on. Cognitive IOT solutions can sense all this data and provide strong insights to improve yield. Proximity Sensing and Remote Sensing are two technologies which are primarily used for intelligent data fusion. One use case of this high-resolution data is Soil Testing. While remote sensing requires sensors to be built into airborne or satellite systems, proximity sensing requires sensors in contact with soil or at a very close range. This helps in soil characterization based on the soil below the surface in a particular place. Hardware solutions like Rowbot (pertaining to corns) are already pairing data-collecting software with robotics to prepare the best fertilizer for growing f corns in addition to other activities to maximize output.

**2. Identification of optimal mix for agronomic products -**

 Based on multiple parameters like soil condition, weather forecast, type of seeds and infestation in a certain area and so on, cognitive solutions make recommendations to farmers on the best choice of crops and hybrid seeds. The recommendation can be further personalized based on the farm’s requirement, local conditions, and data about successful farming in the past. External factors like marketplace trends, prices or consumer needs may also be factored into enable farmers take a well-informed decision.

**3. Image-based insight generation -**

 Precision farming is one of the most discussed areas in farming today. Drone-based images can help in in-depth field analysis, crop monitoring, scanning of fields and so on. Computer vision technology, IOT and drone data can be combined to ensure rapid actions by farmers. Feeds from drone image data can generate alerts in real time to accelerate precision farming. Disease detection: Preprocessing of image ensure the leaf images are segmented into areas like background, non-diseased part and diseased part. The diseased part is then cropped and sends to remote labs for further diagnosis. It also helps in pest identification, nutrient deficiency recognition and more. Images of different crops under white/UV-A light are captured to determine how ripe the green fruits are. Farmers can create different levels of readiness based on the crop/fruit category and add them into separate stacks before sending them to the market. Using high-definition images from airborne systems (drone or copters), real-time estimates can be made during cultivation period by creating a field map and identifying areas where crops require water, fertilizer or pesticides. This helps in resource optimization to a huge extent.

**4. Health monitoring of crops -**

 Remote sensing techniques along with hyper spectral imaging and 3D laser scanning are essential to build crop metrics across thousands of acres. It has the potential to bring in a revolutionary change in terms of how farmlands are monitored by farmers both from time and effort perspective. This technology will also be used to monitor crops along their entire lifecycle including report generation in case of irregularity.

**5. Automation techniques in irrigation and enabling farmers –**

 In terms of human intensive processes in farming, irrigation is one such process. Machines trained on historical weather pattern, soil quality and kind of crops to be grown, can automate irrigation and increase overall yield. With close to 70% of the world’s fresh water being used in irrigation, automation can help farmers better manage their water problems.

**6. Drone Based Technology –**

 One of the most promising areas is agriculture, where drones have the potential to address major challenges. Drone technology is giving agriculture a high-tech makeover. Here are six ways drones will be used throughout the crop cycle:

* **Soil and field analysis**: By producing precise 3-D maps for early soil analysis, drones can play a role in planning seed planting and gathering data for managing irrigation and nitrogen levels.
* **Planting**: Startups have created drone-planting systems that decrease planting costs by 85 percent. These systems shoot pods with seeds and nutrients into the soil, providing all the nutrients necessary for growing crops.
* **Crop spraying**: Drones can scan the ground, spraying in real time for even coverage. The result: aerial spraying is five times faster with drones than traditional machinery.
* **Crop monitoring**: Inefficient crop monitoring is a huge obstacle. With drones, time-series animations can show the development of a crop and reveal production inefficiencies, enabling better management.
* **Irrigation**: Sensor drones can identify which parts of a field are dry or need improvement.
* **Health assessment**: By scanning a crop using both visible and near-infrared light, drone-carried devices can help track changes in plants and indicate their health and alert farmers to disease. UAVs may one day consist of autonomous swarms of drones, collecting data and performing tasks. The biggest obstacle to that becoming a reality is sensors capable of collecting high-quality data and number crunching software that can make that high-tech dream a reality.

