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Emerging role of artificial intelligence in agriculture

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Agriculture is the mainstay occupation in many countries worldwide and with rising population, which as per UN projections will increase from 7.5 billion to 9.7 billion in 2050, there will be more pressure on land as there will be only an extra 4 per cent of land, which will come under cultivation by 2050. According to the same survey, the food production will have to increase by 60 per cent to feed an additional two billion people. This means that farmers will have to do more with less. India is already facing problems in agriculture. The only answer to this is the use of advance technologies which can redefine farming along with increase in income and profitability and reducing stress of farmers in agriculture. Artificial Intelligence in agriculture in India has immense potential and the agri-tech momentum is gaining pace in India which is not only redefining farming but also improving farmers' efficiencies and increasing their income. ICAR has also compiled more than 100 mobile apps developed by ICAR, State Agricultural Universities and Krishi Vigyan Kendras and uploaded on its website. These mobile apps provide advisory services and intelligent decisions based on the underlying database.

Predictive analysis: Farmers are unable to predict weather patterns or crop yields accurately, making difficult for them to take financial or operational decisions. The only answer to predict in advance is the use of artificial intelligence which has immense potential in agriculture. Using this technology, the app is able to predict more accurately and advise local farmers on when they should plant their seeds based on weather models and data on local crop yield and rainfall. The apps are available which send SMS messages to farmers in their native languages. The time of sowing is very important for good crop, therefore, timely information about correct sowing time results in profitable year. Predictive analytical tool is available which not only give precise date for sowing but also weather forecast, soil health, fertilizers recommendations and over all sowing methodology to enhance productivity and reduce costs.

Developing sustainable agriculture: Sustainable agriculture can be defined in many ways, but ultimately it seeks to sustain farmers, resources and communities by promoting farming practices and methods that are profitable, environmentally sound and good for communities. A sustainable agriculture must be economically viable, socially responsible and ecologically sound. The economic, social and ecological are interrelated, and all are essential to sustainability. Sustainable agriculture fits into and complements modern agriculture. Its benefits are environment preservation, economic profitability, most efficient use of non-renewable resources, protection of public health and social and economic equity. India as an IT country has potential to take advantage of it to develop sustainable agriculture sector. Geo-referencing methods that employ the use of unmanned aerial vehicles and drones are being used in crop management and pest control. The farmers are now been able to remotely monitor and manage crops through mobile phone connected to GPRS.

Soil health monitoring: Soil health is most important to get good yield, which comprised of an adequate level of moisture and nutrient along with favourable weather conditions. For restoring soil health corrective measures can be taken using distributed soil monitoring performed via image recognition and deep learning models. Based on inputs like historical data about monsoons, local snapshots of the farm, crop-output information and history of soil health AI models can be created. These models provide vital information about the farmland, assisting farmers in planning activities related to soil restoration,

crop growth, farm watering, etc. Soil health cards are being issued once in two years by the Government to provide correct information to farmers on nutrient status of their soil along with recommendations on application of appropriate dosage of nutrients for improving soil fertility and crop productivity.

Pest and weed management: AI can be used for predicting in advance the risk of pest attack and can benefit farmers in preventive action, guidance on the probability of pest attacks and reducing crop loss. Remote satellites are available which can monitor crop health and also warn against pest attacks in advance. AI sensors can detect and target weeds and then decide which herbicide to apply within the region. These intelligent AI sprayers can improve the quality of agricultural produce and bring in cost efficiency and also reduce drastically the number of chemicals used in the fields. See and spray weed controlling technology is available that can reduce expenditure on weedicides by 90 per cent.

Water management: Efficient water management in agriculture can have a huge impact on the looming problem of water scarcity. Irrigation systems need to be well planned along with building of rainwater harvesting systems to store rainwater and use them in drought prevailing conditions. Thermal imaging cameras which continuously monitor water availability to crops can be used for optimization of water usage in agricultural land.

Price realization of farmers: Farmers in India are facing problem to sell their produce due to minimal resources and lack of information about market. Thereby they are forced to sell the produce to middlemen who always exploit the farming community as a whole and smallholder farmers in particular. In India only 6 per cent farmers are availing the benefits of Minimum Support price (MSP) from the government. In order to provide better price realization to farmers a price discovery model using AI can be one of the alternatives in presenting more accurate demand-supply information and predicting demand for agricultural produce to farmers. Government has launched e-National Agriculture Market initiative to provide farmers an electronic online trading platform. Hence, they can get good price of their produce at the right price and right time.

Improving overall harvest quality: AI technology helping in improving overall quality of crops through detection of diseases, insect pests, soil nutrient deficiency, weeds detection etc. AI sensors are being used to detect and target weeds and then decide application of correct herbicide which helps in reduced usage of herbicides and cost savings. Now robots are available with computer vision and artificial intelligence which monitor and precisely spray on weeds. Use of robots resulting in drastically reduction of number of chemicals used in the fields, volume of chemicals, expenditure on spraying and thus, improve the quality of agricultural produce.

Farm harvesting: The best thing that AI can do in agriculture is to avoid drudgery from many agricultural operations. A mobile application 'Farm Machinery package for Different Agro-Climatic Zones in India' is available which gives information on farm machinery package available for state-wise, agro-climatic zone wise, district-wise, cropping pattern wise and power source wise. Robotic machines are being usedin bulk harvesting with more accuracy and speed along with improving the size of the yield and reduce waste from crops being left in the field.