**SOME EXAMPLES OF A.I. STARTUPS IN AGRICULTURE**

**1. Prospera -** Founded in 2014. This Israeli startup has revolutionized the way farming is done. It has developed a cloud-based solution that aggregates all existing data that farmers have like soil/water sensors, aerial images and so on. It then combines it with an in-field device that makes sense of it all. The Prospera device which can be used in green houses or in the field, is powered by a variety of sensors and technologies like computer vision. The inputs from these sensors are used to find a correlation between different data labels and make predictions of farming depends largely on adoption.

**2. Blue River technology -** Founded in 2011. This California-based startup combines artificial intelligence, computer vision and robotics to build next-generation agriculture equipment that reduces chemicals and saves costs. Computer vision identifies each individual plant, ML decides how to treat each individual plant and robotics enables the smart machines to take action.

**3. FarmBot -** Founded in 2011. This company has taken precision farming to a different level by enabling environment conscious people with precision farming technology to grow crops at their own place. The product, FarmBot comes at a price of $4000 and helps the owner to do end-to-end farming all by himself. Ranging from seed plantation to weed detection and soil testing to watering of plants, everything is taken care of by this physical bot using an open source software system.

**4.** **Harvest CROO Robotics – Crop Harvesting** - Harvest CROO Robotics has developed a robot to help strawberry farmers pick and pack their crops. Lack of laborers has reportedly led to millions of dollars of revenue losses in key farming regions such as California and Arizona. The robot picks up strawberries, helping farmers reduce the cost of harvest labor. Strawberries need to be picked in a certain time period and hence qualified pickers are needed. Harvests CROO Robotics believes that their invention will save money, increase yields, reduce energy usage and improve quality. Watch this short vision and learn more.

**FACE UP TO ARTIFICIAL INTELLIGENCE IN AGRICULTURE**

 Though Artificial Intelligence offers vast opportunities for application in agriculture, there is still exists a lack of familiarity with high tech machine learning solutions in farms across most parts of the world. Exposure of farming to external factors like weather conditions, soil conditions and presence of pests is quite a lot. So ‘What might look like a good solution while planning during the start of harvesting may not be an optimal one because of changes in external parameters?’ AI systems also need a lot of data to train machines and to make precise predictions. In case of vast agricultural land, though spatial data can be gathered easily, temporal data is hard to get. For example, most of the crop-specific data can be obtained only once in a year when the crops are growing. Since the data infrastructure takes time to mature, it requires a significant amount of time to build a robust machine learning model. This is one reason why AI sees a lot of use in agronomic products such as seeds, fertilizer, pesticides and so on rather than in-field precision solutions. While working on AI, Indian agriculture also casting the tools of precision farming and observing the problem of land fragmentation, it seems to be very challenging to reach the goals. The other crucial aspect is the extortionate cost of the various cognitive solutions for farming readily available in the market. The AI solutions have to become more viable to assure that this technology reaches the farming community. If the AI cognitive solutions are offered in an open source platform that would make the solutions more affordable, which eventually will result in faster adoption and greater insight among the farmers.

**WRAPPING UP**

 In order to explore the enormous scope of AI in agriculture, applications need to be more robust. Only then will it be able to handle frequent changes in external conditions, facilitate real-time decision making and make use of appropriate framework/platform for collecting contextual data in an efficient manner. AI technologies help farmers to analyze land/soil/health of crop etc and save time and allow farmers to grow right crop in each season that has best yield. Vertical cropping can reduce water usage, make efficient land usage, can be cultivated in urban areas in buildings. It can reduce the problems with labor unavailability. It Allow prediction of next year crop seasons / weather / climate / rainfall etc. AI based predictions enable suggesting appropriate pesticides / crops / place at right time before large scale incidence of disease. With a huge space still untouched in agriculture for the intrusion of automatic response systems, there is a vast opportunity for the agriculture industry to leverage emerging technology of catboats for assisting farmers with the answers to all their queries and giving relevant advice and recommendations to their specific farm related problems. This in turn propels the growth of the AI market in agriculture. AI can be appropriate and efficacious in agriculture sector as it optimizes the resource use and efficiency. It solves the scarcity of resources and labor to a large extent. Adoption of AI is quite useful in agriculture. Artificial intelligence can be technological revolution and boom in agriculture to feed the increasing human population of world.

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