Precision agriculture: According to United Nation, India's population will reach to 1.5 billion by 2030 which will be a threat of land crunch to our country. Therefore, the alternative to counter such malady is to adopt precision agriculture as fast as we can to enhance crop yield of our country.

Precision Agriculture Technology is the process of utilizing technology for producing high-end equipment used on farms to enhance traditional practice of farming. Precision Agriculture Technology aims at optimum production, efficient management, cost-effective methods and overall sustainability. Precision farming will go a long way in helping farmers by providing data-driven guidance for water management, optimizing harvest and planting times and scheduling crop rotation. This reduces the pressure on farmers, cuts down costs and improves crop yield. Hence, farmers should adopt revolutionary strategies for increasing production in the most cost and time-efficient way.

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. The IOT app, a new sensation in the agricultural landscape is able to show the collected data from the satellites to the farmers on their phones. This automated work processes will empower farmers to make informed decisions in a much lesser time and take more preventive steps to improve the crop production cycle.

Feeds from drone image data can generate alerts in real time to accelerate precision farming. Today's farming is labour oriented and repetitive in nature which should be

replaced as early as possible by precision farming which provides guidance about crop rotation, optimum planting and harvesting time, water management, nutrient management, pest attacks and so on. There are several examples of precision farming management such as high-resolution images and multiple sensor data on plants and machine learning models trained on plant images can be used for identification of stress levels in a plant.

In India agriculture is slowly changing due to use of artificial intelligence, robotics, machine learning and deep learning. Drones the aerial vehicles with latest sensors and technology are being used to achieve higher yields. Drones are definitely a crucial invention and a long-term solution, however, it demands close co-operation amongst governments, technology giants and the agriculture sector. How precision agriculture can be useful in agriculture:

Soil data collection: Manual efforts are not enough to collect precise data and samples on soil, manual inputs are always prone to human error. Artificial intelligence has been successful to overcome this problem by using AI-based soil sensors, valves and flow meters to collect static and dynamic data on the soil and then analyzing it to regulate the flow of water to the crops on the farmlands. The entire functioning is facilitated efficiently by this agriculture technology. Proximity sensing and remote sensing are two technologies which are primarily been used for intelligent data fusion. 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.

Crop growth monitoring: For monitoring of crop health farmers need to take pre-emptive and preventive approach by using multispectral imaging technology. The another technologies like remote sensing along with hyper spectral imaging and 3rd laser scanning to build crop metrics across thousands of acres will also be used for crop monitoring entire lifecycle. This will help farmers not only saving time but also from efforts point of view. Drones are very useful in maintaining the health of the crops by producing colour-coded images that help in nutrient deficiency recognition and pest identification.

Weather prediction: Artificial intelligence and machine learning are very effective in weather forecasting and climatic disaster prediction. Therefore, these technologies in precision farming can help farmers to save their crops from any future damage. Based on these accurate forecasts farmers can take right decision to grow which crop in which season thereby resulting inbetter harvest.

Sowing: AI is helping farmers sowing seeds with fast speed and in an accurate manner. This technology uses 'firing drone' and is more useful for farmers having fields at hills slopes which otherwise are difficult to reach. The drone shoots germinated seed pods at high speed from six feet above the ground so it penetrates the soil along with the necessary plant nutrients.

Monitoring of the farms: Drones can be used to monitor farms of any size as these are equipped with standard video and still cameras. Drones are also equipped with thermal imaging cameras which indicate hot and cold areas which can be used to detect plant disease and to monitor irrigation needs. Now resource optimization is possible by using high-definition images from airborne systems (drone or copters) which create a field map and identify areas during cultivation where crops require water, fertilizer or pesticides.

Weed control: Weed control is essential as they consume the nutrients from soil intended for crops, thereby reducing quality and yield. For controlling weeds farmers spray herbicides to the entire area of farming which is time consuming and results in wastage of herbicides. In addition to it excessive chemicals may damage crops and make them unsafe for consumption. Now weed detection is possible across farm through the use of drones equipped with weed pressure analysis tools. Weed pressure analysis tool is created by the analysis of the HD drone data which depicts the percentage of weeds spread across the farm. All this happens in real-time within a couple of seconds. Previously weed detection and control was herculean task which involved not only labour but also precious time for farmers.

Summary : Agriculture has been the mainstay of India since time immemorial. With the ever changing weather and climate conditions, agricultural revolution in terms of crop cultivation, farming and animal breeding has also taken shape. Precision farming or precision agriculture offers an opportunity to perform the right thing, in the right way, in the right place and at the right time. Precision farming is meant to match agricultural practices as per agro-climatic conditions and crops to increase their respective applications accuracy. AI is going to play significant role with the growing introduction of complex algorithms, robotics, sensors, and satellites in precision agriculture to solve challenges like climate change and global warming and improving crop yields. We should be seeing more robots deployed in the fields to help speed up the process of harvesting. In the upcoming future, maximum number of farmers will come forward to accept

and apply these technologies in order to improve their food security and per capita income. In order to handle technological advances all farmers including large or small, need to be properly trained. No doubt AI shows great promise in helping us deal with the challenges of the future; however, it will need continuous feeding of new information and increasing the amount of information in the backend databases used for performing tasks with almost accuracy. The future of AI in agriculture is more important for a country like India for livelihood and profitability of farming community.

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